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Fertility and Virtual Reality

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I. Introduction

The genesis of this Article was an invitation to attend a conference on children and virtual worlds and deliver a brief keynote address. Keynotes are supposed to take the conference participants beyond current thinking, and therefore enjoy some latitude in terms of subject matter and method. While most of the symposium presentations explore how law and regulation of virtual worlds affects children, this Keynote address considers this question somewhat in reverse. Given freedom to roam, one issue comes to mind that often eludes everyone's perception when talking about children and their well-being: the basic question of existence and how children, or the lack thereof, will fundamentally change the law and regulation of virtual reality.

It is common for policy discussions to focus on making current children flourish, without considering how many children there are.[1] This seems odd

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1. *See, e.g.*, NANCY K. CAUTHEN & SARAH FASS, TEN IMPORTANT QUESTIONS ABOUT CHILD POVERTY AND FAMILY ECONOMIC HARDSHIP 18 (National Center for Children in Poverty

given that coming into existence is surely also part of any reasonable definition of states like *flourishing* and *well-being* and *happiness*. How can we make a child happy if we do not let her be? The perspective of mere existence, invoked in the context of virtual worlds, raises difficult questions.[2] Virtual worlds may discourage the creation of children. Is this likely? How large an impact? What should be done, if anything? These questions are the subject of this exploratory Article.

If you have been around a little while, you come to realize that the formation of new humans occurs generally through sexual congress between a human male and a human female. A physical element produced by the male must transit physically from his body and enter into the body of the female, where it conjoins with some part of the female's body and thereby initiates a sort of auto-perpetuating bio-chemical process. For months the process is entirely contained within the body of the female human. If you have witnessed the process underway, in yourself or in others, you know that internal and external signs soon make the presence of the process undeniable. Unless disturbed through direct action, the process continues on its path and soon results in a serious medical condition for the female, during which the biomass generated by the process erupts from the female's body, sometimes in a most frightful and damaging way. There is blood and pain. Nonetheless the expelled biomass is reported to resemble (though imperfectly) a human being in miniature. Interestingly, the new human has acquired the sexual physiology of one but not both of the two entities whose fleshly contributions caused it to come into being. Still more interesting, the rate of reception of one or the other sexual physiology, male or female, is equal—fifty percent for each. Observed over long periods, the new human eventually grows to resemble ever more closely the humans whose conjoined physical bodies initiated its being. Grown, the human then at times conjoins with others, of the other sexuality, to repeat the process. It is truly something interesting to observe.

This sequence of events, which come together under the label "human fertility," is a less common event than it used to be among some populations of

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2009), *available at* http://www.nccp.org/publications/pdf/text_829.pdf (discussing "what children need to develop into healthy, productive adults"); Brigid Shulte, *Year Round School? My Kids Love It. Yours Will, Too,* WASH. POST, June 7, 2009, at B1 (indicating that year long school can help children succeed and President Barack Obama is interested in proposals to extend the school day and year).

2. *See, e.g.*, F. Gregory Lastowka & Dan Hunter, *Virtual Worlds: A Primer, in* THE STATE OF PLAY: LAW, GAMES AND VIRTUAL WORLDS 13, 16–17 (Jack M. Balkin & Beth Simone Noveck eds., 2006) (discussing the overlap between real and virtual worlds, in terms of economics, social interactions, and legal systems).

humans.[3] Sexual congress leading to babies—fertility—is just one element of a large set of interactions that humans refer to as "sex." Fertility can happen without sex, but it takes a lot of work. Sex can happen without fertility, however, and that takes no work at all.

Why are sex and fertility distinct? Sexual motivations evolved before media, communications, and medicine. On the savannah a person with a sex urge could only satisfy it in a limited number of ways, and having sex with another person of opposite gender was primary among them. Not all sex was fertile, but a lot of it was. Certainly, enough sex was fertile enough that basic, unmediated sex urges were sufficient to produce more humans of diverse genetic makeup.

Note however what an unmediated sex urge is: It is the desire for sexual gratification.[4] It is not a desire to have babies. And that is why the advent of medicine, media, and communications technology has allowed sex to become increasingly separated from fertility. The urge to seek sexual gratification can be satisfied in any number of ways, only one of which—sexual congress with a person of opposite gender leading to the deposit of a special material in a special place—involves fertility.[5] Thus people pursue sex for its own sake, and fertility for its own sake.[6] Fertility and sex are separate conscious choices.

This Article explores fertility issues raised by the most advanced forms of mediated communications technology, especially virtual reality (VR).[7] After a

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3. *See, e.g.*, Matthias Doepke, *Accounting for Fertility Decline During the Transition to Growth*, 9 J. ECON. GROWTH 347, 347 (2004) (tracing patterns of fertility decline in developed and developing countries).

4. *See* MATT RIDLEY, THE RED QUEEN: SEX AND THE EVOLUTION OF HUMAN NATURE 14–17 (1994) (discussing the purpose of sex from the perspective of an "adaptationist"). The urge to have sex is an evolved motivation. It follows that we pursue sex for its own sake. It may appear that sex was designed to help us have babies, but that is a false conclusion. Sex urges were not designed; they emerged. They emerged only because they caused our ancestors to do things that led to more procreation. Thus, the sex urge requires no explanation in terms of a purpose—it is not connected in any way to cognitive awareness of any "use" or "meaning" or "purpose" of being sexual. We simply are sexual.

5. *See, e.g.*, Briony Eckstein & Andrew Hinde, How Helpful are Coale's Preconditions for Fertility Decline in Explaining the British Experience?, 9–10 (Oct. 2–4, 2002) (unpublished paper from Session 4C at the 2002 Australian Ass'n Population 11th Biennial Conference), *available at* http://www.apa.org.au/upload/2002-4C_Eckstein.pdf (using demand for contraception as evidence that human sexual desires are largely separate from desires to procreate).

6. Fertility of course carries its own utility. *See generally* Gary S. Becker, *An Economic Analysis of Fertility*, *in* DEMOGRAPHIC AND ECONOMIC CHANGE IN DEVELOPED COUNTRIES 209 (Nat'l Bureau Econ. Res. ed., 1960) (analyzing "family size decisions within an economic framework" where "children [are] . . . considered a consumption good").

7. It is worth noting some terminology. Virtual reality attempts to emulate reality by making the user feel as though what she is experiencing is "real." This is the common "goggles

conceptual discussion, we use a toy[8]—a simple evolutionary simulation of virtual reality and fertility—to explore certain assumptions about how VR affects long run population. The purpose of the toy is not to persuade the reader that one and only one outcome is possible, but rather to serve as scholarly output itself. Readers interested in the conceptual discussion of the Article could go play with the toy and make their own conclusions. Even better, they could modify the toy's workings and disassemble its core assumptions. It is hoped that using this toy will advance thinking about what is, after all, a very complex system of technological and biological coevolution.

Part II discusses the general meaning of VR and how it has been incorporated into modern life. Part III explores how human fertility has been affected by technology and how evolving technology, specifically increasingly realistic VR sex simulations, will continue to affect human fertility patterns in cultures that adopt the technology. Part IV discusses these developments in relation to broader trends in fertility related to nontechnological, cultural phenomena. Part V considers the sustainability of VR in a world with a shrinking population. Part VI introduces the reader to the author's toy—a computer-based model that can predict changing population trends as a result of humans' engagement with VR. After explaining how the toy functions, Part VII presents the results of ten scenarios mapped by the toy. The Article considers the long-term outcomes of these results in terms of total population and the percentage of the population adopting VR technology. Part VIII reviews the conceptual discussion of VR and human fertility and concludes that as humans co-evolve with developing VR technology, certain cultures will replace physical reproductive sex with cyber equivalents to such a degree that populations decline and these segments are eventually extinguished. This exploratory Article does not seek to answer the many questions relating to VR, or the ways in which law may attempt to control the spread of these technologies. Instead, it attempts to provoke the reader to consider the

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and gloves" reality in science fiction. Many virtualization technologies—like virtual worlds—do not engage in virtual reality; they instead rely on more socially useful and less bandwidth-intensive graphics such as two-dimensional or cartoon-like three-dimensional representations. *See, e.g.*, *Second Life* Frequently Asked Questions, http://secondlife.com/whatis/faq.php#01 (last visited Sept. 29, 2009) (indicating that *Second Life* is a three-dimensional world that requires users to download a *Second Life* viewer to participate) (on file with the Washington and Lee Law Review); *Second Life* System Requirements, http://secondlife.com/support/sysreqs.php (last visited Sept. 29, 2009) (providing the system requirements to participate in *Second Life*) (on file with the Washington and Lee Law Review).

8. For access to the toy, please visit http://law.wlu.edu/deptimages/LawReview/VRandFertility2.0.xls (on file with the Washington and Lee Law Review).

implications of a worldwide technology-based population decline, and how the law might be brought to bear on these new developments.

II. Virtual Reality

Advances in VR will play a special role in human fertility. VR makes erotic pursuits ever more satisfying. The person who first raised public awareness of VR, Howard Rheingold, was immediately aware of its implications for sex.[9] VR makes visual and auditory sensations better, in the sense of both realism and fantasy. It makes fantasy elements better fantasy and the faked real elements less fake. VR improves tactile sensations as well: Controllers vibrate and move in synch with visual and auditory sensations.[10] Equally important, the Other in virtual reality can become better.[11] Whether friend or foil, the Other in VR uses both scripting and artificial intelligence to be a fine Other. VR can increase aspects of human likeness to the extent that our fantasies desire humanity; it can improve aspects of in- or super-humanity as we desire encounters with villains or saviors. The cultural depth and geographic size of virtual environments grows without bounds. Among all of these virtual entities we now find many genuine humans, as avatars, dressed up and structured into social constructs that best support each person's heroic and demonic impulses.[12]

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9. *See* HOWARD RHEINGOLD, VIRTUAL REALITY 345–77 (1991) (predicting the evolution of fully functional sex machines operating in virtual realities); *see also* JULIAN DIBBELL, MY TINY LIFE 11–33 (1998) (describing rape in cyberspace); Al Cooper et al., *Sexuality in Cyberspace: Update for the 21st Century*, 3 CYBERPSYCHOL. & BEHAV. 521, 521–22 (2000) (discussing the changing norms of internet sexuality and relationships on the Internet). Internet sex is apparently good enough to be addicting. *See* Mark Griffiths, *Sex on the Internet: Observations and Implications for Internet Sex Addiction*, 38 J. SEX RES. 333, 334 (2001) (exploring the popularity and addictive nature of online pornography and internet sex).

10. *See, e.g.*, Real Touch, www.realtouch.com (last visited Sept. 29, 2009) (specializing in teledildonic devices and advertising) (on file with the Washington and Lee Law Review). Diagrams of the device can be found at http://gadgets.boingboing.net/2009/01/12/real-touch-interacti.html. Links are not safe for work.

11. *See, e.g.*, DAVID LEVY, LOVE AND SEX WITH ROBOTS 289–93 (2007) (contending that technology will increase the potential for sexual gratification); Real Touch Blog: Frequently Asked Questions, http://blog.realtouch.com/faq/ (last visited Sept. 29, 2009) (stating that "[t]his is one-of-a-kind technology designed to make sure that you get the most authentic sexual experience possible, however you like it") (on file with Washington and Lee Law Review).

12. *See* Jamie F. Metzl, *Life: Coming to a Screen Near You*, 25 WORLD POL'Y J., Fall 2008, at 247, 247 (indicating that avatars often "represent an alternative fantasy life projected by their creators").

There does not appear to be any end to this development. David Levy frankly discusses the mechanics of having direct, physical sex with robots driven by erotic artificial intelligence (EAI).[13] Some readers might be put off by this, but when one considers what people do to satisfy their sexual urges, can it be ruled out? When you add VR's deeply immersive imagery, sound, and setting, it seems likely that humans will avidly pursue all kinds of desires that technology provides. While it will never be exactly like the real thing, realism is not important. Satisfaction is the main issue. Let us ask ourselves: Will VR and EAI replicate all sensations that we now have? No. Will it provide sensations and experiences that we will desire more than those available now? Yes.

The content of the next few paragraphs is graphic. Specifics are necessary, however, so that the reader may grasp how real and present certain issues relating to human fertility have become.

It may surprise readers how far things have already developed in this area. There is a clear historical trend of improvement in sexual media.[14] Since the invention of art and writing it has been possible for one person to provide another erotic imagery from a distance.[15] Pornography is an old art form.[16] Within the last century, the direct transmission of the human voice has enabled "phone sex": people saying naughty things to others over the phone for their mutual or collective stimulation.[17] "Cybersex" emerged in the 1990s, whereby people would write erotic text messages to others in real time.[18] As internet communications have improved, graphics and voice have been added. In the virtual environment of *Second Life*, it is possible to build avatars that connect to "sex balls" which arrange the avatars in certain positions.[19] Narrated by voice

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13. *See* LEVY, *supra* note 11, at 289–93 (discussing the "sexual possibilities that have been created by the teledildonic age").

14. *See id.* at 220–68 (discussing developments in sexual technologies from the nineteenth century to the present day); *see also* Griffiths, *supra* note 9, at 333 (remarking that "[p]ornographers have always been the first to exploit new publishing technologies").

15. *See* EBERHARD KRONHAUSEN & PHYLLIS KRONHAUSEN, PORNOGRAPHY AND THE LAW 28–29 (1959) (commenting on the spread of erotic literature).

16. *See* Sarah Leonard, *Pornography and Obscenity*, *in* PALGRAVE ADVANCES IN THE MODERN HISTORY OF SEXUALITY 180, 182 (H.G. Cocks & Matt Houlbrook eds., 2006) (dating the development of the modern pornography concept to nineteenth century Europe).

17. *See* AMY FLOWERS, THE FANTASY FACTOR: AN INSIDER'S VIEW OF THE PHONE SEX INDUSTRY 3–4 (1998) (noting the increasing prevalence of phone sex lines in the 1980s and 1990s).

18. *See* Griffiths, *supra* note 9, at 335 ("[C]ybersex involves online users swapping text-based sexual fantasies with each other. These text-based interactions may be accompanied by masturbation.").

19. *See Having Sex*, WIRED, Oct. 2006, *available at* http://www.wired.com/wired/

or chat, a full scene can be both observed and created in a pageant of live-action puppet pornography.[20]

Things move rapidly. Consider the technology of remote erotic stimulation known as teledildonics (*tele* (Greek τηλε- "afar") + *dildo* (English, obscure origin, an artificial penis used for female gratification) + *ics* (Greek *-ós* "pertaining to"). A teledildonic device is connected to a computer via USB port and then used as its nontele counterpart.[21] Software allows signals originating from the computer to affect the settings of the device. The software also allows these signals to originate from a computer linked to this home computer via the Internet.[22] Similar devices for the human male have been developed recently.[23] This technology was only envisioned by Rheingold,[24] but it now exists.

Words, pictures, voice, action, and now direct stimulation: Many elements of the sexual encounter are already entirely virtualized and robotized.[25] Each of these forms of stimulation has their benefits and costs. Single-person observation of still pornography is lonely. It maximizes control, however. Moving-picture pornography tells a story, but again the story is not in the user's control. Pairs or groups meeting remotely generate more reality,

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archive/14.10/slentertainment.html (explaining the "sex culture" in *Second Life*).

20. *See* Bonnie Ruberg, *Getting Started with Sex in* Second Life, VILLAGE VOICE, June 19, 2007, http://www.villagevoice.com/2007-06-19/columns/getting-started-with-sex-in-second-life (last visited Sept. 29, 2009) (indicating that "[m]ore commonly, Second Life sex is a combination of the visual and the verbal") (on file with the Washington and Lee Law Review).

21. *See* RHEINGOLD, *supra* note 9, at 345 (discussing teledildonic systems).

22. *See id.* (averring that "[t]hrough a marriage of virtual reality technology and telecommunication networks, you will be able to reach out and touch someone").

23. *See id.* (discussing a patented machine "capable of converting sound into tactile sensation").

24. *See id.* (hypothesizing that "[t]hirty years from now, . . . most people will use [teledildonic systems] to have sexual experiences with other *people*").

25. The popular medical information site WebMD already includes an information guide on virtual sex. *See* Rob Baedeker, *Virtual Sex: Everything You've Been Afraid to Ask About Sex in Cyberspace*, WEBMD, http://men.webmd.com/guide/virtual-sex (last visited Sept. 29, 2009) (exploring the connections between virtual sex, teledildonics, and the real world) (on file with the Washington and Lee Law Review). A piece from the Club of Amsterdam Journal contains the following excerpt:

> In an on-stage interview with Moira Gunn about the book on October 11, 2005, Dr. Gunn reluctantly allowed the question "How will the singularity help me to get more sex?" and Kurzweil and Gunn then engaged an elaborate and playful yet serious half-hour discussion of why "version 3.0" of the coming virtual reality or augmented reality will provide really good sex while avoiding some of the risks of traditional sexual intercourse as experienced circa 2000.

Futurist Portrait: Ray Kurzweil, CLUB OF AMSTERDAM J. DIGITAL, Mar. 2008, http://www.clubofamsterdam.com/press.asp?contentid=741 (last visited Sept. 30, 2009) (on file with the Washington and Lee Law Review).

which may be exciting but also threatening. Voice feels more real, but text-based chat preserves anonymity, assists role-play fantasy, and encourages literary flings. Chat, however, typically requires two hands for typing. Teledildonic devices may free the hands but surrender some control over physical sensation to others. If others are the problem, EAI is on the way.[26] The task of finding the right lover may become easier to solve than ever.

III. Effects of Technology on Fertility

The path of technology is fairly clear. Consider a continuum of reality in sexual congress. At the right end is ordinary unprotected sex between a man and a woman. At the left end is a single person imagining sex in the mind and bringing him or herself to orgasm without looking at, hearing, or touching any person or representation of a person. In a world of zero technology, humans pursuing sexual gratification had to choose one end of this spectrum or the other: Either full indulgence of the individual's fantasy in a physically less satisfying experience, or full physical communion with another person with only limited indulgence of things the mind can conceive of.

Technology is enabling other choice points on this continuum, where orgasms can be achieved with different degrees of realism. The sweet spot for a given person is the place where there is as much reality as possible relative to the desire to preserve the mind's fantasies. In terms of direction, it appears that technology is primarily developed to push the envelope at the left end of the spectrum, to enable fantasy-based sex to become ever more real.[27]

Note, however, that of all the options on the continuum, one and only one results in more people: The right-hand anchor—complete and totally "real" sex, where two people physically come together.[28] In its closest vicinity are activities like mutual masturbation and watching pornography together. These activities do not initiate the bio-chemical process of human being creation. There is a caesura, a break point, a discontinuity, a cliff, a barrier: If a man and a woman have sex in any way that does not deposit the man's semen in the woman's vaginal channel, children will not result from that sex.[29] There are no

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26. *See* LEVY, *supra* note 11, at 290–91 (asserting that sex with robots will become the sexual outlet for certain segments of the populations such as the very shy).

27. *See id.* at 291–93 (using current developments in haptic technology and sexual robotics to hypothesize about future successes in creating realistically humanoid sexual robots).

28. The term "real" here intends no offense to forms of sexual intercourse that do not involve mixed genders. I intend "real" in the sense of "direct physical contact."

29. Of course, given that fertility and sexuality diverge significantly, there is a chance that technology will drive fertility without sexuality at all. *See, e.g.*, Katherine T. Pratt,

virtual sex technologies of which I am aware that enable, encourage, permit, allow, afford, spur, or avoid ruling out entirely the deposit of a man's semen in a woman's vaginal channel. The continuum of sexual reality and fantasy is occupied entirely by opportunities to experience orgasm without having children, with the thoroughly singular exception of the point on the far right end, the point at which a man and a woman conjoin their sexual organs physically until the man ejaculates there.

The technology seems to be emerging under a rule of *anything and everything but that*; it is providing all kinds of opportunities for orgasm, none of which will produce children. If we assume a normal distribution of sexual desires regarding fantasy and reality in the population,[30] it seems very, very unlikely that this distribution would be anchored and concentrated at the right end. Rather, the middle desire is probably for a good fantasy with enough reality to make it exciting. At the right tail of the distribution are those who want their sex completely natural—all fantasy in the mind while joining physically with another person. Thus the right tail is occupied by people who definitely want children or who do not like any virtuality at all in their sex. At the left tail of the distribution are people who do not want to directly interact with others in sexual matters, preferring to keep things as virtual as possible. But the middle, the great mass of people, is somewhere in between.

Though this is where the mass of people are most likely to be, no children are created there. Children are only created at the far right-hand anchor of the reality-virtuality/sex-desire continuum. The great mass of people is not at the right-hand anchor. They are somewhere to the left of it. No children are created anywhere to the left.

The effect of this change is akin to what would happen if there was an increase in opportunities to drink different kinds of beverages and only one provided a special benefit. Imagine a world in which there were only two kinds of drinks: Beer and Milk. People would look things over and choose one or the other. A good number of them would choose Milk because it is not alcoholic and most people do not want to be drunk all the time. Because of the amount of Milk being drunk, society would have few problems with osteoporosis—lots of calcium is going into the tummies. Now suppose,

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Inconceivable? Deducting the Costs of Fertility Treatment, 89 CORNELL L. REV. 1121, 1126–30 (2004) (describing the emotional impact of infertility and the nonsexual human motivations to seek fertility treatment).

30. The term "normal" understood in its technical sense, meaning a statistical distribution in which most data points are concentrated in the center, with approximately equal results falling on each side of the mean value. The normal distribution is commonly recognized by the bell curve that occurs when graphing these data points.

however, that there comes about a vast increase in the number of things to drink. In addition to Milk and Beer there is now Juice, Water (bottled, tap, sparkling), Wine, Tea, Coffee, and Soda, in addition to thousands of mixes of these beverages. Clearly while people would still drink Milk, fewer would do so because now if they want a nonalcoholic drink they can choose among many offerings. They are not forced into Milk as the only available alternative. Indeed if we understand people correctly, their choices will be scattered all over the range of drinks and Milk drinking will fall to a tiny fraction of what it was before. All of this is well and good—having more options is a good thing. But there is one negative consequence. Of all those drinks, only Milk provides calcium. Only Milk reduces osteoporosis. Osteoporosis rates will therefore rise as indirect effect of increasing diversity in beverage choices.

Drawing from the presumed normal distribution of the reality-virtuality/sex-desire continuum,[31] we may assume that the great mass of people desire some mix of reality and virtuality in their sex lives, rather than pure reality. The emergence of technologies that allow people to have whatever mix they wish implies that in the future the great mass of people will choose forms of sexual activity that will not produce children.[32] Rather, some tiny minority, those whose desires place them on the right-hand anchor of the reality-virtuality sex desire continuum, will still have babies just because they have been fooling around. But that will increasingly be viewed as strange. The "normal" way to have sex will not involve babies at all or any prospect of them. Instead, sex will have to change, to become nonnormal, in order to produce a baby. Couples will have to temporarily re-orient their sexual activity out of the virtual and into the increasingly uncomfortable real, just so that a child may come to be.

How many people will temporarily return to old fashioned fooling around, just to have a baby?[33] The desire to have a child is just another human desire. Cats and dogs and other pets seem to satisfy some element of

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31. *See supra* note 30 and accompanying text (discussing the probable distribution of sexual desires regarding fantasy and reality among the population).

32. *See* Levy, *supra* note 11, at 289 (citing a 2003 survey investigating what sex technology people most desire). Forty-one percent of respondents expressed desire for the technology to develop "android love slaves." *Id.* Twenty-four percent suggested mind-to-mind sexual interaction, and seventeen percent rated virtual-reality sex as their most desired technological development. *Id.*

33. I overlook technologies such as in vitro fertilization for the sake of space. They are an obvious alternative to old fashioned fooling around. The core of the argument is unaffected I think.

the desire to take care of a human child.[34] Some elements of this desire can be satisfied virtually. The concept of a virtual pet is by now ancient in digital years.[35] Online sites already exist where a person can create and then care for a virtual human baby.[36] As with any desire, impulse, or dream, a virtual representation offers some elements of satisfaction and cannot offer others.[37] Digital technology makes it possible to greatly enhance the pleasure obtained from experiences that can indeed be digitized.[38] Remember, realism is not the issue: Satisfaction is what drives choice, and realism is only one element of satisfaction. Can digital technology make a virtual baby that is exactly like a real human baby? No. Can it make a virtual baby that replicates some parts of the experience so well, and gets rid of other experiences—such as feeling baby vomit inside your shirt—that are not so great, such that the mix of enhanced experiences and censored experiences makes for a total experience that many people will prefer to the real thing? Sure it can. And will.

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34. *See* ALAN BECK & AARON KATCHER, BETWEEN PETS AND PEOPLE: THE IMPORTANCE OF ANIMAL COMPANIONSHIP 41–44 (1996) (equating the bond between people and pets to that of a parent and young child).

35. *See* Linda-Renée Bloch & Dafna Lemish, *Disposable Love: The Rise and Fall of a Virtual Pet*, 1 NEW MEDIA & SOC'Y 283, 284–85 (1999) (talking about the development of the first virtual pets in 1996).

36. *See* Cyber Infants, http://www.cyberinfants.com (last visited Sept. 29, 2009) (allowing users to adopt a virtual baby for free) (on file with the Washington and Lee Law Review); Mag's Nursery, http://maggiemarket.kizash.com/games/mags_nursery/ (last visited Sept. 29, 2009) (providing a game in which users take on the role of a caregiver in a nursery) (on file with the Washington and Lee Law Review); Babyluv, http://www.fenomen-games.com/baby-luv.htm (last visited Sept. 29, 2009) (providing a game in which users "[p]lay hide and seek, feed and take care of [a cartoon baby]") (on file with the Washington and Lee Law Review). There is an entire genre of "dollhouse games," among them the immensely popular Sims series. *See* The Sims Official Site, http://thesims.ea.com (last visited Sept. 29, 2009) (providing access to information on all games in the Sim series) (on file with the Washington and Lee Law Review). The urges these games satisfy are not combat or puzzle solving but simply raising a virtual family and making a nice house for it: Nesting. *See* Daniel Terdiman, *The Russian Nesting Doll of Games*, WIRED, Feb. 14, 2004, *available at* http://www.wired.com/gaming/gamingreviews/news/2004/02/62287 (stating that the object of the Sims is for "players [to] control the lives of virtual people . . . and determine their daily activities to keep them content").

37. *See* Albert Lin, *Virtual Consumption: A* Second Life *for Earth?*, 2008 BYU L. REV. 47, 49–51 (2008) (arguing that because virtual worlds satisfy preferences, video games may provide an alternative and less environmentally-unfriendly method of consumption).

38. *See, e.g.*, Metzel, *supra* note 12, at 248 (predicting that, through avatars, virtual book clubs "will form allowing readers from across the world to meet and discuss even the most obscure books as a group in front of a virtual fireplace").

IV. Broader Trends in Fertility

Population growth requires the creation of more new humans with each generation. Population decline, barrenness, is the opposite. Statistics indicate that the advent of technologies unrelated to virtual reality have already made numerous cultures barren. Birth rates are well below replacement levels in most of Europe.[39] On the other hand, comparatively fertile peoples from the Middle East, Africa, and Asia continue to migrate into Western Europe, offering the only hope for sustaining population there.[40]

Those who write about demographic change in Europe generally see these developments as driven by the contrast between Western and non-Western norms regarding proper family size and the role of women in society.[41] Some would be comfortable predicting that as peoples from elsewhere migrate into the West, they will inevitably adopt the same norms, and thus join the family of enlightened peoples. From the perspective of population growth, this time of enlightenment would also be marked by transition into a barrenness similar to that of native Western Europeans and their cultural offspring.

VR will affect fertility in the same way. Technologically more advanced societies will be the first to see fertility fall as a result of VR. Yet because they are advanced, and rich, these same societies will see a constant influx of migrants from cultures where VR is not as advanced. If VR appeals to all people regardless of race, creed, and culture—I assume it does, or can be made to, and *will* be made to simply through pursuit of profit—these immigrants will

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39. *See* Elisabeth Rosenthal, *European Union's Plunging Birthrates Spread Eastward*, N.Y. TIMES, Sept. 4, 2006, at A3 (indicating that "birthrates in European countries have reached a historic low"). The article states that 2.1 children per woman are needed to sustain population. Of twenty-seven European countries listed in statistics accompanying the article, none has a birth rate above 2.0. The closest country, at 1.9, is Ireland. The situation is similar in Japan. *See* Blaine Harden, *Japanese Women Shy From Dual Mommy Role*, WASH. POST, Aug. 28, 2008, at A8 (indicating that, in the CIA's 2008 ranking of global fertility rates, Japan is seventh from the bottom with a rate of 1.22 children per woman).

40. *See* Marat Kengerlinsky, *Immigration and Asylum Polices in the European Union and the European Convention on Human Rights: Questioning the Legality of Restrictions*, 12 GEO. PUB. POL'Y REV. 101, 104 (2007) (indicating that "[a]ll European states are . . . net immigration countries" and stating that immigrants come from the Middle East, Africa, and Asia). *But cf.* U.N. Dep't of Econ. and Soc. Affairs, Population Div., *Replacement Migration: Is It a Solution to Declining and Aging Populations?* 7 (2001) (assessing "the question of whether replacement migration is a solution to population decline and population ageing"). The answer seems to be: No, it will not be enough. *See id.* at 13 (indicating that "[e]ven massive immigration cannot be a remedy for population ageing, unless migrants leave the receiving countries before they reach retirement age").

41. *See, e.g.*, Rosenthal, *supra* note 39 (discussing the social factors contributing to the phenomenon of falling birthrates in Europe).

become fans of VR themselves. The technology will suck them in, as it were. Immigrants will be comparatively fertile until they work their way into society far enough to be able to afford a few devices and an internet connection. At that point, birth rates will begin to slip. If immigration rates exceed the rate at which VR depresses fertility, population in a technologically advanced society may still grow. However, if immigration is slower than VR's fertility effect, population will fall.

One might casually glance at the Earth at the turn of the twenty-first century and assert that there cannot possibly be a problem of population *decline* here. Populations grow madly within any number of vast, underdeveloped regions.[42] Yet even the casual observer may be reminded that virtual reality, like any other technology, is not a passive force. It will not just sit in the rich person's hands. Adoption by one person begets adoption by others. Human commerce spreads ideas, practices, and gear. A technology that is cheap and enjoyable to people in general will be widely adopted. In 2009, very many people around the globe drive cars, watch TV, and talk on cell phones.

Is VR a cheap technology in this sense? Yes. VR requires processing, memory, and network.[43] The costs of all these things are falling.[44] If they continue to fall at historical rates, which most observers seem to believe they will, the relative price of VR in terms of today's incomes will not merely fall, it will vanish.[45] And this is true of any day you might wish to choose. A good whose marginal cost of production is falling exponentially will eventually become free relative to any standard.[46] Computation, storage, and communication technologies appear to be on a path of ongoing exponential productivity increase.[47] The cost of sexual content is also falling as a result of

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42. *See* U.N. POPULATION FUND, STATE OF WORLD POPULATION 2008, at 90 (Alex Marshall ed., 2008), *available at* http://www.unfpa.org/swp/2008/presskit/docs/en-swop08-report.pdf (indicating that the total fertility rate in least developed countries is 4.60 compared to 1.60 in the more developed regions).

43. *See* George Lawton, *Making Virtual Reality More Accessible,* COMPUTER, June 2006, at 12, 12–14 (discussing the components and requirements of VR systems).

44. *See id.* at 12 (providing that the costs of VR components are decreasing).

45. *See, e.g., id.* at 12–13 (discussing the pricing trends of VR systems). The predictive estimate that while dollar costs for technology remain constant, the performance of computer chips doubles every eighteen months is colloquially known as Moore's Law. *See* Michael Fitzgerald, *Trying to Put New Zip Into Moore's Law*, N.Y. TIMES, Feb. 24, 2008, at BU4 ("If innovation has a heart, it's probably a semiconductor, beating to the pace of Moore's Law.").

46. *See* Chris Anderson, *Free! Why $0.00 Is the Future of Business*, WIRED, Feb. 25, 2008, *available at* http://www.wired.com/techbiz/it/magazine/16-03/ff_free ("And every year, like some sort of magic clockwork, [technology] does more and more for less and less, bringing the marginal costs of technology in the units that we individuals consume closer to zero.").

47. *See id.* (indicating that "[w]e're still just beginning to exploit atomic-scale effects in

the falling costs of content distribution.[48] A couple in Japan may enact and casually record a particularly fascinating scene and within seconds, billions of VR users around the globe will have access to that content.

We commonly think of the Earth as having a rich-and-barren half partnered with a poor-and-fertile half.[49] The poor-and-fertile half, we say, is poor and fertile because the people there have not adopted the ways of the rich-and-barren half. But VR changes this dynamic. It will depress fertility regardless of the role of women and children in society. Though it will have its first effects in the rich-and-already-barren half of the Earth, it will, by becoming cheap, be adopted by many people in the poor-and-fertile half too. Poor people do have less means, but much more reason, to seek refuge from reality.[50] Cheap, easily deployed VR technologies will storm the underdeveloped world. The dreams of Streets Paved With Gold that have drawn so many people to cross boundaries will be satisfied with small electronic devices instead. Sexual content will be part of the package. Fertility will go down everywhere. The immigrant streams that barren countries now rely on to sustain population will narrow to mere trickles.

V. Sustainability

Though the cost is falling, technologies do cost money. A falling population has less overall production, since labor is a primary input.[51] As

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revolutionary new materials—semiconductors (processing power), ferromagnetic compounds (storage), and fiber optics (bandwidth)").

48. *See, e.g.*, *Playboy Shedding DVDs in Favor of Online*, REUTERS, Oct. 15, 2008, *available at* http://www.reuters.com/article/internetNews/idUSTRE49EAEO20081015 (reporting Playboy's decision to cease DVD production and provide all content online, with an expected benefit of $10–12 million annually in distribution costs).

49. *See, e.g.*, Weldon E. Havins, *Reproductive Surrogacy at the Millennium: Proposed Model Legislation Regulating "Non-Traditional" Gestational Surrogacy Contracts*, 31 MCGEORGE L. REV. 673, 688 (2000) ("[T]he rather large payment used as consideration in a surrogacy contract gives rise to an unacceptable class distinction whereby rich, barren women benefit at the expense of poor, fertile women." (citing *In re* Baby M., 537 A.2d 1227, 1249 (N.J. 1988))).

50. *See* Michael Cieply & Brooks Barnes, *In Downturn, Americans Flock to the Movies*, N.Y. TIMES, Mar. 1, 2009, at A1 ("Americans, for the moment, just want to hide in a very dark place, said Martin Kaplan, the director of the Norman Lear Center for the study of entertainment and society at the University of Southern California. 'It's not rocket science,' he said. 'People want to forget their troubles, and they want to be with other people.'").

51. *See, e.g.*, Bruce A. Babcock, *Brains or Brawn: Which Economic Development Policy is Best for Iowa?*, 9 IOWA AGRIC. REV., Winter 2003, at 1, 2, *available at* http://www.card.iastate.edu/iowa_ag_review/winter_03/IAR.pdf ("From the perspective of a state's industry, a balance between young and old means an adequate supply of new workers

populations shrink, will virtual reality technology remain economically feasible? If everyone is in a pod, who pays for the pods? If one believes that the price of VR will eventually fall to zero, then sustainability is not a problem. It is more likely, however, that populations and VR prices will go down at the same time. What happens will depend on which goes down first.

If populations fall more rapidly than the cost of VR, then eventually VR technologies will be unsustainable. The population gets so small that it cannot support the maintenance of communication networks and the armies of digital artists and coders necessary to make ongoing streams of compelling virtual environments. Population falls until the VR industries collapse. At that point, many things could happen. Perhaps fertility returns to normal and population grows again. Perhaps at some point VR technologies are re-established and once again depress the population. Perhaps there is a sustainable long-run equilibrium at low population and just-sustainable VR technology.

If the cost of VR falls more rapidly than the population, then at any population size there is a compelling system of VR environments available. These environments continually call people into them and in so doing reduce their fertility. There is never a point at which VR technology collapses.

The question then becomes, how powerful is VR's siren song? If VR ends up being a "hunting" technology, it is one that actively propagates itself in all kinds of social media (from the TV to the water cooler), and actively broadcasts its existence to people who do not know of it directly.[52] Television is an

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will be entering the labor force to replace retiring workers. Clearly, a shrinking labor force threatens existing industries that rely on plentiful labor."); Tomoko A. Hosaka, *Japan's Industrial Production Falls Record Amount*, ASSOC. PRESS, Feb. 27, 2009, *available at* http://abcnews.go.com/Business/wireStory?id=6970382 ("The world's second-largest economy, which is more dependent than ever on exports to drive growth to offset a shrinking population, is sinking into what officials are calling the worst recession since World War II."); *see also* Bhooma Krishnan, *Japan's Shrinking Population and Its Economic Implications*, CHILLIBREEZE, *available at* http://www.chillibreeze.com/articles/Japans-population.asp (discussing the phenomenon of Japan's falling birth rate). Bhooma's explanation on the effect of a shrinking population and workforce is rather astute:

> The economy will not be able to get enough skilled work force for its manufacturing and services sectors. Labour would become costlier, increasing the cost of production. There will be more elders to tend, straining the medical and pension systems. The social sector expenditure by the Government will have to increase. By 2025, it is expected that there will be two dependents for every three workers. A drastic fall indeed from 1:12 in the year 1950. The dwindling work force would also result in lower purchasing power and reduced demand for goods and services. The domestic market will shrink, production will fall, as will the Government's revenue, forcing it to manage higher medical and pension expenses with a lower income.

Id.

52. *See* Edward Castronova, *Achievement Bias in the Evolution of Preferences*, 6 J. BIOECONOMICS 195, 199–202 (2004) (discussing the way that a norm may be systematically

example of a hunting technology in this sense: When people use a television, people who do not use television will become exposed to it accidentally. They will hear it about it on the radio; they will see something about it on the Internet; they will encounter people who use it and talk about it. Contrast this with elite dungeons in online games, which are in many ways a "hiding" technology: When people use a high-end dungeon in games like *World of Warcraft*, other people who do not use this technology are not likely to be exposed to it accidentally.[53] High-end raiders stay in their rooms. Relative to others, they have less social contact. Their activities are not broadcast anywhere. A person walking down the street, watching TV, or even stopping over at a neighbor's house is not likely to be exposed to the high-end dungeon. Rather, the entire community of elite raiders is sequestered away from ordinary society.

Is VR more likely to be like TV or like elite dungeons? If VR's future is more like dungeons, then we would expect that as people use VR more and more intensely, they will tend to become isolated and separated from other communities of people.[54] If their population falls to the point of extinction, no one else will know. It will simply be the case that Bob went off into VR and never married, and the genes that made Bob so interested in VR will die with him. If VR is a hiding technology, it can only have a limited effect on the overall human population.[55] It will depress population, but only to the extent that some people shift into a VR lifestyle and then die out. Others will remain largely unexposed to VR technologies because those technologies continually hold their most avid users on the margins of society.

If VR is more of a hunting technology, it could have an impact on the entire human population. Those who adopt VR-driven lifestyles will not have babies, but they will not be marginalized either. Their technology will be part

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favored by persons with access to income or other resources, with the result that their behavior with respect to the norm is seen by many others). Such a norm has the characteristic of seeking followers, whereas an opposite norm, one systematically favored by those without access to resources, does not seek in this fashion but remains marginalized; this biased resource-based behavior of the norm is analogous to the hunting behavior proposed for technology here.

53. *See id.* at 199–202 (asserting that "no one hears the voice of the lonely hermit, happy though he may be"); Keith Stuart, *'I'd Close* World of Warcraft*!' MUD Creator Richard Bartle on the State of Virtual Worlds*, GUARDIAN.CO.UK, July 17, 2007, http://www.guardian.co.uk/technology/gamesblog/2007/jul/17/idcloseworld (last visited Sept. 29, 2009) (discussing the evolution of multi-use dungeons since 1978 through to virtual worlds like *World of Warcraft*) (on file with the Washington and Lee Law Review).

54. *See* Castronova, *supra* note 52, at 202 ("In the jungle of human minds, the entity 'a taste for oratory' is better able to survive than the entity 'a taste for silence.'").

55. *See id.* at 200 (indicating that a garrulous and public actor will be more likely than a silent and private actor to pass his tastes on to others).

of mainstream discourse and the lure of VR will be present to everyone, always. When Bob goes off into VR and has no children, his decisions will be known to many other people and they, upon exposure, may decide to follow his example. In this case, there will be a constant flow of people into VR, and there is no limit on how strong this flow may be. If VR is sufficiently wondrous to entice anyone and everyone, and if it is also a hunting technology to which anyone and everyone is exposed, then anyone and everyone will adopt VR lifestyles and will not have babies. A hunting VR, with costs falling more rapidly than population, could bring about the end of humanity.

Hunting is more likely than hiding. In economic competition, a hunting technology earns more profits than a hiding technology. Companies do better by making their technology into something that broadcasts itself, that exposes itself to the most number of people possible. How much profit is there in creating high-end dungeons, which appeal to a few elite players and then sequesters them away from everyone else? How is anyone else going to hear about the wonders of this mode of gaming, if the most avid users never talk to anyone but themselves? It is not impossible to make money by building this kind of technology, but it is far easier to make money with technologies that not only provide wonderful experiences but also make it apparent to other people that wonderful experiences are being had. Thus it seems likely that the most powerful VR environments of the future will also be delivered in ways that impress folks who ordinarily would have nothing to do with such things.

The Wii went into nursing homes not because retirees needed a gaming fix, but because middle-aged aides played Wii tennis with their own kids and thought retirees might get some exercise.[56] The Wii is a hunting technology: You can see and hear people playing tennis; the remote is easy to use; you can pass the control from one person to another just like that. The Wii consistently outsells its competitor consoles, despite having worse graphics.[57] Hunting

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56. *See* Jack Halpern, *Nintendo Wii Being Used in Nursing Homes for Rehab*, MY ELDER ADVOCATE, Oct. 18, 2008, *available at* http://myelderadvocate.typepad.com/blog/2008/10/nintendo-wii-being-used-in-nursing-homes-for-rehab.html ("McLean County Nursing Home residents experienced 'Wiihabilitaion' when an employee brought them a console to allow residents to play. 'The Wii gets them moving. It's also great for motivating sensory stimulation. And best of all, they really enjoy it,' Donna Holtzinger, activity director for the McLean County Nursing Home, said.").

57. *See Nintendo's Wii Becoming Big Hit in Nursing Homes Nationwide*, FOX NEWS, Mar. 25, 2007, http://www.foxnews.com/story/0,2933,260990,00.html (last visited Sept. 29, 2009) ("While [the PS3 and Xbox 360] focused on cutting-edge graphics and high-tech bells and whistles, Nintendo focused on making game play easier, more intuitive and more appealing to a mass market. That bet paid off. The Wii outsold the new Microsoft and Sony consoles in January and February and is generating its own buzz with everyone from nuns to cancer patients to toddlers.") (on file with the Washington and Lee Law Review).

technologies make more money. The future VR will hunt for new people, not hide away the people it has already found.

VI. A Toy for You to Play With

The future of VR and human population involves many forces working at the same time. People will have core tastes for or against VR, determined by upbringing and genes.[58] Cultural forces and the nature of the technology will make VR prominent or marginalized.[59] People will switch into VR lifestyles, or out of them, depending on what is being offered and what the cost is. The cost in turn depends on how many people there are who are willing to pay for VR systems. The number of people available depends on how VR affects fertility—a lot or a little. All of these things depend on everything else. It is a complex system.

It is possible however to simulate the essential features of the situation with a simple model of evolution. One approach would be to construct this black box and then persuade the reader that it produces one outcome. Instead, my strategy is to make the box and then treat it as a toy, pointing readers to a website where they can get it for themselves. In the rest of the Article I will explain how I built the toy and what dials I put on the outside. Then I will show some of the things the toy can do and discuss some of my own conclusions from playing with it.[60] Consider an evolutionary model with the following elements, each of which can be expressed as a mathematical parameter in a simulation model or, alternatively, as a dial on a software toy.

There is a technology that people may or may not adopt. People who "adopt the technology" live their lives deeply immersed in it. Those who do not adopt the technology simply do not have it in their lives at all. People are born into the world with certain inherent tastes with respect to the technology, with some liking it, intrinsically, and others not liking it, again intrinsically. Assume that these idiosyncratic tastes for the technology are distributed in the

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58. *See* J. PHILIPPE RUSHTON, RACE, EVOLUTION, AND BEHAVIOR: A LIFE HISTORY PERSPECTIVE 2–3 (Transaction Publishers 1994) (indicating that the "nature-nurture debate is fought between those who . . . advocate an extreme 100 percent environmentalist position and those who advocate a moderate, even 50-50, position" since "no behavioral geneticist believes in 100 percent genetic determinism").

59. *Cf. Diet Choices 'Written in Genes,'* BBC News, Oct. 22, 2007, http://news.bbc.co.uk/2/hi/health/7057060.stm (last visited Sept. 29, 2009) (reporting a study from Kings College London that indicates that dietary selections are strongly influenced by genetics, with some influence by upbringing) (on file with the Washington and Lee Law Review).

60. *Infra* Part VII.

population according to some well-behaved density function. In other words, there is a middle ground taste for the technology, and then a range of likes and dislikes such that there are always some people who fanatically enjoy the technology and others who just as fanatically hate it. Inherent likes and dislikes are partly idiosyncratic, and partly genetic. That is, some element of a person's tastes for the technology is inherited from her parents.

In addition to these inherent likes and dislikes, a person is also motivated by upbringing and society. A person raised by a parent who has adopted the technology is more likely to adopt it herself, regardless of inherent tastes. A person entering a society with many adopters is also more likely to adopt it, regardless of inherent tastes. Note that these factors may be in conflict. A person may hate the technology intrinsically but live with a parent who has adopted it, in a society filled with adopters. Such a person may adopt the technology despite her own dislike of it. Alternatively, if her dislike is very strong, she may not adopt the technology despite the pressure. It all depends on where she is in the like-dislike distribution, as well as the strength of parental and societal role models in influencing her decisions.

A further factor in technology adoption is the technology's cost. Assume that the cost of the technology is shared by all who adopt. Thus if the technology has a cost C, and N people adopt the technology, each one must pay C/N. A person considering whether to adopt the technology decides whether her taste for it is strong enough to overcome this cost factor.

Adopting the technology also depends on whether the technology propagates itself powerfully through society's media (a "hunting" technology, like TV) or rather tends to marginalize itself (a "hiding" technology, like elite dungeons). Adopting the technology affects fertility. Assume that nonadopters replicate themselves with 100% probability. (They will not *copy* themselves; rather, they create another person whose tastes are genetically related to their own but not a perfect copy.) Thus, a population of nonadopters will stay at one population level forever. This abstracts away from other things that might be affecting population; we assume that VR adoption is the only effect, and otherwise population remains stable.[61] Those who adopt the technology,

61. The right way to think about this assumption is that we are establishing a baseline of 100% replication against which to measure the effects of VR adoption. If baseline population in the real world is falling, for other reasons, then the results here will contribute to that decline. If baseline populations are rising, the declines here should be seen as effects that moderate the rise. In the cultures that now dominate the developed world, the ones in which VR has begun to catch on, reproduction rates are already below replication for reasons that have nothing to do with VR. In these cultures the effects of VR will be to exacerbate the current trend. We assume 100% replication among nonadopters not to ignore this trend, but only to identify how VR would affect an otherwise stable population in the abstract. Comparing VR's effects to the

however, are less likely to replicate themselves. The probability that an adopter will have a child is less than 100%. Thus, a population of adopters will decline in size, generation by generation.

As the adopter population declines, it becomes less likely that adopters dominate the population, less likely that the adopter "gene"—that is, inherent tastes for the technology—will spread, and less likely that new children will be raised by technology-adopting parents. Moreover, with fewer adopters, the cost of the technology has to be borne by fewer people, so that the cost per person rises. Thus, the lower fertility of adopters generally reduces the impact of the technology on society.

At the same time, the technology continues to be something that many people like, so that people born to nonadopting parents may switch over to adoption. This effect increases the impact of the technology on society, and thus works directly against the effect of lower fertility among adopters. The adopter population falls due to lower birth rates, but it gets refreshed by new converts. Whether the technology persists, dies out, or completely dominates depends on whether the outflow of population due to lower fertility is larger or smaller than the inflow of population due to conversion from nonadopters.

Pursuant to this conceptual discussion of a model, consider the following parameterizations:

Let the probability of a person adopting the technology be

(1) $\Pr(\text{Adopt}) = 1 / (1 + \exp(-Z))$

where

(2) $Z = \rho(\text{Parents Adopt}) + B - (C/sN) + \theta + \beta s$

and

(3) $B = \alpha(\text{Parent's B}) + (1 - \alpha)(u + \sigma\text{RANDOM}(-1, 1))$

(4) $\Pr(\text{Child}) = \delta^*(\text{Adopt}) + 1^*(1 - \text{Adopt})$

The variable Z is unique to each person and can range from negative to positive infinity. When passed through the formula in Equation (1), different values of Z produce numbers between 0 and 1. These numbers are interpreted as probabilities. Moreover, as Z rises, these probability numbers rise. Thus, a person with a higher value of Z has a higher probability number, closer to 1 than to 0, and is therefore more likely to adopt the technology. A person with a

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current population decline in Western, developed countries raises much more general issues of culture and fertility, discussed *infra* Part VIII.

very high Z is almost certain to adopt; a person with a very largely negative Z is almost certain not to adopt.

The parameter Z is then made up of the factors considered above. It is defined in Equation (2). The first term, ρ(Parents Adopt), contains a variable called "Parents Adopt," indicating whether or not this person's parents are technology adopters. If they are, this variable has the value 1; if not, it has the value 0. Then the parameter ρ indicates how much this factor affects Z. If ρ is very large, then being raised in a family of adopters has a very large positive effect on Z, and hence on the probability of adoption. If ρ is small, then parental behavior has little effect on the child's behavior.

The second term in Equation (2) is B, which is the person's personal benefit of adoption—their utility or "taste." This is the extent to which the person likes the technology. In Equation (3), this benefit is defined in terms of two things, the parent's taste parameter ("Parent's B") in the first term, and an intrinsic taste in the second term. The parental and intrinsic valuations of the technology are weighted by a parameter α which lies between 0 and 1. If α is large and close to 1, it means that a person's basic taste for the technology is derived almost entirely from her parent's tastes. If α is close to 0, it means that parental inheritance has almost no effect.

The second term in Equation (3) is $u + \sigma$RANDOM(-1, 1), and it gives a random number, drawn from a distribution, to indicate the person's intrinsic utility from the technology when that utility is not immediately derived from the parent. In other words, if the child's tastes are not an exact copy of the parent's tastes, they are a mutation drawn from this distribution of all possible mutations. In this way, new tastes for VR can enter into the population. The formula here defines mutated tastes as being distributed randomly according to a uniform distribution with mean utility u and utility bounds of $u - \sigma$ and $u + \sigma$. Thus, we assume that the part of individual tastes that does not come from the parents is usually a value like u, but can range from very high values like $u + \sigma$ to very low values like $u - \sigma$. A person is born with some generic liking or disliking for the technology, which is a number chosen randomly between $u - \sigma$ and $u + \sigma$. This number is then combined in a weighted average with the parent's tastes, so that a person's basic like or dislike of the technology is derived partly from mom and dad's likes and dislikes, and partly from purely random personality factors. This kind of framework for genetic inheritance is quite common; for example a structure like this applied to height would imply that tall fathers have tall sons, but those sons usually would not be quite as tall

as their dads. This inheritance structure, in other words, exhibits the very common property of regression to the mean.[62]

Returning to the definition of the adoption likelihood parameter Z in Equation (2), the next term after the individual taste factor B is a negative factor C/sN, which represents the cost. The cost term has variables C as the cost of the technology, s as the share of adopters in the current population, and N as the current population size. Thus, the technology's cost is divided among those who adopt it. This abstracts from many factors that could be investigated involving market structures, government subsidy, and so on, but the abstracting is done in the interests of simplicity. There is a technology; it costs something to maintain; that cost is spread among users; as per-user costs rise, a person is less likely to adopt.

The next term θ is the media power effect, indicating the degree to which this technology "hunts" using available media, or rather "hides." If this is a hunting technology, then θ will be large and positive, meaning that, all else equal, every person in society is more likely to adopt the technology simply because it broadcasts itself widely and exposes itself to everyone. If the parameter θ is negative, it means that, all else equal, a person is less likely to adopt this technology simply because the technology is rarely encountered.

The final term in the adoption likelihood Equation (2) is βs, which can be thought of as the technology's viral effect. Notwithstanding the technology's ability to propagate itself generally in society using media sources, it will still spread more widely if more people adopt it. Above, s was identified as the share of the current population that adopts the technology, and β is a parameter showing how strong this viral effect is.

Taking these last two terms together, the model assumes that as more people adopt a technology, there is an increasing likelihood that others will adopt it as well. However, this viral force may be increased ($\theta > 0$) or decreased ($\theta < 0$) by the ability of the technology to make itself known. If one considers the example of TV, one might think of the viral term βs as indicating how rapidly TV spreads as a result of people seeing other people watching TV, and the "hunting" parameter θ as indicating how rapidly TV spreads as a result of people hearing about TVs on the radio. The former is a direct viral effect, a spreading of technology from person to person. The latter is an indirect effect, a spreading of technology driven by media exposure, broadcasting, advertising, reputation, rumors, and promotion.

The final equation, Equation (4), exhibits the fertility effect of technology adoption. It says that the probability that a person will have a child depends on the

62. *See* Sir Francis Galton, *Regression Towards Mediocrity in Hereditary Stature*, 15 J. ANTHRO. INST. 246, 247–58 (1886) (discussing his research that children's heights, on average, will regress towards the mean height of the population).

variable "Adopt," which equals 1 if a person adopts the technology and 0 if the person does not adopt it. The equation says that a technology adopter has a probability δ of having a child, while a nonadopter has a probability 1 of having a child. The fertility parameter δ lies between 0 and 1, so that a low value of δ indicates that adopters have very low fertility, whereas a high value indicates that adopters and nonadopters have similar fertility. A value of $\delta = 0.5$ indicates that adopters are fifty percent less likely to bear children than nonadopters.

With these parameters, the model permits the following iterative simulation of population change and technological adoption. Assume a set of parameters and a population size. Assume that one person has adopted the technology. Since there is only one adopter, the per-person cost of the technology is at its maximum, C. Thus, each potential adopter assumes his cost will be the entire cost.

Next, simulate tastes in the first generation using random draws from the uniform distribution on $[u - \sigma$ and $u + \sigma]$. In other words, this first generation has no parental inheritance effects on taste (because it has no parents).

Using these parameters and Equations (1) and (2), simulate technology adoption for each person in this first generation. Recalculate the per-adopter cost of technology, C/sN.

Generation 1 has children, with the probability of replication depending on adoption of the technology as in Equation (4). The new children, Generation 2, are given tastes for the technology based on parent's tastes as in Equation (3).

Assume time dynamics for VR, specifically, the rate at which its quality improves and the rate at which its costs fall. Quality improvements are parameterized as linear increases in the average utility of VR, u. If the per-generation quality improvement is λ, then after five generations the mean of the utility distribution has risen to $u + 5*\lambda$: As VR improves, the average person likes it more. We also assume there is a maximum quality to VR, a limit beyond which it cannot improve, reflecting the fact that VR cannot perfectly replace lived experience. Denote this maximum VR quality ω. Finally, let γ indicate the per-generation reduction in the costs of maintaining VR. Since VR is an information technology, it is sensible to assume that costs fall exponentially over time.[63] Thus $0 < \gamma < 1$, and if costs are C_t in generation t, they are γC_t in generation t+1. In general, these time dynamics have quality improving gradually up to some maximum while costs decline dramatically without limit.

Given the time dynamics of VR, simulate technology adoption in Generation 2.

Generation 2 has children, thus producing Generation 3.

Repeat Steps six to seven for fifty generations.

Observe the time path of the population size and the technology adoption rate.

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63. *See supra* note 45 and accompanying text (discussing Moore's Law and the falling cost of VR systems).

This iterative simulation has been executed within a simple spreadsheet program and is available for download at http://law.wlu.edu/deptimages/LawReview/VRandFertility2.0.xls. There are many ways to fiddle with the dials and see what happens. Moreover, the toy could be built in other ways that would lead to different outcomes. Readers are invited to play with the toy themselves and draw their own conclusions.

VII. Results of the Author's Play

Results will be presented in terms of ten scenarios with different parameters. In each of these scenarios, we will examine the long run outcome in terms of two critical variables: the population and the share of that population adopting VR technology. The author's play was driven by a desire to know what questions we should be asking about VR technology.[64]

Scenario 1. Status Quo
Table 1. Scenario 1 Parameters

Starting VR quality	u	-5
Distribution range for VR tastes	σ	40
VR improvement increment	λ	0
VR Max	ω	-5
Starting cost	C	10
Cost decline rate	γ	1
Heritability of VR taste	A	0.8
Parental environment effect	P	0.8
Viral effect	B	0.5
Media power effect	Θ	0
Differential fertility	Δ	1

64. In my play, parental environment and genetic effects had very little impact on long run outcomes; changes in these parameters only slowed things down or speeded them up. Therefore they will not be discussed in any detail. I also pass over scenarios with high costs of VR or low average taste for VR. These scenarios, logically, produce long run outcomes in which no one finds it in their interest to adopt the technology. The average person does not like VR enough, or it is too expensive. However, the real world is already past this point: VR technologies already exist whose per-person cost relative to individual desires result in massive levels of adoption. *See, e.g.*, *Second Life* Membership Plans, http://secondlife.com/whatis/plans.php (last visited Sept. 29, 2009) (providing free basic plans and premium plans as low as six dollars per month) (on file with the Washington and Lee Law Review). Therefore we only examine scenarios in which the average tastes for VR, relative to the money cost to first adopters, is such that VR is adopted by at least a small share of the population at some point.

The starting parameters make conservative assumptions about the current state of affairs with respect to VR and fertility. They assume that should a child develop a taste for VR independent of genetic inheritance, it will generally be negative (u = -5) but could have a wide range, from -45 to 35. In other words, mutations on any "genes" for VR are generally against VR but allow substantial love of VR as well. This population will always be exposed to people who really like VR and people who really hate it.

These starting parameters also assume that VR never improves; the improvement increment is 0. The maximum VR quality is therefore -5 as well. Moreover, the cost of VR (C) is assumed to be high (10) and unchanging. Thus, VR is assumed to remain largely what it is today: An expensive technology of fairly cheap quality, pursued avidly only by those who like such things.

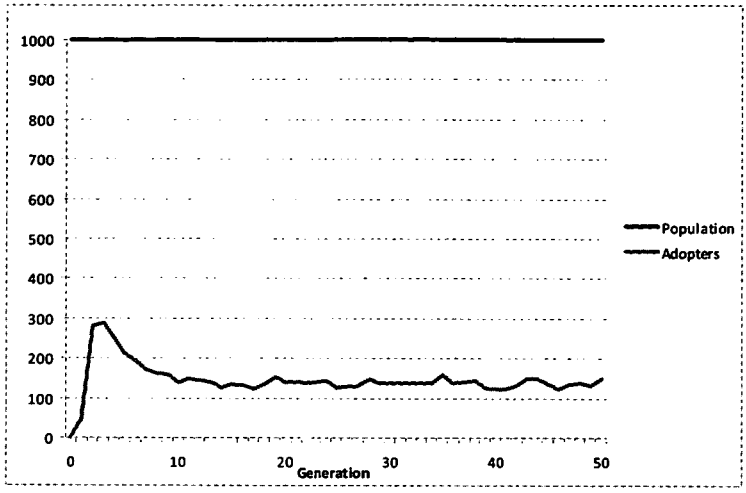
The heritability effect and parental environment effects are set at 0.8 each. This means that a child's taste for VR is eighty percent determined by his parent's genes and whether or not the parent adopted the technology. The implication is that the simulation gives genes and environment a great deal of influence. One is unlikely to adopt VR if raised by parents who do not like it and avoid it.

The viral effect of VR is set to 0.5, meaning that the share of technology adopters (the parameter s) contributes to the likelihood of adoption, and the level of that contribution is equal to one-half of the adoption share, or, (.5 x s). There is a viral effect, but it is not overwhelming relative to tastes and costs. People will not "do" VR just because everyone else does.

The media power effect is assumed to be 0 here at the start of our simulations. Therefore, we assume initially that VR is no more or less likely to spread in the population through media, rumors, broadcasts, and so on. It may spread because people are using it (through the viral effect above), but not because TV news broadcasts regularly report on it.

Finally, to start the discussion we assume there is no fertility effect at all: VR users and nonusers simply replicate themselves with 100% probability. This assumption is again part of the current status quo. All together, the first scenario assumes there is no fertility effect at all, no improvements or cost declines in VR, and a population that is largely uninterested in VR.

Figure 1. Scenario 1 Results



Discussion

Logically, population is unaffected by VR since there is no fertility effect from adopting it. VR adoption is caused by the distribution of tastes and inheritance in the population. After an initial spike due to viral effects, the adoption rate is driven to a stable long-run level by environment, costs, and genetic regression to the mean. This scenario is arguably a status quo scenario in the sense that most people assume things will continue largely as they are, with no large-scale effects of VR on anything. We are, if anything, experiencing the spike. In the long run, most feel, use of VR will remain a marginalized activity, pursued by some small fraction of the population and with no greater consequence.

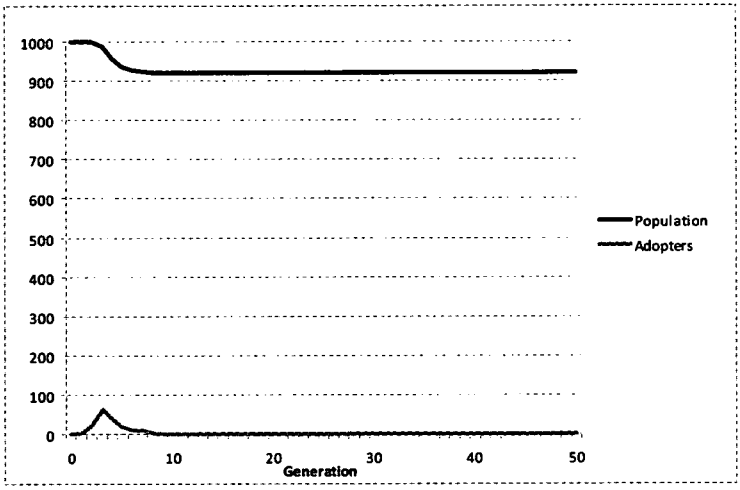
Scenario 2. Geek Extinction

Table 2. Scenario 2 Parameters

Starting VR quality	u	-10
Distribution range for VR tastes	σ	40
VR improvement increment	λ	0
VR Max	ω	-10
Starting cost	C	10
Cost decline rate	γ	1
Heritability of VR taste	α	0.8
Parental environment effect	ρ	0.8
Viral effect	β	0.5
Media power effect	θ	0
Differential fertility	δ	0.5

The status quo parameters are adjusted first by making VR's quality even lower, so that u = -10 instead of -5: VR is more marginalized than before. To this we add a change in fertility from $\delta = 1$ to $\delta = 0.5$: Those interested in VR ("geeks") have babies at one-half the rate of others.

Figure 2. Scenario 2 Results



Discussion

The initial spike in VR usage is dampened by the fact that VR adopters are less likely to reproduce. In fact, within a few generations they are extinct. Their genes have left the gene pool, never to return. Therefore VR is never adopted again.

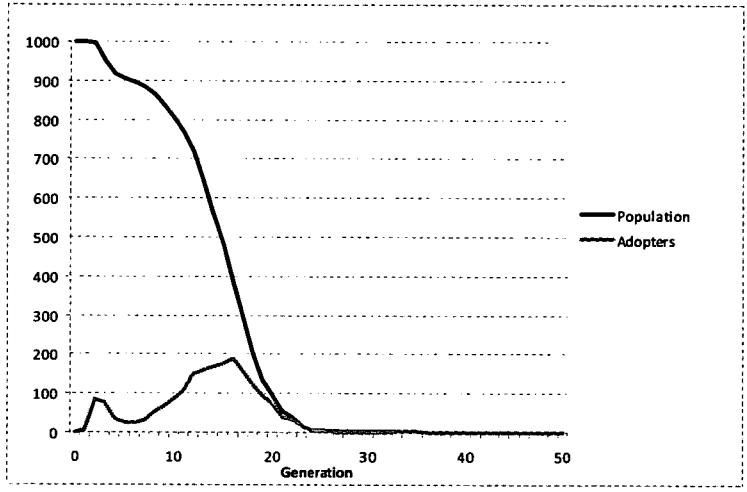
Scenario 3. VR Improves

Table 3. Scenario 3 Parameters

Starting VR quality	u	-10
Distribution range for VR tastes	σ	40
VR improvement increment	λ	1
VR Max	ω	10
Starting cost	C	10
Cost decline rate	γ	1
Heritability of VR taste	α	0.8
Parental environment effect	ρ	0.8
Viral effect	β	0.5
Media power effect	θ	0
Differential fertility	δ	0.5

We now assume that VR technology does not remain at a constant level of quality, but rather improves generation by generation at a moderate rate. In terms of the average utility of VR, we assume it begins at -10 but then rises by 1 every generation to a maximum of +10. The first twenty generations of the scenario, therefore, are witnessing a gradual increase in the interest of the population in VR technologies. Once marginalized, they come to be enjoyed by the average person. Even then, when the average VR utility rises to +10, the range of utilities is still -30 to +50: There are still many who dislike VR.

Figure 3. Scenario 3 Results



Discussion

With VR improving in quality, it gradually overcomes any cost factors, so that adoption rates rise well beyond the marginalized level. The nonadopting population faces the ongoing probability that their offspring will randomly turn out to be VR-favoring and thus relatively barren. This event soon becomes more likely than not because by the twentieth generation the average child who is unaffected by parental genes likes VR rather than hates it. Regression to the mean, in other words, continually pushes the population toward VR adoption. It therefore pushes people toward less fertility. VR-favoring genes become dominant in a dwindling population. VR adoption rises to 100% but population falls. This does not stop until no one is left. It is an extinction scenario, produced just by gradually improving VR.

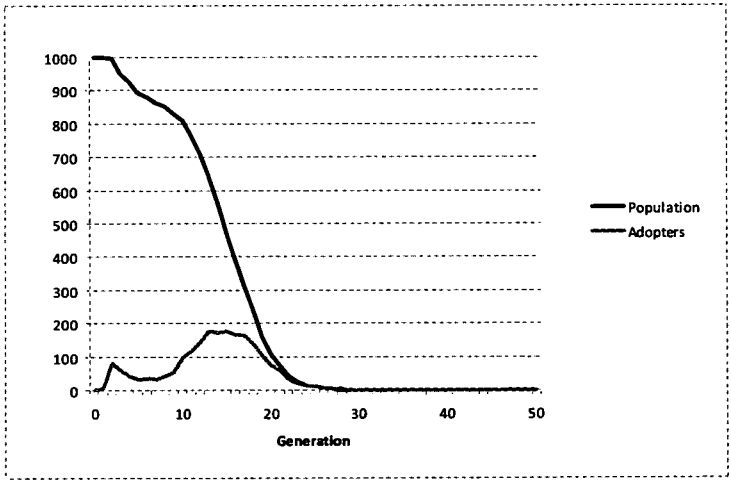
Scenario 4. Falling Costs

Table 4. Scenario 4 Parameters

Starting VR quality	u	-10
Distribution range for VR tastes	σ	40
VR improvement increment	λ	1
VR Max	ω	10
Starting cost	C	10
Cost decline rate	γ	0.5
Heritability of VR taste	α	0.8
Parental environment effect	ρ	0.8
Viral effect	β	0.5
Media power effect	θ	0
Differential fertility	δ	0.5

Now we assume that VR's costs will fall by fifty percent per generation. This is conservative relative to Moore's Law, which holds that computation costs should fall fifty percent every two or three years.

Figure 4. Scenario 4 Results



Discussion

Scenario 4 is the same as Scenario 3, indicating that falling costs are not the main force driving VR adoption. This makes sense. At a given level of quality and a range of public interest in that quality, there will either be many or few people who are greatly interested in VR. If many are interested, it becomes possible to provide the technology at low cost per person simply because C/sN becomes small. If in addition the cost factor C

is falling, it only adds to the phenomenon of cost decline. In Scenario 3, adoption rates are rising to 100% regardless of cost. Making the costs fall only contributes to this effect; it adds nothing new.[65]

Scenario 5. Persistent Mutation

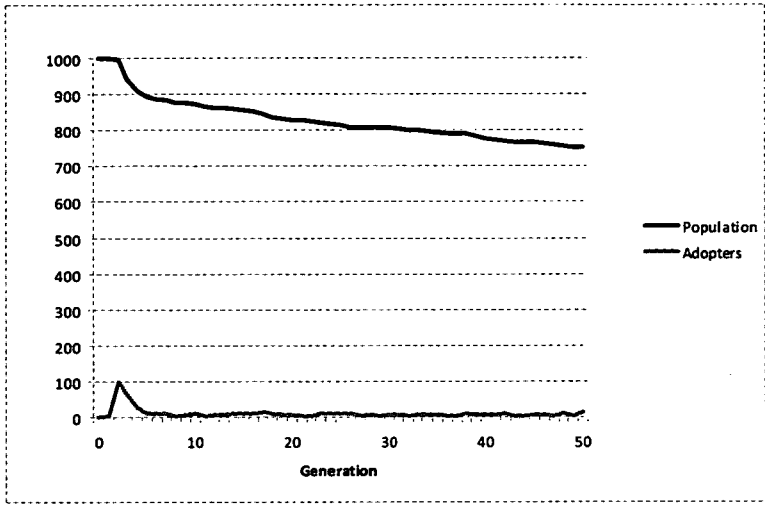
Table 5. Scenario 5 Parameters

Starting VR quality	u	-10
Distribution range for VR tastes	σ	40
VR improvement increment	λ	0
VR Max	ω	-10
Starting cost	C	10
Cost decline rate	γ	0.5
Heritability of VR taste	α	0.8
Parental environment effect	ρ	0.8
Viral effect	β	0.5
Media power effect	θ	0
Differential fertility	δ	0.5

We return to the case of VR that does not improve in quality (Scenario 2). However, we maintain the assumption of Scenario 4 that infrastructure cost is falling.

65. The cost effects are driven by the assumption that the relevant costs here are the costs that must be shared among all users. The economic reasoning behind this set-up is as follows. Any cost that can be assigned directly to the individual will be. It then becomes netted out of their benefit-cost calculation. In other words, the individual-specific utility of VR, which is drawn from the distribution [u - σ, u + σ], is net of the individual costs. If this is positive, it means that the person's benefits exceed her costs. If negative, the cost exceeds the benefit. Changes in this part of the economics are captured in changes in u, in the mean of this distribution. However, this part of the calculation overlooks the social element of costs. There is an infrastructure issue in providing VR. A vast information network infrastructure is required for it to work. The costs of the infrastructure are fixed by past investments and must be spread among the current users. If the number of users is zero, the infrastructure cost is born by the first adopter. This element of costs is potentially important and is the element captured by C/sN.

Figure 5. Scenario 5 Results



Discussion

After its initial spike, VR adoption dies out. Yet because of falling costs, there are at times people generated out of the nonadopting population whose liking of VR, relative to the cost of being the first user, induces them to adopt. Every time this happens, another person has exited the nonadopting, fertile population. Thus, there is a state of slow change in which occasional bursts of VR adoption lead to another tiny part of the population dying out.

Scenario 6. Pre-Technological

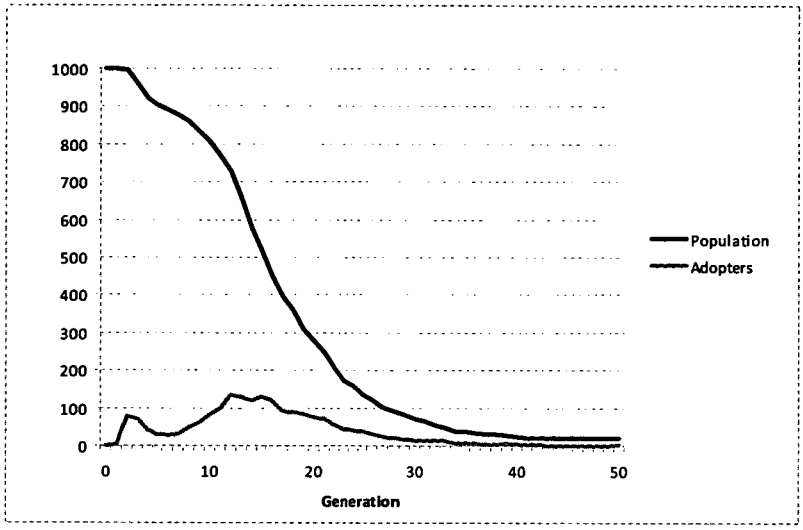
Table 6. Scenario 6 Parameters

Starting VR quality	u	-10
Distribution range for VR tastes	σ	40
VR improvement increment	λ	1
VR Max	ω	0
Starting cost	C	10
Cost decline rate	γ	1
Heritability of VR taste	α	0.8
Parental environment effect	ρ	0.8
Viral effect	β	0.5
Media power effect	θ	0
Differential fertility	δ	0.5

We return to the extinction scenario (3) and make the growth of VR's quality less powerful. Instead of rising to the point that the average person

enjoys VR (VR Max = +10), it only rises to the point that the average person is indifferent (VR Max = 0). Costs remain high and do not fall over time.

Figure 6. Scenario 6 Results



Discussion

With VR not achieving a high quality, it no longer dominates society and adoption rates never rise to 100%. However, the simulation shows that VR adoption does not need to be 100% for population to decline. In this scenario, adoption rates are generally below 50%, but as we saw above, any level of adoption takes people from the fertile part of the population and adds them to the less fertile part, where they are less likely to reproduce. As long as this happens, population will fall. What is unique about this scenario is that while population falls, it does not die out completely. Rather it stabilizes at a low level and, at that low level, the (mediocre) technology is abandoned. When population falls to 1%–2% of its starting value, the sheer number of people left is so small that the odds of any one of them being a VR fanatic, a person who would pay the entire infrastructure cost in order to have VR, are too low. VR use drops out of the population and usually no one is sufficiently mad to bring it back. If one such madman appears, he dies out at once and the population goes down by one person. Such a structure can be maintained for many generations. The scenario can be thought of as a society that becomes persistently underdeveloped with low technology and no VR: A gradual return to the pre-technological age.

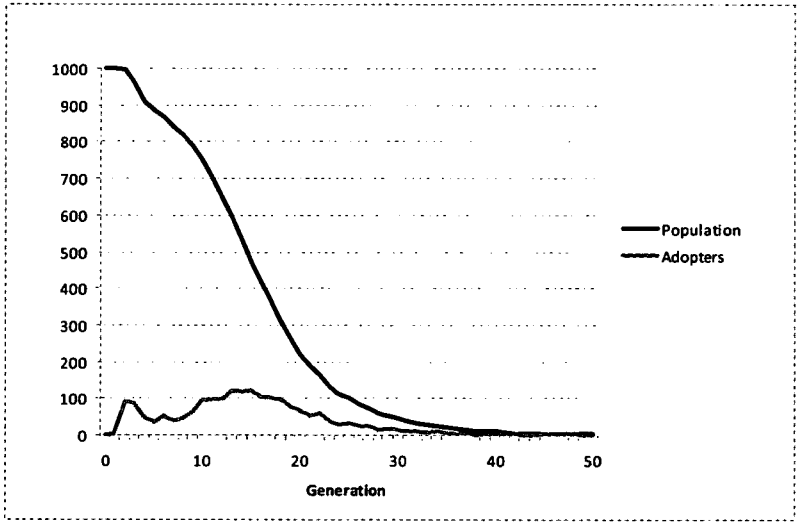
Scenario 7. Pre-technology with Falling Costs

Table 7. Scenario 7 Parameters

Starting VR quality	u	-10
Distribution range for VR tastes	σ	40
VR improvement increment	λ	1
VR Max	ω	0
Starting cost	C	10
Cost decline rate	γ	0.5
Heritability of VR taste	α	0.8
Parental environment effect	ρ	0.8
Viral effect	β	0.5
Media power effect	θ	0
Differential fertility	δ	0.5

We repeat the Scenario 6 assumption that VR will not improve very much in the future. However, we assume that costs will fall as in Scenario 4.

Figure 7. Scenario 7 Results



Discussion

The results are very similar to Scenario 6 in that the moderate VR improvements are still sufficient to cause population to decline. However, in Scenario 6 the continued high cost of technology kept adoption rates below 100% regardless of population size. In this scenario, falling costs reduce this barrier and adoption becomes universal. With universal adoption, it is possible that a small population may all decide not to reproduce, thus wiping themselves

out. In fact extinction occurs in about 10 out of every 100 replications of this scenario. Thus, extinction is possible when VR does not improve much, if its costs fall.

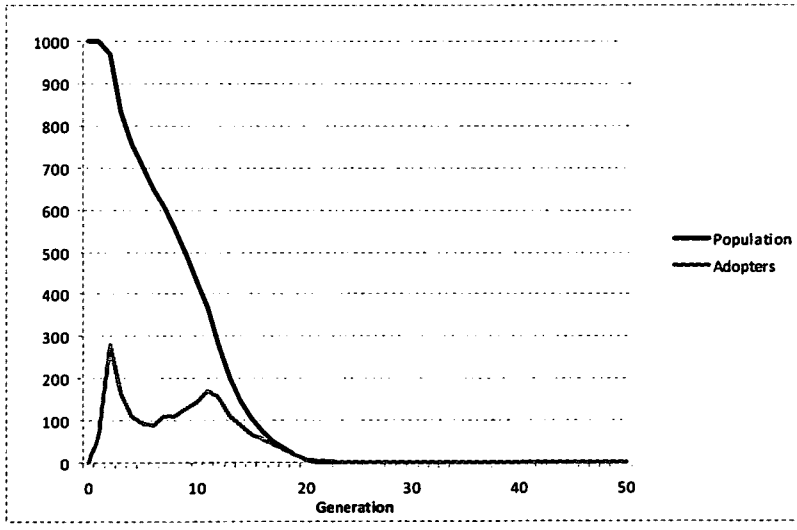
Scenario 8. Hunting Technology

Table 8. Scenario 8 Parameters

Starting VR quality	U	-10
Distribution range for VR tastes	Σ	40
VR improvement increment	Λ	1
VR Max	Ω	10
Starting cost	C	10
Cost decline rate	Γ	1
Heritability of VR taste	A	0.8
Parental environment effect	P	0.8
Viral effect	B	0.5
Media power effect	Θ	5
Differential fertility	Δ	0.5

We return to the basic VR improvement scenario (3) that leads to extinction. However, we now assume that some people will adopt VR because of VR's media broadcast power: We set $\theta = 5$.

Figure 8. Scenario 8 Results



Discussion

When VR hunts potential adopters, extinction happens more quickly.

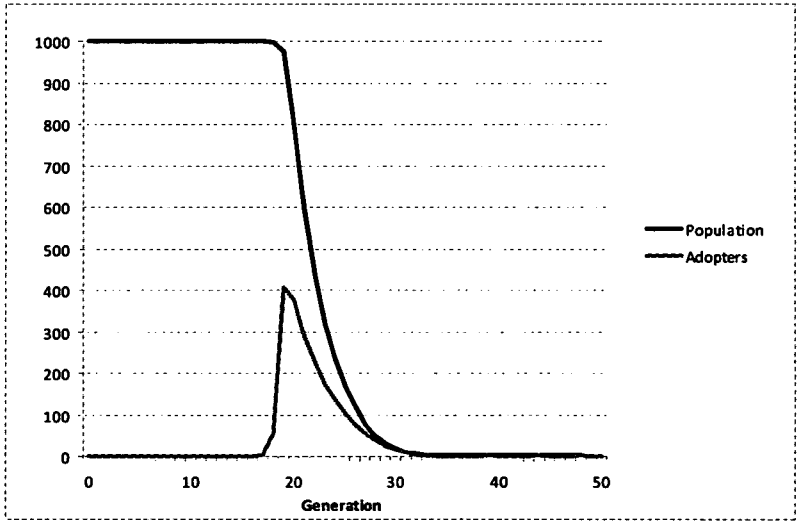
Scenario 9. Hiding Technology

Table 9. Scenario 9 Parameters

Starting VR quality	u	-10
Distribution range for VR tastes	σ	40
VR improvement increment	λ	1
VR Max	ω	10
Starting cost	C	10
Cost decline rate	γ	1
Heritability of VR taste	α	0.8
Parental environment effect	ρ	0.8
Viral effect	β	0.5
Media power effect	θ	-5
Differential fertility	δ	0.5

Now we assume that VR technology does not hunt potential adopters, rather it sequesters them away. People who are using VR are comparatively unlikely to broadcast that use to others. The technology has a tendency to marginalize itself. Set $\theta = -5$.

Figure 9. Scenario 9 Results



Discussion

When VR hides its users away, the population converges to 100% adoption more slowly. Extinction happens more slowly.

Scenario 10. Reasonable Estimates
Table 10. Scenario 10 Parameters

Starting VR quality	u	-10
Distribution range for VR tastes	σ	40
VR improvement increment	λ	1
VR Max	ω	20
Starting cost	C	10
Cost decline rate	γ	0.5
Heritability of VR taste	α	0.8
Parental environment effect	ρ	0.8
Viral effect	β	0.5
Media power effect	θ	5
Differential fertility	δ	0.1

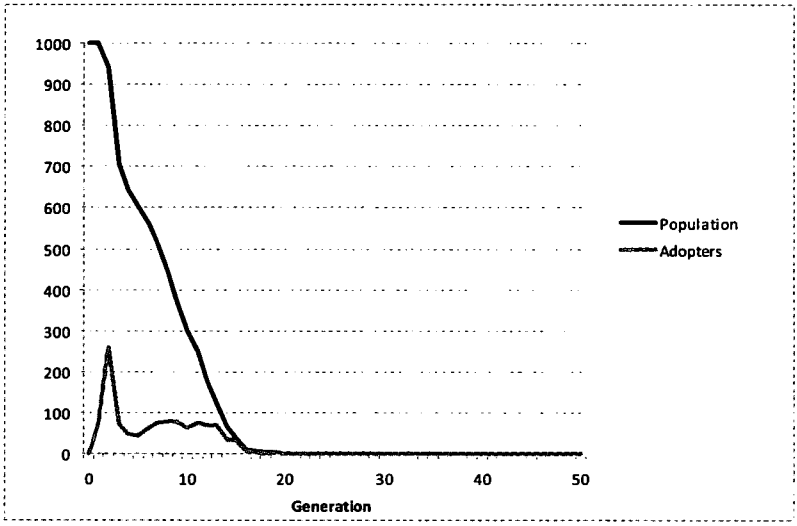
What if we were to build a scenario not as a whole but by examining each parameter individually and assigning a value that seems most likely? In this spirit, assume that VR is initially marginalized as it is now, with u = -10. Yet the history of media technologies suggests that VR will become significantly more powerful in the future and hence much more desired by the average person.[66] Set the maximum utility of VR at u = 20 and let VR quality grow at 1 unit per generation. At the same time, it seems highly likely that costs will fall dramatically, so set the cost decline parameter γ to 0.5.[67] Finally, for reasons discussed in the concept sections,[68] VR will most likely be a hunter; companies pursuing profits will prefer VR technologies that make much of themselves and propagate widely in other media. Set θ = 5.

66. *See* STEPHEN BEST & DOUGLAS KELLNER, THE POSTMODERN ADVENTURE: SCIENCE, TECHNOLOGY, AND CULTURAL STUDIES AT THE THIRD MILLENNIUM 150 (2001) (noting the exponential advances in speed and computational power of media, video, and photographic technologies).

67. *See* Lawton, *supra* note 43, at 13 (reporting that technological advances are lowering the cost of VR systems).

68. *See supra* pp. 1087–90 (discussing hunting technology).

Figure 10. Scenario 10 Results



Discussion

Extinction happens quickly.

VIII. Conclusion

This Article began with a conceptual discussion of signs currently evident that advanced networking and representational media, summarized in the term "virtual reality" or VR, would have a depressing effect on human fertility.[69] These conjectures arose from a discussion of human sexuality, which evolved in a media-free environment. When human sex evolved, all imagery was analog. A gene that drove humans to pursue sexual gratification could only drive them to pursue other humans, or their own imaginations. Imagination proved (or evolved so as to be) a comparatively weak competitor for the real thing, and thus humans driven by sexual appetites mated and made more humans.

The emergence of mediated communication changed things significantly. There came to be a cornucopia of practices leading to sexual satisfaction,[70] only

69. *See supra* Parts II–V (discussing whether virtual reality will have a depressing effect on human fertility).

70. *See* Monica T. Whitty & William A. Fisher, *The Sexy Side of the Internet: An Examination of Sexual Activities and Materials in Cyberspace*, *in* PSYCHOLOGICAL ASPECTS OF CYBERSPACE: THEORY, RESEARCH, APPLICATIONS 185, 202 (Azy Barak ed., 2008) (predicting

one of which, plain old fooling around, led to more children. The power of other forms of satisfaction, in the present hour, seems likely to eventually supersede the joy of fooling around. It will do this probably not for everyone, probably not at all times, but certainly for many people and at many times.

Teledildonics, realistic art and audio, immersive environments and advanced network communication increasingly provide the wherewithal to experience the deepest and most forbidden fantasy, at any moment, in real time, with other people, utterly without consequence.[71] If a baby is to be produced, it seems, it must increasingly be through conscious effort: Potential parents will have to pause their fantastical erotic gymnastics for a moment to put the right stuff together.

As more people spend more time in VR, population seems likely to decline. At the same time, VR is expensive. Should VR cause a demographic implosion, it might destroy the means for its own sustenance. If we all end up in pods, who will pay for the pods? Technology and population co-evolve as part of a complex system.

Though complex, this system of technological-biological evolution lends itself to simulation using common software tools. The simulation constructed here was consciously designed as a toy that readers can play with if they choose at http://law.wlu.edu/deptimages/LawReview/VRandFertility2.0.xls. The author's play indicated that in general the cost of VR would not put a significant dent in the decline of population. That cost is likely to fall, in any case, because VR is an information technology.[72] Rather than cost, the quality of VR seemed to be a more significant factor.[73] If the core human desire for VR rises, as it would if VR improves in quality even gradually, adoption will rise. If, further, those who spend time in VR are less fertile, population will fall. There is no brake to this decline. Even families who for generations have hated VR face a positive probability of producing offspring that regress toward the population mean, and that population mean will gradually favor VR more and more. Nonadopters thus become ever more likely to lose their offspring to VR, and VR adopters ever less likely to lose their offspring (if they have any) to technological abstinence. Whenever an offspring abstains, his offspring are in

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that further technological developments will offer alternative ways for people to interact sexually).

71. *See* Metzel, *supra* note 12, at 248–49 (explaining how increasingly immersive digital environments might alter intimate interactions).

72. *See supra* note 45 and accompanying text (discussing Moore's Law and the falling cost of VR systems).

73. *See supra* pp. 1100–02 (indicating that if VR improves in quality, it will eventually overcome any cost factors and adoption rates will rise).

turn likely to go back to VR eventually. The line will eventually die out. In the most likely scenario, all lines will eventually die out.

The VR extinction event emerges in a context where the non-VR population simply replicates itself. Perfect replication is the baseline against which VR's effects are measured, but it is not an accurate depiction of contemporary demographic trends in the developed countries where VR is beginning to appear. Since the introduction of the birth control pill, birth rates in developed countries have fallen well below the level necessary for replacement.[74] A demographic implosion is already underway and it has nothing to do with VR.

It is accurate, though challenging, to point out that fertility is a matter of cultures, not nations. We are not discussing the end of humanity here. We are discussing the end of a culture, of a way of living. The demographic implosion is happening in Europe and Japan not because of something unique about Europe and Japan as territories but because of something unique about the way people live in those territories.[75] The cultures of the West promise many good things: good health, leisure, gender equality, racial and religious peace, empowerment, personal growth, and freedom. In the long run, these goods make these cultures powerful. Who would not prefer such a culture to all others? Who would not prefer it, even if it meant fewer births? Fewer people living better lives: A formula for progress.

Yet this discursion into the effects of VR should give us pause. In the age of VR, we may find ourselves not with fewer people in these cultures, leading better lives, but rather with no people at all. Imagine a time when every single satisfaction that can come from human sex, coupling, and birthing can be satisfied by a virtual equivalent. Recall that there are already virtual baby sites, where one can create and then tend to a mock human child.[76] Is it like real

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74. *See* Samuel H. Preston, *Changing Values and Falling Birth Rates*, 12 POPULATION & DEV. REV. (ISSUE SUPPLEMENT) 176, 181–82 (1986) (describing effects of contraceptive technology on fertility); John Bongaarts, *Fertility and Reproductive Preferences in Post-Transitional Societies*, 27 POPULATION & DEV. REV. (SUPPLEMENT) 260, 261–63 (2001) (charting birthrates in the industrialized world since the 1950s and identifying when fertility fell below replacement level).

75. *See, e.g.*, Patricia Boling, *Demography, Culture, and Policy: Understanding Japan's Low Fertility*, 34 POPULATION & DEV. REV. 307, 312 (2008) (explaining how Japan's "long hours" work culture puts families under pressure and contributes to Japan's low fertility rate); Jacquelyn H. Slotkin, *Rabenmutter and the Glass Ceiling: An Analysis of Role Conflict Experienced by Women Lawyers in Germany Compared with Women Lawyers in the United States*, 38 CAL. W. INT'L L.J. 287, 290–91 (2008) (indicating that due to German societal prejudice against mothers also working, "[m]any women feel they must choose between working and raising children[, and] [m]any choose to forego having children").

76. *See supra* note 36 and accompanying text (presenting websites where a person can

cuddles? Of course not. But the virtual baby does not defecate either. At what point will all desire evaporate to set aside virtual sex—increasingly the norm, and a most excellent one at that—to actually have a baby? What force will prevent the disappearance of genuine babymaking?

The late Karol Wojtyla, known to some as Pope John Paul II, spoke often of the need for a Culture of Life to oppose what he saw as the Culture of Death now regnant in the developed world.[77] A Culture of Life, he argued, values life for its own sake.[78] It strictly prefers life of low quality (however that may be defined) to no life at all. Adherents to a Culture of Life would make babies for the sake of making babies—not because they felt good putting the right stuff together, not because they love to cuddle infants, not because they are conscious of a desire to "pass on genes"—not for any of these reasons but simply out of fidelity to the moral view that babies are good things and we ought to make them if we are able.[79]

What sort of challenge does such a view pose to VR? None, really. VR is just another technology that, like the car and the TV, need only be integrated healthily to produce benefits. The question is what is a healthy and proper use of the technology?

The Culture of Life idea does not challenge VR, but it does challenge the fertility culture that already exists and the (anti-)fertility culture whose fire VR will so richly fuel. Returning to the simulation, consider the possibility that the baseline fertility practice is not merely to replicate oneself, but is rather to create more people than there were before. Scenario 11 returns to the extinction path of Scenario 10, where VR improvements, falling costs, and fertility declines eventually led to the end of all bloodlines. However, Scenario 11 assumes that all people, adopters and nonadopters, create 1.2 people when they do reproduce, as opposed to the default 1.0. A Culture of Life is assumed, in which those who reproduce do so avidly.

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create and care for a virtual baby).

77. *See, e.g.*, Pope John Paul II, Encyclical Letter, *Evangelium Vitae* ¶ 95 (Mar. 25, 1995), *available at* http://www.vatican.va/holy_father/john_paul_ii/encyclicals/documents/hf_jp-ii_enc_25031995_evangelium-vitae_en.html ("What is urgently called for is a general mobilization of consciences and a united ethical effort to activate a great campaign in support of life. All together, we must build a new culture of life . . . .").

78. *See id.* ¶ 34 ("Life is always a good. This is an instinctive perception and a fact of experience, and man is called to grasp the profound reason why this is so.").

79. *See, e.g.*, Sylvia Moreno, *Roe v. Wade Protesters Fired Up by President*, WASH. POST, Jan. 23, 2001, at A4 ("As Brenda Baltimore and marchers from Bethel Church in Beltsville marched past the Supreme Court, she said: 'Abortion is against God's law. . . . God told man to be fruitful and multiply and to have communion.'").

Figure 11. Scenario 11 Results

We see that as VR improves and its costs fall, adoption increases and population falls. But the population decline is broken by the fecundity of both adopters and nonadopters. A long-run equilibrium emerges in which VR, though fully integrated into the population, depresses population only just enough to offset the population growth produced by the heightened fertility in every bloodline. When VR enters a society dominated by a Culture of Life, it depresses the population but does not destroy it.

Terms like "Culture of Life" and "Culture of Death" are of course fiercely contested socially, and they are often deployed in debates about legal and regulatory matters.[80] This analysis suggests that the legal and regulatory issues will only become more acute as VR spreads. Avid users of VR—they exist among us already—are easy targets: They speak their own language, have their own scales of importance on various matters, and lead different lives. Those who fear VR label them as losers, sociopaths, miscreants, rogues, depressives. For their part, heavy VR users today tend to think of fans of the offline world as broken, corrupt, misguided, pointless, boring, and stupid. An ideological fault line has already appeared.

It will widen. There will be calls for the criminalization of VR. There will be calls for its complete deregulation. Judges and legislators will spend

80. *See, e.g.*, Abby Goodnough, *The Schiavo Case: The Overview*, N.Y. TIMES, Apr. 1, 2005, at A1 (reporting on President Bush's call on the nation to build a culture of life in response to the Schiavo case and on the Florida legislature's passage of a law in response to the case).

years trying to distinguish "good" VR from "bad" VR. Norms of proper VR use will emerge and face vicious criticism. Meanwhile, governments and courts will inexorably be drawn themselves into the vortex of VR. Virtual town hall meetings will lead to virtual legislative sessions; the resulting statutes will be implemented by virtual agencies and adjudicated before virtual benches. The world will experience the irony of a holographically projected judge declaring that a certain holographic projection violates a law; two legislators will be discovered to be having cybersex during a virtual floor debate on a law regulating cybersex.

In the end, this Article only raises questions and does not answer them. Technology itself is never the actor; it never produces anything good or bad. The good and the bad come from the decisions that people make. How will we, as citizens, respond to the growth of VR technology? How will we choose to regulate the system? VR will surely produce tension between cultures of life and cultures of death, each of which will make its own case for the way VR should best be used. Can all the good things about Western society be retained alongside a commitment to greater fertility? How do we put together high incomes, freedom, VR, and 2.1 babies per woman? What policies and laws will best encourage this tricky combination? Perhaps, with the law's support, individual families will successfully negotiate all four. Perhaps society will integrate VR in its practices of good living in full respect of human dignity. Or, perhaps the law will seek to prohibit VR and prevent healthy, safe, successful integration. Perhaps, the curtain has begun to fall.