



METaverse ROADMAP

Pathways to the 3D Web

A Cross-Industry Public Foresight Project

Co-Authors

John Smart, Acceleration Studies Foundation
Jamais Cascio, Open the Future
Jerry Paffendorf, The Electric Sheep Company

Contributing Authors

Corey Bridges, Multiverse
Jochen Hummel, Metaversum
James Hursthouse, OGSi
Randal Moss, American Cancer Society

Lead Reviewers

Edward Castronova, Indiana University
Alexander Macris, Themis Group
Richard Marks, Sony Computer Entertainment
Rueben Steiger, Millions of Us

LEAD SPONSOR



FOUNDING PARTNERS



MVR Summit Attendees

Distinguished industry leaders, technologists, analysts, and creatives who provided their insights in various 3D web domains.

Bridget C. Agabra	Project Manager, Metaverse Roadmap Project	Patrick Lincoln	Director, Computer Science Department, SRI International
Janna Anderson	Dir. of Pew Internet's Imagining the Internet ; Asst. Prof. of Communications, Elon University	Julian Lombardi	Architect, Open Croquet ; Assistant VP for Academic Services and Technology Support, Office of Information Technology
Tod Antilla	Flash Developer, American Cancer Society	Richard Marks	Creator of the EyeToy camera interface; Director of Special Projects, Sony CEA R&D
Wagner James Au	Blogger, New World Notes ; Author, The Making of Second Life , 2008	Bob Moore	Sociologist, Palo Alto Research Center (PARC), PlayOn project
Jeremy Bailenson	Director, Virtual Human Interaction Lab , Stanford University	Randal Moss	Manager of Futuring and Innovation Based Strategies, American Cancer Society
Betsy Book	Director of Product Management, Makena Technologies/ There ; Editor, Virtual Worlds Review	Jerry Paffendorf	Research Director, Acceleration Studies Foundation ; Futurist in Residence, Electric Sheep Company
Corey Bridges	Co-founder, Executive Producer and Marketing Director, Multiverse	Marty Poulin	Co-founder and CTO, Yoick ; Former Director of Online Technology for Disney's Interactive Studios
Jamais Cascio	Founder, Open the Future ; Former Editor, Worldchanging	John Smart	President, Acceleration Studies Foundation
Edward Castronova	Author, Synthetic Worlds , 2005; Director of Grad Studies, Dept of Telecom, U. of Indiana	David Smith	Architect, Open Croquet ; CTO, 3DSolve
Helen Cheng	Assistant Product Manager, Seriosity	Rueben Steiger	CEO, Millions of Us
Giff Constable	VP of Business Development, Electric Sheep Company	John Swords	Host, SecondCast
Esther Dyson	Editor, Release 1.0 and Editor at Large, CNET Networks	Daniel Terdiman	Writer, CNET
Doug Englebart	Pioneer of human-computer interaction at SRI; Director, Bootstrap Institute	Barry Tolnas	Web Development, American Cancer Society
Randy Farmer	Community Strategic Analyst, Yahoo!, Inc.	Sibley Verbeck	Founder and CEO, Electric Sheep Company
Guy Garnett	Director, Cultural Computing Program , University of Illinois at Urbana-Champaign	Mark Wallace	Journalist; Blogger, 3pointD and Second Life Herald ; Co-Author, Only a Game , 2006
Eric Gruber	Freelance Producer, MTV Networks	Payton White	Manager of Distributed Network Technology, US R&D, Sony Computer Entertainment
Will Harvey	Founder and CEO, IMVU	Ian Wilkes	Director of Operations, Linden Lab/Second Life
Daniel James	CEO, Three Rings	Nick Yee	Founder, Daedalus Project ; Ph.D. Student, Department of Communication, Stanford University
Joaquin Keller	Lead Designer, Solipsis ; Senior Researcher, France Telecom R&D	Ethan Zuckerman	Fellow, Berkman Center for Internet & Society, Harvard University
Raph Koster	MMORPG Designer; Former CCO, Sony Online Entertainment		
Mike Liebhold	Senior Researcher, Institute for the Future		

Other Contributors and Reviewers

Other foresighted individuals who contributed ideas to or feedback on the MVR.

Paul J.S. Beaubien	Independent.	Jonas Karlsson	Research scientist, Images and Services Technology Center , Xerox Innovation Group .
Alvis Brigis	Entrepreneur, new media producer, futurist.	Mason Lee	Blog, Mason Lee .
Peder Burggaard	Event Manager, Innovation Lab , Denmark.	Tim Moenk	Futurist, What a Concept . Blog, Continuous Partial Attention .
William G. Burns III	CTO, VR5 Online. Blog, City of Nidus .	Rik Panganiban	Blog, The Click Heard Round the World .
David Carmein	CEO, Virtual Space Devices .	Giulio Prisco	Blog, Uvvy .
Joel Greenberg	Sr. Planner, GSD&M . Friends Talking Podcast.	Byron Reeves	Director, CLSI , Stanford University. Expert on the psychological processing of media.
John Hanke	General Manager, Google Earth .	Joyce Schwarz	Principal of JCOM . Strategic marketing, branding, and new product introduction.
Darren Herman	Co-Founder of IGA Worldwide . Blog, Darren Herman .	Fred Stutzman	Co-Founder, Claim ID online identity management system, an implementation of the OpenID standard.
James Hursthouse	CEO, Online Game Services, Inc. Hosting and managing Massively Multiplayer Online Games since 1999.	Phillip Torrone	Associate Editor, Make Magazine .
Joi Ito	Blogger ; CEO and Founder, Neoteny ; Board, ICANN.	Philippe Van Nederveelde	European virtual world developer, entrepreneur, and futurist.
Sven Johnson	Independent product development consultant. Blog, reBang .	Bruce Woodcock	Researcher in Massively Multiplayer Online Games, mmogchart.com .
		Baba Yamamoto	Director, LibSecondLife ; SL History Wiki .



What happens when video games meet Web 2.0? When virtual worlds meet geospatial maps of the planet? When simulations get real and life and business go virtual? When you use a virtual Earth to navigate the physical Earth, and your avatar becomes your online agent? What happens is the metaverse.

Introduction

Over the past year the Acceleration Studies Foundation (ASF) and its supporting foresight partners have explored the virtual and 3D future of the World Wide Web in a first-of-its-kind cross-industry public foresight project, the Metaverse Roadmap (MVR). We use the term Metaverse in a way that includes and builds upon Neal Stephenson's coinage in the cyberpunk science fiction novel, *Snow Crash*, which envisioned a future broadly reshaped by virtual and 3D technologies.

The MVR has "near-term" anticipation horizon of ten years (to 2017), a "longer-term" speculation horizon of twenty years (to 2025), and a charter to discover early indicators of significant developments ahead. Seeking diverse points of view, our process included an invitational Metaverse Roadmap Summit, public and expert surveys, a few workshops and roundtables at major U.S. conferences, social meetups, and a public wiki. Many helpful people from the IT, virtual worlds, professional, academic, futurist, and lay communities contributed ideas to the MVR.

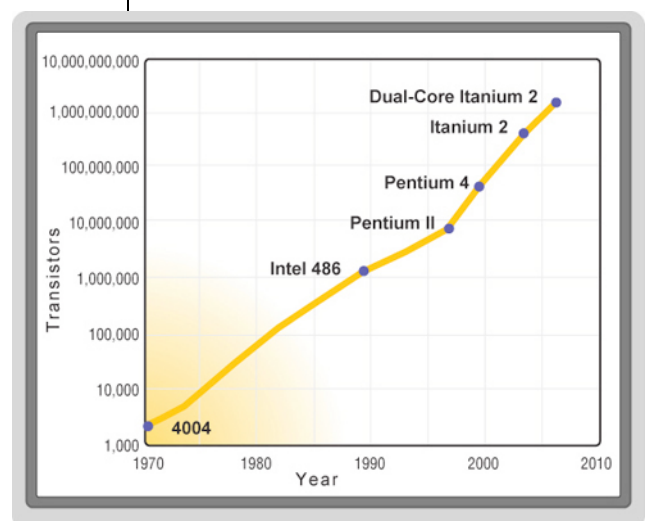
In its inaugural version, the MVR focuses on defining and exploring this major new social space. In future versions we expect to add industry-developed timelines for Metaverse technology development. Our inaugural MVR budget was roughly \$100K, paid for by our generous financial sponsors. With the resources provided we endeavored be as multinational and inclusive as possible. With greater recognition, more visibility and more sponsorship support, we look forward to bringing an even broader range of expertise to the next version of the roadmap.

The MVR comprises two documents, both available at MetaverseRoadmap.org: 1) a set of [MVR Inputs](#) (75 pages) which summarize key insights in 19 foresight categories, and 2) this MVR Overview (22 pages + Appendix) which synthesizes some (not all) of the Inputs into a series of narratives to explain important features of the change and opportunity ahead.

The goal of the MVR project is to regularly update our ten- and twenty-year public foresight by

periodically seeking the guidance of experts at sponsored MVR summits, and engaging in extended interaction with online communities through the use of blogs, wikis, podcasts, and other media channels.

We invite you to contribute your unique insights to future Metaverse Roadmap summits, conversations, and updates through feedback, volunteer effort, and financial support. In these early days of the Metaverse, financial sponsorship is particularly helpful to improving the quality of future roadmaps. Email us at roadmap@accelerating.org.



Moore's Law: A doubling of real computing power has occurred every 2.3 years, on average, since the birth of modern computing. Moore's Law is one of several enabling technological trends for Metaverse development.

Metaverse Definition

The Metaverse is a complex concept. In recent years, the term has grown beyond Stephenson's 1992 vision of an immersive 3D virtual world, to include aspects of the physical world objects, actors, interfaces, and networks that construct and interact with virtual environments. We have collected several definitions in the [Glossary](#) (Sec. 20) of the MVR Inputs. Here is one that seems as good a starting point as any: The Metaverse is the convergence of 1) virtually-enhanced physical reality and 2) physically persistent virtual space. It is a fusion of both, while allowing users to experience it as either.

There is no single, unified entity called the Metaverse—rather, there are multiple mutually-reinforcing ways in which virtualization and 3D web tools and objects are being embedded everywhere in our environment and becoming persistent features of our lives. These technologies will emerge contingent upon potential benefits, investments, and customer interest, and will be subject to drawbacks and unintended consequences.

In time, many of the Internet activities we now associate with the 2D Web will migrate to the 3D spaces of the Metaverse. This does not mean all or even most of our web pages will become 3D, or even that we'll typically read web content in 3D spaces. It means that as new tools develop, we'll be able to intelligently mesh 2D and 3D to gain the unique advantages of each, in the appropriate context.

Although the "Web" technically refers to a particular set of protocols and online applications, the term has become shorthand for online life. It's possible that "Metaverse" will come to have this same duality: referring to both a particular set of virtualizing and 3D

web technologies, and the standard way in which we think of life online. Like the Web, the Metaverse wouldn't be the entirety of the Internet—but like the Web, it would be seen by many as the most important part.

The emergence of a robust Metaverse will shape the development of many technological realms that presently appear non-Internet-related. In manufacturing, 3D environments offer ideal design spaces for rapid-prototyping and customized and decentralized production. In logistics and transportation, spatially-aware tags and real-time world modeling will bring new efficiencies, insights, and markets. In artificial intelligence, virtual worlds offer low-risk, transparent platforms for the development and testing of autonomous machine behaviors, many of which may be also used in the physical world. These are just a sampling of coming developments based on early stage Metaverse technologies.

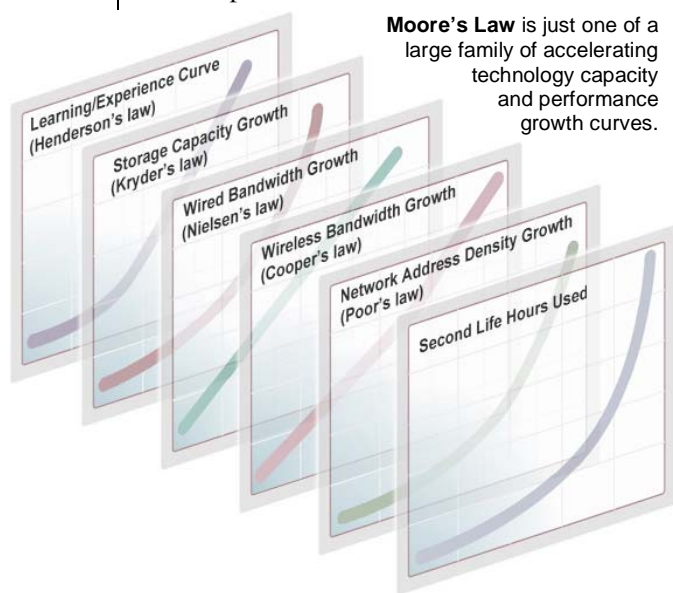
In sum, for the best view of the changes ahead, we suggest thinking of the Metaverse not as virtual space but as the junction or nexus of our physical and virtual worlds.

Enabling Trends

The back story of the Metaverse is that its emergence is being enabled by a number of exponential technology capacity and performance growth trends. Together, these rapidly expanding digital capacities and abilities are creating the "soil" in which our 3D web computing ecosystem is emerging.

See the [Constants](#) (Sec. 3) of the MVR Inputs for a sampling of their breadth and impact. Due to the special physics of the nanocosm

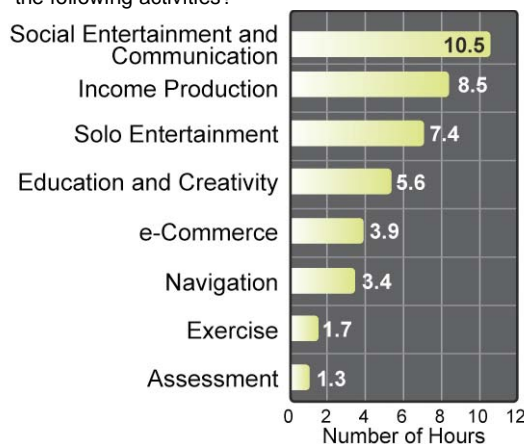
(efficiencies of ICT, nanotechnologies, and process automation based on these technologies), it is most reasonable to expect the great majority of these technology trends to continue accelerating over the time horizon of this roadmap.



MVR Survey

A twenty-two question survey of key uncertainties in the Metaverse future was developed and administered to our 50 summit experts (30 responded) and also briefly posted for public input at the MVR website (115 to 136 responded). Some valuable insights emerged, and a number of responses are included in the discussion below. Please see the [Appendix](#) for the full response set.

MVR Survey Question 22. In 2016, how many hours per week will a typical member of the U.S. population ages 13-30 use interactive, internet-accessing, 3D visual environments for EACH of the following activities?



In 2016 the Metaverse may be primarily a social and communication space, but experts suggest it will have many other uses as well.

Metaverse Scenarios

The complexity of the Metaverse suggests great uncertainty about how and when its forces and features will manifest in society. In such conditions, foresight professionals frequently use a scenario approach, creating a set of partly-unique and partly-overlapping stories of future conditions. Scenarios aren't a method of finding probable futures; instead, they're tools for exploring possible futures, and looking for less-obvious implications. Nevertheless, we do venture a few predictions in the following pages.

For those seeking additional opinions on probable Metaverse futures, we refer you to [Cycles](#) (Sec. 7), [Trends](#) (Sec. 8), and the many [Predictions](#) (Sec. 9), recorded in the MVR Inputs. Prediction analysis, another foresight practice, has repeatedly shown that even the best long-range technology forecasts typically have only a 50% success rate (*Megamistakes*, Schnaars, 1989). Assuming we have met that standard, which half of our MVR predictions are correct we leave to you, and the future, to determine.

To construct our scenario set we selected two key continua that are likely to influence the ways in which the Metaverse unfolds: the spectrum of technologies and applications ranging from *augmentation* to *simulation*; and the spectrum ranging from *intimate* (*identity-focused*) to *external* (*world-focused*).

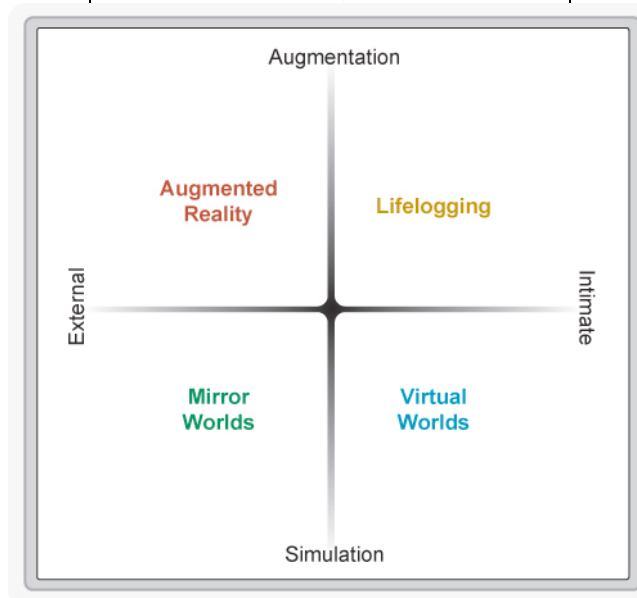
- *Augmentation* refers to technologies that add new capabilities to existing real systems; in the Metaverse

context, this means technologies that layer new control systems and information onto our perception of the physical environment.

- *Simulation* refers to technologies that model reality (or parallel realities), offering wholly new environments; in the Metaverse context, this means technologies that provide simulated worlds as the locus for interaction.

- *Intimate* technologies are focused inwardly, on the identity and actions of the individual or object; in the Metaverse context, this means technologies where the user (or semi-intelligent object) has agency in the environment, either through the use of an avatar/digital profile or through direct appearance as an actor in the system.

- *External* technologies are focused outwardly, towards the world at large; in the Metaverse context, this means technologies that provide information about and control of the world around the user.



These continua are "critical uncertainties"—*critical* because they are fundamental aspects of the coming Metaverse, and *uncertainties* because how they will emerge, their relative and absolute

development in various contexts, is yet to be seen.

Combining the two critical uncertainties gives four key components of the Metaverse future:

Virtual Worlds Mirror Worlds Augmented Reality Lifelogging

These four scenarios emphasize different functions, types, or sets of Metaverse technologies. All four are already well into early emergence, yet the conditions under which each will fully develop, in particular contexts, are far from clear.

There are of course other types and functions of technology likely to influence Metaverse development which are not explicitly covered in our scenarios.

Several of these minimally mentioned or neglected topics are likely to be major near-term influences, such as Internet Television (ITV) and Videoconferencing. Others, such as the Conversational Interface (CI) to the web may become key drivers only in the longer-term speculation horizon of the roadmap (2016 to 2025).

For more on such important factors, and several mini-scenarios relating to them, see [Positive Scenarios](#) (Sec. 10), [Negative Scenarios](#) (Sec. 11) and [Wildcard Scenarios](#) (Sec. 12) in the MVR Inputs.

Recognizing the complexity of the Metaverse space, we nevertheless consider the following four major scenarios an excellent starting point for understanding our virtual and 3D digital future.

Virtual Worlds (Intimate/Simulation)

Virtual worlds increasingly augment the economic and social life of physical world communities. The sharpness of many virtual and physical world distinctions will be eroded going forward. In both spaces, issues of identity, trust and reputation, social roles, rules, and interaction remain at the forefront.

Issues and Technologies

Discussion of the Metaverse usually begins with massively multi-user virtual worlds (VWs), a fast-growing space that is already mixing physical and virtual social, economic, and to a limited extent, political systems via both asynchronous single-user and realtime multi-user modes. Of all our scenarios, Metaverse Roadmap participants talked most about virtual worlds. At the same time, VWs evoked the greatest uncertainty and disagreement.

A key component of the VW scenario is one's *avatar* (or in multiplayer games, *character*), the user's personification in the VW. As in the physical world, capabilities accessible in digital space are contingent on the limitations of the avatar. But in comparison to one's physical persona, growth in the social, economic, and functional capabilities of one's avatar can be far more rapid, and learning experiences can be greatly accelerated. By contrast with the general 3D web, MVR participants expected only a limited non-entertainment adoption (and by inference, social utility and intelligence) of avatars and VWs over the near-term, ten-year roadmap horizon.

MVR Survey Question 17. In 2016, what percentage of internet users in more developed countries (MDCs) will use an interactive 3D avatar at least once a week for any purpose other than games and entertainment, including socializing, communication, creativity, education, barter, commerce, exercise, etc?

Summit Survey: 50% of users

Website Survey: 52% of users



Avatar image from [Perfect World China](#) website.

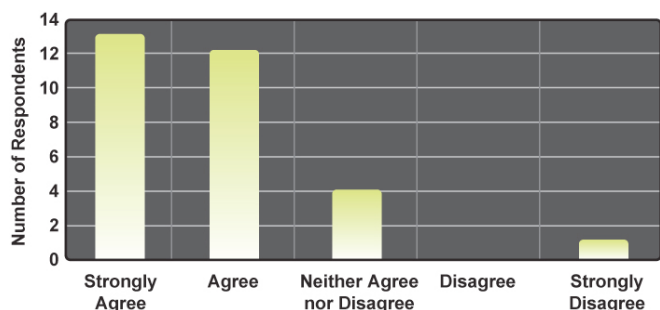
Electronic virtual worlds (first text based, later graphical) have existed since our first personal computers (e.g., MUD, Adventureland, and CBBS 1978). See [History](#) (Sec. 1) in the MVR Inputs. They are digital versions of narratives set in “other realities” since the beginning of civilization. In the earliest years, the quality of textual narratives, story, and emotional appeal drove adoption. Later, visual aspects became a leading differentiator. As graphical technology improved, it crossed a usability threshold, then broadband connectivity increased, and now software advances are giving new creative powers to the user. These developments have allowed social and economic potential to become major new differentiators. Many of today's “2.5D” VW's such as Playdo and Habbo Hotel attract millions of youth users. Their less-than-3D graphics can be overlooked due to their social benefits, simplicity, and speed of operation on today's computers.

There is a useful distinction between VW-based multiplayer games, such as Everquest or World of Warcraft, and VW-based social environments, such as Second Life and Sony's Home. Multiplayer games are goal-oriented, with social interaction used as a tool for task completion; such worlds are set in an internally-consistent fictional or fantasy-based realm. In most, entertainment is a primary goal. In so-called “serious games,” training and education are primary goals.



Screenshots from [Peacemaker](#), a serious game that teaches diplomacy, development, and conflict resolution in a fictional Middle East.

MVR Survey Question 6. Within the next five years, a leading global web company will launch, or buy and launch, a 3D virtual world where users are encouraged to engage in economic transactions and own as legal property products they create in the world.



Social VWs, by contrast, exhibit fewer overt goals and value structures, and offer more open-ended user freedoms, creation of objects, economic and social interaction, and interpersonal networks. In a few social VWs, such as the

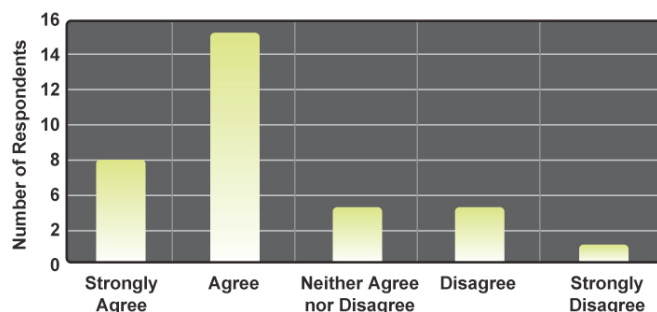
rapidly growing world of Second Life, the user retains some ownership rights to the objects, land, and other assets acquired in the world. The emergence of broader individual rights inside VWs, a move beyond historically restrictive EULAs (End-User License Agreements) was discussed by MVR participants as a new convergence between virtual and physical space. While inspiring, the vision (John Perry Barlow, 1996) of an emerging independent cyberspace, with its own political and economic rules and jurisdictions, like any sovereign nation, was not echoed by MVR participants, who talked of increasing physical world regulation over virtual space in the foreseeable future.

In practice, the game vs. social world distinction is often blurred, as goal-directed games always emerge inside social VWs, and as social experiences broaden inside the more popular game worlds. The distinction may be further eroded by interoperability, as VW “syndication” emerges in coming years. Having more user freedom to move avatars, interfaces, and assets between worlds—subject to the need to maintain story integrity in game-based worlds—was a common desire of MVR participants. But to move beyond today’s “Walled Gardens,” not only new standards and syndicates, but better systems for user identity, trust, and reputation will be needed, to ensure player accountability to the unique rules of each world.

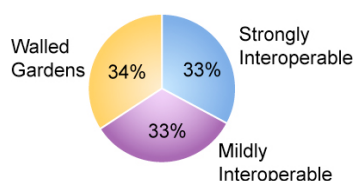
MVR Survey Question 2. In 2016, the most popular global 3D worlds (by user base) will allow the importing of user trust and reputation rating systems from a variety of other online environments.

Summit Survey N=30, Mean=3.87

Website Survey N=134, Mean=3.94



MVR Survey Question 21. In 2016, of the top 100 global 3D-enhanced online environments how many belong in each of the following interoperability categories?



Both VW’s and “mirror worlds” (virtual spaces that model physical space) offer object creation tools. But in

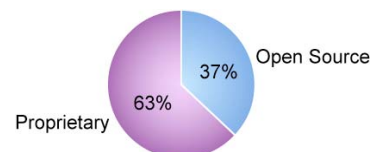
multiplayer VWs, object creation is constrained by the setting and game rules. In mirror worlds, creation is constrained by the need to reflect reality. Only in social VWs is the creation process truly open-ended, and many are becoming open-source as well. At present, Second Life (SL) offers the most powerful object-creation toolset in a virtual world. With some effort, SL objects can be converted to professional 3D programs (Maya, 3DS Max, Solidworks, etc.) for animation, blueprint roughs, and even computer-aided design and production of simple physical-world objects. SL’s next generation of server upgrades will also support spatial audio streams of its inhabitants, which will provide an attractive and useful new dimension to the VW. These are promising developments, though many challenges remain.



A panel discussion inside Second Life. Avatars can watch video, hear audio of the speakers, and text chat with each other privately during the event.

How many social VWs will themselves be open source in the longer term future, and how many will flourish with a limited use of open source on top of proprietary platforms was another topic of debate. Most MVR participants expected significant growth in open source VWs, but with the majority of commerce staying in proprietary worlds.

MVR Survey Question 8. In 2016, what percentage of global 3D virtual world and game commerce will occur in worlds that are operated under each of the following business models?



What is life like in this scenario?

The virtual worlds scenario imagines broad future participation in virtual space commons. Many new forms of association will emerge that are presently cost-prohibitive in physical space, and VWs may outcompete physical space for many traditional social, economic, and political functions. In the 20 year scenario, they may become primary tools (with video and text secondary) for learning many aspects of history, for acquiring new skills, for job assessment, and for many of our most cost-effective and productive forms of collaboration.

In the stronger version of this scenario, VWs capture most, if not all, current forms of digital interaction, from entertainment to work to education to shopping to dating, even email and operating systems, though the 3D aspects may remain minimally used in the latter contexts. Youth raised in such conditions might live increasingly Spartan lives in the physical world, and rich, exotic lives in virtual space—lives they perceive as more empowering, creative and "real" than their physical existence, in the ways that count most.



New identities, new social experiences.

Aided by VW interoperability, an individual may easily access a far broader set of experiences in digital settings than she or he could in the physical world, as well as a vastly larger social network. At the same time, the emerging Participatory Web is providing tools and platforms that empower the user to tag, blog, comment, modify, augment, select from, rank, and talk back to the contributions of other users and the world community. Tomorrow's 3D Participatory Web technologies will greatly enrich our virtual spaces. See [Current Conditions](#) (Sec. 2) of the MVR Inputs for more on the Participatory Web.

Many of today's "netizens" use 2D personal web pages and home pages in MySpace, and in Korea, 2.5D "minihompy" in Cyworld as their preferred interface to the world. Will tomorrow's "Metaversans" require potential contacts (those seeking emails, profile info, or live contact) to teleport to the VW address of one of their beautiful virtual homes, with exteriors that display their public interests and values to the world?



Virtual house in Sims 2. When will our favorite virtual objects be available from physical world retailers?

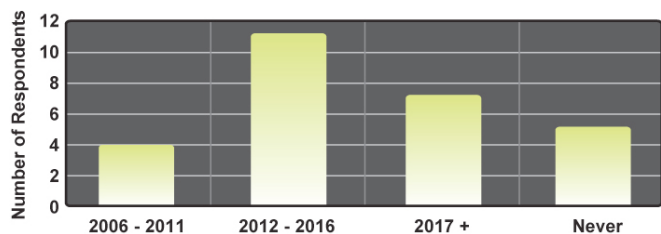
In a more limited version of the scenario, VWs become popular for a few social and professional interactions, and as an interface in certain social contexts, but end up filling a circumscribed role similar to that of present-day televisions, home game consoles, or personal computers. Much of what people do today in the physical world continues with little input from virtual worlds. This limited scenario came primarily from non-technologists, who thought cultural conservatism and economic barriers would be major roadblocks to the stronger vision. The

limited VW scenario would be most likely to be dominated by large traditional media companies rather than the pluralistic ecosystem we might expect in the stronger VW scenario.

New thresholds in dynamic photorealism of computer graphics, driven by the entertainment industry, will clearly drive incremental adoption. For example, the ability of webcams to dynamically map the facial expressions of computer users onto their virtual world avatars was considered a probable near-term VW development. The ultimate expression of the VW scenario would include simulation of proprioception (body position), touch, scent and even taste, a form of immersive virtual reality. Yet few participants considered such science fictional advances likely for mass use even in a twenty-year speculation horizon.

A key enabler for the utility of avatars as representatives, screeners, assistants, etc. would be a Conversational Interface (CI), [Inputs 8Ac](#), a dialog platform sophisticated enough to support web queries and responses (text or voice) using seven or more word "sentences," approximating simple human conversation. Today humanity uses an average of three words in our web searches, and we used an average of 1.3 words in searches on a much smaller and simpler web in 1998. Most participants expected the CI to emerge some time after 2012, and a substantial portion expected it after 2017 or never. Empowering avatars with primitive conversational intelligence would allow us to use them as simple secretaries, agents, and customer support. Individuals could query your "digital twin" 24/7 to learn your public persona and current status, and a CI would promote universal access to and use of the 2D and 3D web, even for nonliterate youth in emerging nations.

MVR Survey Question 19. For users in the U.S., when will the average query length used in leading search applications grow to seven words (voice or text)?



On the social side, perhaps the most obvious persistent trend will be identity experimentation, self-revelation and role play in VWs, and the creative variation of social norms around gender, ethnicity, social class, etiquette, and group values and goals. We see this in today's pioneering social VWs like Second Life, and social networks like MySpace. As the virtual worlds scenario unfolds, we can expect an explosion in the number of people engaged in such activities, and the ensuing social change to bring both positive and disruptive effects.

Mirror Worlds (External/Simulation)

Mirror worlds are informationally-enhanced virtual models or “reflections” of the physical world. Their construction involves sophisticated virtual mapping, modeling, and annotation tools, geospatial and other sensors, and location-aware and other lifelogging (history recording) technologies.



Google Earth home screen, North America

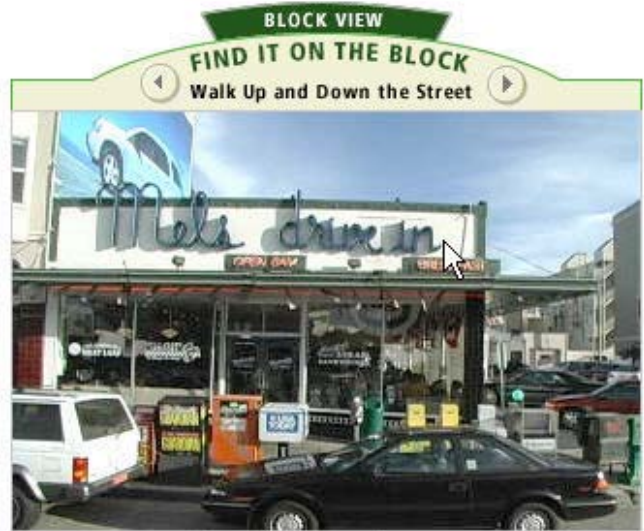
Issues and Technologies

Unlike virtual worlds, which involve alternate realities that may be similar to Earth's or wildly different, mirror worlds model the world around us. The best-known example of a mirror world (MW) is presently Google Earth, a free, web-based, open-standards digital map of Earth. Yet Google Earth is just one of a large class of mirror worlds, which are also known as geographic information systems (GIS). GIS systems capture, store, analyze and manage data and associated attributes that are spatially referenced to the Earth.

The first digital mirror worlds were government-built public resources (eg., the Canadian GIS, 1967). The next were expensive proprietary pre-Internet systems, funded by business and institutional customers (eg., ESRI's ArcGIS). Such systems remain very popular today, and have some free components. With the advent of the free Google Earth in 2005, a powerful open-standards MW came to the web. Google, Microsoft and others also offer for-pay MWs with additional GIS features not available in the free versions.

Initially, MW maps were based on cartographic surveys, with informational overlays. Later maps were updated with satellite and aircraft imagery, and now some (Google Earth, military systems) are being augmented by ground-based imagery, often produced by cars mounted with scanning cameras, driving

around cities to add ground-level images to the building models in our urban mirror worlds.



Amazon's Block View, street-level GIS images

Amazon's BlockView (2004-2006), was an early effort at ground-level urban images to supplement online Yellow Pages. While street pictures alone didn't increase adoption of online Yellow Pages, they make more sense as part of a free open-standards MW with multiple uses (shopping, tourism, navigation, business, research, etc.) especially if the provider (Google, Yahoo, Microsoft, etc.) can sell location-based advertising to accompany MW use. In this regard, new picture-based MWs, like Street View in Google Maps, deliver compelling visual information. The addition of live camera feeds to popular destinations will further increase the stickiness of such environments, and these platforms may be the most direct path toward the Virtual Town Square scenario (see below).



3D building model imported from SketchUp to Google Earth.

With the acquisition and free release of SketchUp, an intuitive 3D modeling program, Google has made it easy for users to add 3D building data (example above) to any of the GIS overlays (tourist attractions, real estate maps, roads, businesses, etc.) in Google Earth. Such tools will help the current generation of web users to more easily create virtual objects. By and large however, individual humans will not build tomorrow's 3D mirror worlds, though they will most certainly annotate them.

Look instead to automated 3D city model construction software, which converts digital pictures, video, laser, and embedded environmental inputs into 3D models via rapid

drive-thru acquisition. This technology is presently in use for small 3D spaces (eg, RealViz, 3rd Tech) and is nearing city-level utility. MVR participants considered such automated 3D hardware and software likely to be a major contributor to our mirror worlds in the near-term roadmap timeframe.



First-gen 3D buildings in Osaka, Japan on Google Earth.

Digital Earth systems add a precise spatial context to physical world information, a context that is either missing or very poor in other media formats. MW maps serve not only as representations, but also as interfaces for access to other networks and devices.

Open-standards and public platforms, like Google Earth, may become the dominant mirror worlds within the near-term roadmap horizon, but proprietary and private versions are also likely to see continued growth in the corporate and institutional sectors, to protect strategies and to seek competitive advantages.

Firms with GIS, sensor or virtual world strategies and experience are potential first-movers in the MW scenario. Standards will be important here, and open source has some potential to shake things up.

What is life like in this scenario?

Some futurists have proclaimed that virtual worlds, the Internet, global outsourcing and telepresence are heralding the “end of geography.” Such ideas were paralleled with advent of the airplane and telegraph a century earlier, which led to predictions of a “borderless world.” There is certainly a limited truth to these perspectives, yet mirror worlds will also make borders, cities, and spatial positioning even more interesting, productive, and important.

In coming years, the proliferation of location- and context-aware sensors will create smart urban and rural environments, and the quality of our mirror world simulations, augmented reality interfaces and object and user lifelogs (history recording systems) will steadily improve. Future classes of RFID and other

sensors will allow the emergence of “local positioning systems” (aka location-based systems) that enable us to locate everything we care about in our environment (e.g., tools in the house, children in the neighborhood, friends on the planet) on a realtime MW map.

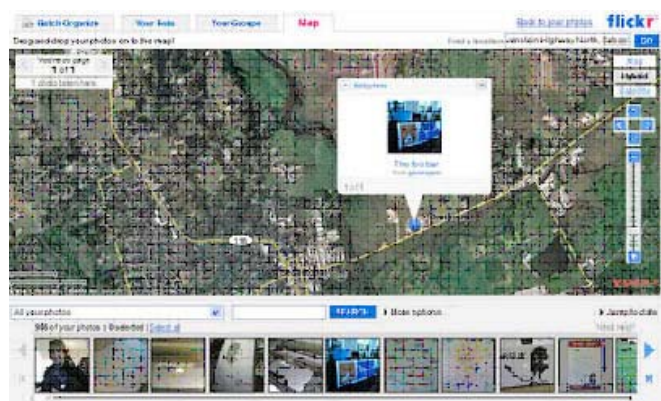
Mirror worlds for the home will be a significant new market. Security, property insurance, moving and storage, rental and barter, interior decorating, construction, and home automation are just a few of many industries that will be significantly affected. The informational power of these tools will create new challenges for crime prevention and privacy protection.



Google Maps on the Blackberry PDA

As GPS migrates to the car and cellphone, MW navigation and community search functionality will achieve mass adoption. Location-based search on the cellphone is a near-term development that will be a major new source of social value and provider revenue. Google and other companies are presently sourcing low-price GPS-equipped cellphones, to be offered even in emerging nations. Google’s mobile browser, incorporating Google Maps, will return search queries (eg, “coffee shop” or “supermarket”) filtered based on dynamic user location, with location-based ads a click away.

GIS integration with virtual world object creation (SketchUp, Second Life, etc) will also advance, and mirror world mashups with web-based digital photo sites (Flickr, etc.) are already in use. As internet television software and bandwidth develop (Joost, etc.), MW video integration will be next.



A Mirror World and Flickr photo sharing mashup.

The mirror world interface is a compelling educational, organizational, and commercial tool for understanding and managing global events such as climate and geopolitics. Transnational institutions, NGOs, and others with global focus are likely to be early users as MW functionality

improves. Digital Earth systems also offer a unique way to transition between global and local context.

At the regional and city level, the mirror world interface is very useful for navigation, education, commerce, and business analytics, including logistics, marketing, and finance. Once GPS-localization and videoconferencing can both be done within the MW, it seems a compelling platform for socializing and entertainment as well. See [Inputs 8Bj](#) for more on recent videoconferencing trends.

Imagine the following Virtual Town Square (VTS) scenario ([Inputs 9Bb](#)), in Anytown, USA, circa 2012. You are contemplating your evening entertainment options, so you teleport to various local VTS's, accurate but flashier mirror world models of your town's most popular social locations, to efficiently review your options. In each, you can browse 2D screens for movies, entertainment, etc., and quickly see which of your friends are at what venues, based on public reporting by their GPS-equipped phones.

You can also see their 3D avatars and talk to them firsthand, by voice or text, to see what's going on, or unobtrusively read their public calendars to see if they'd like others to join them. You can talk with the avatars of others visiting the space, who are either browsing along with you or who are downtown in person. Once the digerati of one city find personal value in a social VTS mirror world, others may be built in rapid succession. As with websites, there would be a good economic case for businesses to keep them up to date with the most recent information, live feeds (webcams, etc.) and advert video of the local activity.



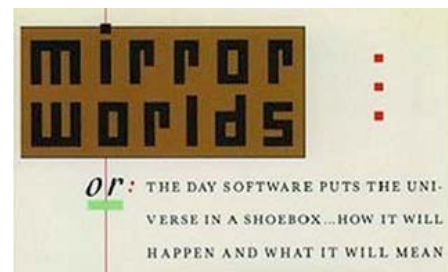
A virtual town square in the social VW Second Life.

Personal use of mirror world tools arises from the value of visual location-based information: directions, local weather, traffic, business conditions, subtle environmental concerns (such as pollution or pollen levels), and the like. Media companies may end up preferring mirror world environments as easy ways to control how their content is displayed. The mirror

worlds scenario is one in which a great deal of power comes from the technology's ability to "make the invisible visible"—that is, to reveal processes and flows (e.g. which local restaurants near your present location served the best-rated food last month, according to your preferred social groups) that would otherwise be too subtle or complex to recognize.

In the longer-term time horizon, given a sufficiently robust model of the real world, complete with abundant live data sources and preferences and values maps of the inhabitants, mirror worlds will eventually come to offer a powerful method of testing plans through data mining and simulation. Business, environmental, and political strategists may use a mirror world system to check the plausibility of plans against a physical or virtual community's publicly expressed preferences and values. For more on this concept, see the Valuecosm, [Inputs 9Cp](#).

Such a high-reflectivity model of Earth's visible and intangible aspects is outlined by David Gelernter in *Mirror Worlds*. Gelernter is optimistic that our coming data-rich geographic simulations can give us not only tree-level insight but also forest-level "topstight" into complex global systems, many of which are presently obscure.



Mirror Worlds by David Gelernter, 1992

If the leading mirror world tech trend is towards increased data inputs (proliferating global sensors) and complexity and accuracy in our sims, the leading MW social trend may be efforts of the powerful to control access to the most useful new information. Mirror worlds are democratizing and pluralizing only to the extent that everyone has access to and can annotate them. If that access is restricted, they can easily become instruments of state or corporate control. As long as this is seen as a socially-undesirable outcome, much political effort will go into finding ways to maintain and equalize access. The rising power of the individual to use technology in socially destructive ways will be one problem made worse by MW access. In wise societies, this problem will be countered by the rising social transparency and accountability that mirror worlds, augmented reality, lifelogs and related technologies provide. Different cultures will make different choices with respect to MW prevalence and access, but in general, they hold great promise to be a positive-sum social force, and to protect both civil liberties and social values and identity.

Augmented Reality

(External/ Augmentation)

In augmented reality, Metaverse technologies enhance the external physical world for the individual, through the use of location-aware systems and interfaces that process and layer networked information on top of our everyday perception of the world.



Artist's idea of augmented reality heads-up display (HUD)

Issues and Technologies

Historically, the augmented reality (AR) concept is based on the emergence of mirror world maps and global positioning networks, including the U.S. GPS and its European competitor, Galileo (due in 2011), as well as cellular phone localizers relying in part on triangulating cell towers. As GPS has become increasingly commonplace, new services have emerged to take advantage of this geographic information, from location tagging and logistics monitoring to location-based games and context-aware advertising. Such services are fairly rudimentary today, but will improve greatly in granularity, accuracy and usability.

Augmented reality depends on the further development of intelligent materials and the "smart environment"—networked computational intelligence embedded in physical objects and spaces. As described in Adam Greenfield's *Everyware*, this vision of the so-called "Internet of things" moves well beyond today's primitive classes of RFID (radio frequency identification) tags. Concepts such as the "spimes" described by Bruce Sterling (individually-identified objects that can be tracked through both time and space over their lifetime) or Julian Bleecker's "blogjects" (objects that keep a running public record of their condition and use) offer examples of the ways in which materials, goods and the physical environment play a part in the augmented reality world.

Physical hyperlinks, [Inputs 2A](#), are a recent major AR advance. PHs are machine-readable identifiers (1D and 2D barcode, RFID tag, image, sound, fingerprint) that can be resolved by a cell phone camera. A high-capacity (4,300 character) square 2D barcode called the QR ("Quick Response") code is now proliferating in Japan, with QR code readers preinstalled on all new 3G cellphones. They are appearing on business cards (eliminating data entry), magazine pages (for discount coupons), packaged goods (for nutrition information), airport kiosks (for paperless airline travel), even billboards (for movie trailers). Once recognized by the camera, a single click dials a number, starts an email, or takes the user to an internet site. Future applications are limited only by the imagination.



A few of the many QR code applications in Japan.

Another important aspect of the AR scenario is the interface, the ways and choices users have to access virtual information overlaid on the physical world. One type of interface is a heads-up display (HUD), providing context-significant information through a mobile viewscreen (window, eyeglasses, cell phone screen, etc.). Microvision uses a tiny laser that paints a virtual image on a flipdown screen, or even directly on the user's retina.



Microvision's Nomad AR device

More conventional visual interfaces, such as mobile phones and the navigation screen in cars, are bound to be the most common AR interface for the near-term. Nevertheless there is room for innovation, as in wearable phones whose lightweight visual display covers the back of the hand and wrist (see the Carpal PC, [Inputs 9Ab](#)). Mobile wearable screens are to some degree virtual or mirror worlds, as they command all of the user's attention, at least for a glance. But they are also AR, as context-

sensitive information is overlaid on them as they move through the physical world.

Another promising AR approach is an audio interface, with voice- or context-driven information delivered via earpiece (e.g., the ability to ask your search engine anything, and have an answer whispered into your ear, contextualized to your physical location). Wearable audio AR may require a more robust Conversational Interface before it reaches mass adoption however.

What might emerge in the near-term is location-based cellular radio (LBCR), [Inputs 9Bd](#). Today, 3.5 and 4G wireless platforms can already stream internet audio to the car radio and cell phone. Add GPS and a mirror world directory system and you can deliver location-based streaming radio to the mobile user. Many mobile users would like car and cell phone radio channels that give them 1) ultralocal news, politics, weather, and traffic, 2) reviews and business-published info on local restaurants, shops, and entertainment events, as they are approaching them, and 3) educational and historical information for local landmarks. LBCR might be a multi-billion dollar industry by 2016. Or it may be a white elephant platform still waiting for user adoption.



Steve Jobs demos the iPhone.

MVR Survey Question 12. In 2016, what percentage of global mobile device users (cell phone, PDA, etc.) will have always-on broadband internet accessibility from their devices?

Summit Survey: 81% of users

Website Survey: 79% of users

Another potential near-term AR platform is the Display Table/Game Table, [Inputs 10Af](#), a kitchen, dining room, or workroom table with a touchscreen display surface, networked vertical wall display(s), and individual AR displays for each user/player. Once affordable, such a device will facilitate new videoconferencing, collaboration, entertainment, and social experiences beyond the living room and the standalone computer.

What is life like in this scenario?

The augmented reality scenario offers a world in which every item within view has a potential information shadow, a history and presence accessible via standard interfaces. Most items that can change state (be turned on or off, change appearance, etc.) can be controlled via wireless networking, and many objects that today would be "dumb" matter will, in the augmented reality scenario, be interactive and to a degree, controllable. To the AR generation, such properties will be like electricity to children of the 20th century: essentially universal, expected, and conspicuous only in their absence.

Whoever delivers the first useful and scalable AR operating system and standards, perhaps via the cell phone platform, may become a central player in this future. As virtual data proliferate, information overload will be a common problem. The best of these will regulate human use of the system, respecting natural work, rest, and recreation cycles. In the near-term, AR devices may employ today's collaborative filters, which self-organize to advance one's interests and values. This will empower user annotation and the expression of individual opinion: the Participatory Web. Smart tag-based networks will allow individuals to advise friends on which restaurants, shops or services are worth visiting, and which should be avoided. Time-based processes (such as appointments or deliveries) can be followed with a small widget in one's visual interface, unobtrusive but always available.



Microvision's wearable AR display concept.

In the longer-term future, different people may have very different experiences of the same physical location. In extreme cases, one could use AR to hide images (such as signs, video displays, even other people) considered distracting or offensive. In a new form of self-obsession, isolation, and addiction, some might choose to see only "Potemkin Villages," an information façade catering to their pre-existing biases and desires, and obscuring unpleasant reality. Media services, religious groups, software companies, and many other players are likely to compete in the filter market, and economic and political pluralism should help ensure these systems empower rather than control the individual.

Lifelogging (Intimate/ Augmentation)

In lifelogging, augmentation technologies record and report the intimate states and life histories of objects and users, in support of object- and self-memory, observation, communication, and behavior modeling. *Object Lifelogs* ("spimes," "blogjects," etc.) maintain a narrative of use, environment and condition for physical objects. *User Lifelogs*, ("life-caching," "documented lives," etc.) allow people to make similar recordings of their own lives. Object lifelogs overlap with the AR scenario, and both rely on AR information networks and ubiquitous sensors.

Issues and Technologies

Lifelogging is the capture, storage and distribution of everyday experiences and information for objects and people. This practice can serve as a way of providing useful historical or current status information, sharing unusual moments with others, for art and self-expression, and increasingly, as a kind of "backup memory," guaranteeing that what a person sees and hears will remain available for later examination, as desired—what Microsoft founder Bill Gates called a "documented life" in *The Road Ahead*, 1995.

Lifelogging emerges from accelerating technological trends in connectivity, bandwidth, storage capacity, sensor accuracy, miniaturization, and affordability.



TrackStick, a \$200 GPS lifelog the size of a pack of gum

Object lifelogging is presently seeing a wide range of incremental advances. GPS lifelogs like TrackStick which interfaces to Google Earth, are concealable in cars and objects, and are making inroads in law enforcement. In the consumer market, Toyota Japan offers in-car cameras, networked to the Toyota Security Center, for auto theft prevention and recovery. Some consumer in-car cameras now record outside the windows, to detect the license plates of cars that do damage to the vehicle.

As inexpensive car video lifelogs become widely available, able to relay the last several minutes of their exterior visual footage to any phone number or email address at the touch of a button, accidents, red-light violations, unsafe driving, and other infractions may be

reported by concerned citizens with great frequency. Traffic laws and norms will see adjustment as a result.



Nike+ and iPod: Personal trainer, global running community

Nike and Apple have formed a partnership to turn shoes into lifelogs and personal trainers, using the iPod and the web. Tens of thousands of runners upload their running statistics daily to the Nike Plus community. As their cost drops steadily in coming years, many new object lifelog opportunities will emerge. Would you pay an extra \$10 for a computer screen that logs a memory of its recent visual states in case of a crash? What would you pay for lifelogs on your car, keys and wallet? For a wallet that notified you if the credit cards weren't quickly replaced within it? Used appropriately, object history and smartness can improve our awareness, security, and productivity.



Nokia lifelog organizes cell photos into an organic timeline that can be annotated, mobile blogged, and shared.

User lifelogs are also in broad development. Perhaps the most obvious examples of early user lifelogs are the current generation's widespread use of digital and cell phone cameras to document and share life experiences online. Leading phone makers like Nokia and websites like Flickr have platforms to facilitate photo taking, annotating, sharing and mobile blogging.

Justin.tv, streamed to the web by Justin Kan via a small wearable headcam and four Verizon EV-DO cell modems (\$240/month in bandwidth costs) is just the latest example of early "lifecasting" activities. Such systems may be affordable for youth and specialty use in the near-term roadmap horizon, and new "life sharing" opportunities will emerge.



Justin.TV runs a 24/7 video "lifecast"

MVR Survey Question 14. In 2016, what percentage of the U.S. population ages 13-30 will allow their trusted group to view 3D images of what they are doing in realtime (through wearable cameras) at least once a month, and to be able to give feedback or advice?

Summit Survey: 29% of population

Website Survey: 36% of population

Child security from abduction is a presently a significant public concern, and another potential for near-term user lifelogs. Affordable localizer devices that can be concealed by implant in the body are likely decades away, and may face high hurdles to public acceptance. What is feasible in the next ten years, however, are 3.5 and 4G security cellphones, worn at the belt or like a necklace, on which the camera, by its red light, is obviously on, recording, and wirelessly transmitting its image to a remote network. Such a security lifelog, with automatic recording and manual reviewing features, would capture criminal acts on video, even if the phone were immediately destroyed. In the same way that CCTV cameras in car parks lower car theft rates globally, such a device, worn by very young children and security conscious adults in public, might have some protective effect for their wearers. Recording in school to prevent bullying, etc. would be another potential use, and an obvious personal vs. state's rights issue to be adjudicated in coming years.



Wearable sousveillance concept from Wearcam.org

Lifeloggging technologies offer two primary functions: first, they serve as a kind of "TiVo" for one's life, recording the sights and sounds one encounters throughout the day; second, they enable collaborative sharing and aggregation of life experiences. Both functions are potentially socially-disruptive, even as they offer capabilities of immediate value to users.

The primary technological hurdle for the mature lifeloggging scenario isn't the hardware, but the software: how does one tag, index, search, and summarize the terabytes of rich media archives of one's own life? Several technology companies (Microsoft's My Life Bits, etc.) are hard at work on this problem.

Beyond the near-term youth market, truly powerful user lifelogs seem unlikely to emerge until we have intelligent autocaptioning and autosummarizing systems, and a functional Conversational Interface (post 2016?), allowing voice-driven search on a wearable system through one's archive of past

experiences (e.g., "show me that conversation last Summer when I was discussing abc with xyz.").

MVR Survey Question 15. In 2016, what percentage of the U.S. population ages 13-30 will use 'lifeloggging' systems during significant portions of their lives?

Summit Survey: 24% of population

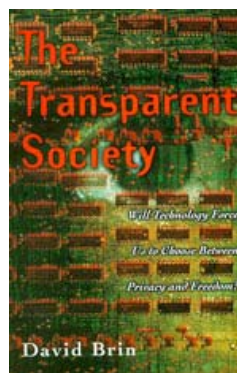
Website Survey: 32% of population

What is life like in this scenario?

Life in the lifeloggging scenario has the potential to be simultaneously empowering and demoralizing, in the sense that the older generations may have some difficulty adjusting and a nostalgia for simpler, earlier times.

For lifeloggging adopters, retention of past experiences will become functionally perfect, but recall and analysis of those experiences will only be as good as the web-based indexing and search software, which will constantly improve itself over the lifespan of the user. Even with minimal analytical capabilities, such systems would be of great value to experimental youth, to technology-inclined elderly (expect early uptake in Japan), to business people, to civil servants, and many others.

A perfect memory isn't necessarily an ideal, at least by current social standards. Human relationships are aided by the consensual misremembering of slights, allowing the sting of insults and personal offenses to fade over time. With easy access to records of past wrongs, "I forgot," will be much less frequent, and some will find it impossible to "let bygones be bygones." On the positive side, new social accuracy will provide opportunities for individuals to more frequently admit their mistakes, and after some ego adjustment, help them be more tolerant and open to a change of mind and behavior. We see such learning on some (not all) blogs today, which are accurate text-based lifelogs of past arguments in social space.



David Brin makes this point well in *The Transparent Society*, 1999, an introduction to the social changes we can expect in tomorrow's highly virtualized and publicly transparent society. Individuals in a democracy ultimately become nicer when their actions are available to social and self-observation, though not without a struggle. Behavior change is never an easy process.

Add network capability to this technology and life gets especially interesting. Unlike virtual worlds, lifeloggging won't allow you to walk in another person's shoes, but it does allow you to look at the world through another person's eyes. Or multiple people's eyes: memories tagged

for a particular time and place can call up similar recordings from others at the scene, giving an individual access to multiple perspectives on an event.

Potential applications of such capacity are legion: more accuracy in law enforcement, better education, training, counseling, self and social awareness, conflict resolution, etc. It is also a powerful example of sousveillance ("watching from below") to balance the surveillance ("watching from above") ability of the modern state.

Today, the WITNESS project's online portal offers global human rights activists a place to send images and video documenting abuses by powerful actors; lifelogging technologies would make that possible for everyone.



Witness.org: Lifelogging circa 2007

Systems advanced enough to recognize objects, symbols and individual faces, visual AI tasks that many experts expect to be accurate enough for general use in ten to twenty years, will offer powerful new abilities not just to society but also to individuals. At a minimum, the software would be able to call up earlier interactions for quick review, or at the very least a name and context. If systems can be readily networked, the lifelogging gear could call up references from trusted friends and relatives, giving any one person access to the collective social memory of her personal network.

This has obvious implications for reputation networks. Inevitably, once it's possible to access networked memory references about someone or something, users will wish to share their opinions about their own experiences with the subject. As long as the reputation network focuses on products and services, the group ratings will differ little from today's collaborative product recommendation systems. Once the network begins to apply to other people, however, questions will arise about liability for spreading harmful misinformation. New legal frameworks will likely ensue.

A leading technological trend over this time period will be the increasing ability of lifelogging systems to make meaningful connections between disparate "memories," both individual and collective. In its fullest expression, such technology may become not simply a backup memory, but a backup sub-conscious, offering powerful cognitive augmentation and advice by past example. Viewed from the biggest picture, when coupled with ongoing work on the development

of artificial general intelligence, lifelogging becomes one of several valuable pathways to a greater integration of human and machine "minds."

We should conclude our final scenario with a major observation: the technologies in three of our four scenarios, mirror worlds, augmented reality, and lifelogging, will all strongly increase public transparency—and with user consent, private transparency as well—in coming years.

How far might we take this transparency trend? Will we come to regard the present, an era where people can go out in public without biometrics or electronic signatures that uniquely identify them to the network as a "Wild West" of crime and lawlessness?

The far future is hard to visualize, but we can imagine many socially attractive near- and longer-term transparency steps along the way. How likely is it, for example, that once they are sufficiently inexpensive and miniaturized, we will see laws mandating networks and lifelogs (eg., GPS-on-a-chip, feeding into a gun's "flight recorder") to be installed on all our new small arms, weapons, explosives, and other mass lethal technologies ([Inputs 8Aj](#))? Would those democratic societies that pioneer such networked and localizable weapons (NLWs) find they turn offensive technologies into defensive social assets?



Networked localizable weapons: A future lifelog development?

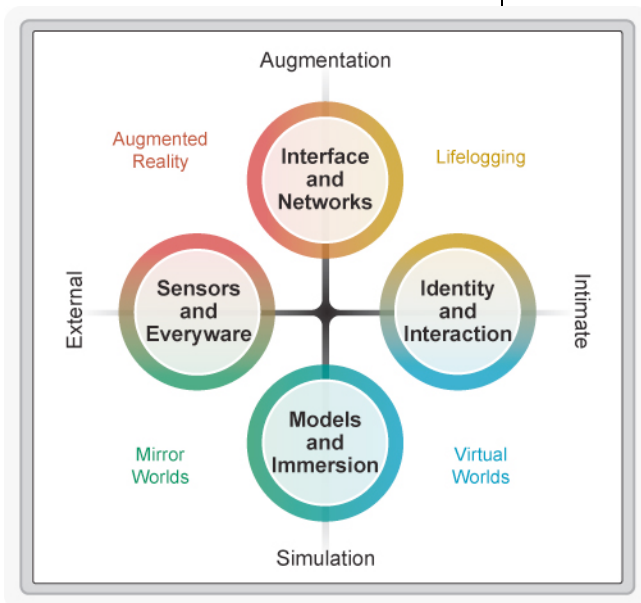
It seems reasonable to expect that the leading long-term social trend in lifelogging will be grappling with the impact of greatly elevated transparency, including all the inevitable attempts to hack, game or otherwise manipulate these systems. Security, privacy, fraud prevention, and the protection of civil liberties for users and those recorded will be ongoing concerns. As Justin.tv's website header says, "We're going to need more lawyers."

We can also expect significantly different responses to these technologies country by country, particularly in their early years. To generalize, we might look to security-conscious and innovative countries like Singapore, Israel, South Africa, the U.S., and Korea for early innovation, to Asia for technical leadership, and perhaps to Europe and the U.S. for legal innovations that define their use consistent with growing personal liberties and social responsibilities.

How These Combine

The Metaverse contains elements of all four scenarios. At the same time, their technologies broadly overlap, as in the use of a mirror world map inside a virtual world, or a heads-up display AR system or object or user lifelog inside a mirror or virtual world. There are also more general ways the scenarios overlap.

One link between the **virtual worlds** and **mirror worlds** scenarios is the refinement of digital models of environments, and the sense of immersion that results from good models. At present, virtual worlds for games, education, or socializing have rudimentary



physics models, and little if any emergent or evolved phenomena—they're scripted, static, or entirely dependent upon user creation. Conversely, today's best mirror worlds have little sense of place or immersion, limited real-time shared content (where the actions of one user changes what other users see), and restrictions on what users can do within the environment. Improvements in either version of simulated worlds will come from lessons learned by examining the alternative.



Google Map of World of Warcraft

A link between the **mirror worlds** and **augmented reality** scenarios is the proliferation of sensors, networked devices, and intelligent materials. Both scenarios are heavily dependent upon the deployment of a multitude of systems able to monitor and influence properties of the physical world—the primary difference is the interface used to access this data. The two scenarios overlap yet have their unique strengths, with mirror worlds effective as tools of large-system monitoring and control, and augmented reality systems effective as mediators of personal interaction and point control.

A link between the **augmented reality** and **lifelogging** scenarios is the development of a sophisticated interface for experiencing an enhanced awareness of one's physical and social environment, and sufficient network capacity to support full-time personal use. As described in the scenarios, the most effective AR and user lifelogging systems are likely to be unobtrusive wearable devices, which hand off most of their computation-intensive tasks to the network. Again, an augmented reality future will have some elements of lifelogging, and

vice-versa, because the tools for one are enablers for the other.

A link between the **lifelogging** and the **virtual worlds** scenarios is the emergence of a consistent digital identity allowing for seamless interaction between in-person and virtual representations of other people. This requires the development of an infrastructure that is open across multiple platforms, secure against spoofing, and able to recognize that you are you, regardless of how or where you're connecting. Advanced identity, trust and reputation may be slowest to emerge in virtual space, where part of the allure is to recreate oneself outside of one's social history. But the growing public transparency that will accompany advances in the other three scenarios is likely to impact virtual worlds as well, though perhaps to a lesser degree.



Facebook Profile

fingertips the biographies, personal trajectories and intimate glimpses into the lives and behaviors of ordinary individuals, organizations and locations around the world. At the same time, we'll run the risk of building overly-subjective appraisals of the world, relying too heavily upon individual observations, and insufficiently upon considered, detached analysis.

Transparency and Political Power

The rise of the Metaverse underscores already-extant, serious social, political, and economic questions about information. Who decides what sources of information should be visible, and what should be obscure? Are there only a few central sources for descriptions of "locations, events and communities of interest" (creating a serious potential for bias and inaccuracy), or is such information pluralistic and emergent from the individual contributions of participants, (making self-promotion, vandalism and other petty abuses likely)? What happens when filters create a distorted view of a topic or location? Who decides what's correct? Who pays for abuses?

Simply choosing to opt out is little help. If these technologies become as commonplace and important as we believe they will, people who choose not to participate may end up as left out of commercial and civic discourse as Web-ignorant people are today. If lifelogging and augmented reality technologies becomes commonplace, those who have access to complete records and fee-based databases may have a big advantage over those who can only access the free data, or worse yet, still rely exclusively on their faulty "meat" memories. In the long-term future, the choice of operating without personal memory technology may even render one unemployable for many professional tasks.

Most ominously, Metaverse technologies could be used by large institutions, particularly major corporations and governments, to maintain and worsen social, political, and economic inequalities in today's only partially democratic societies. There are myriad control and access issues ahead in both the near- and longer-term. If network neutrality is compromised, if walled gardens are allowed unfair competitive advantage, if internet monopolies aren't aggressively countered, in the coming generation Metaverse developments could concentrate power into a limited set of hands, and create transparency only for the "underclass." Monitoring the populace would be simple, and with the wrong application of "everyware" technologies, so too would be the manipulation and limitation of choice.

In addition to enlightened "top-down" leadership, continued "bottom-up" activism, to ensure increasingly democratic and pluralistic access to and control of these technologies, seems fundamentally important to responsible global development.



Jeff Han's multi-touch screen

Business Benefits and Challenges

Information Shadows

Increasingly, businesses talk about the "information shadow" of the products and services they provide: the records of contacts, sources, deliveries, versions and so on that offer a complete history of a business offering. In coming years, the richness of information shadows in virtual space promises even the

smallest Metaverse-using retailer the current logistics power of a Wal*Mart, the analysis power of an Accenture, and the research power of an IBM.

For specialized businesses, the Metaverse will be of substantial benefit to those seeking a better understanding of the more subtle global systems. Transnational companies will love the Metaverse, as will academics and activists trying to better understand globalization and sustainability in the new era. Transportation, product data and responses to customer needs can be made much more efficient. For designers and corporations, such information access will make "mass customization" production and niche marketing cost-effective.

For businesses producing or selling commodity goods, the abundant information will continue eroding margins and rewarding automation on "commodity" products and services, and at the same time creating demand for innovative new dimensions to products and services. Price, product and service comparisons will be available at a glance, undermining the power of brand as differentiator, unless tied to Metaverse metrics.

This is a world where "big box" retailers may extend their services to "little box" subsidiaries (e.g., Wal*Mart, Vons, etc. taking over many of the local liquor/sundries stores). Monopolies of convenience (e.g., uncompetitive local choices for basic goods and services) will be an ongoing risk and regulatory challenge.

Where local convenience is not a factor, businesses will need to offer buyer-specific services to hold onto regular customers; fortunately, the information shadows about people will make that task simpler, and herald a whole new level of

consumer behavior modeling and predictive marketing. For that reason, privacy (as discussed below) will be a heightened concern in the world of the Metaverse.



Google Map pin edited into physical space

Leadership and Competition

The social dimensions of the Metaverse have business implications as well. Many MVR participants noted that the leadership and collaboration skills required in virtual environments are increasingly well-suited to excelling in the business world. In coming years, quest management in virtual worlds, or winning entrepreneurial serious games may be as valid as sports team leadership or other traditional experience for executive training.

Questions about leadership are particularly important in a world seeing a major economic and technological transformation. The challenges facing businesses moving into the Metaverse will be analogous to those that faced in building a web presence, or globalizing operations to stay competitive.

Early adopters will try to figure out how to best use the new medium at each stage of its development, not always successfully. Business models for the use of Metaverse tools may be non-obvious, and new competitive environments are always rife with experimentation which eventually dies away. It's possible that many of the for-profit groups currently exploring Second Life, for example, won't stick it out long enough to make it profitable.

Skillful use of the emerging medium in its earliest stages requires ongoing employee education, low-risk experimentation, and the desire to “learn a new language” of information design. Those companies that get it first may have a significant competitive advantage over the laggards—both in business categories that reward first movers, and in those that reward “fast followers,” companies that use a new medium primarily to watch and learn from the early adopters, and then step in quickly later as prices drop, markets mature, and experience mounts.



Mixed-reality event in Second Life

Early adoption benefits individuals in today's social virtual worlds like Second Life, which currently has 2 million active users (logged in last 60 days) and \$1.5M of daily economic transactions. It also benefits companies serving those users, and may soon apply to virtual companies inside such worlds.

Early adoption benefits are also proven in mirror worlds, which already have a large GIS user community, and where competitive advantages can be built around GIS awareness as new global systems and processes come into simulation. In developed countries with good digital networks, augmented reality and object lifelogging may not be far behind MWs and VW's as innovation spaces and competencies worth exploring for today's global virtual businesses.

Transparency and Reputation

The important questions about transparency apply to the world of business as readily as they do to the world of politics. The generation growing up on blogs, MySpace and Flickr will likely embrace Metaverse tools as a means of operating in as transparent a fashion as possible.

Customers who are well-served will be public with their happiness; customers who feel cheated will be all the more vocal in their unhappiness. Moreover, it will be easy for customers to discover that they have been cheated, simply because of the ease with which they can uncover information regarding competitors, suppliers, and other customers.

This is true even if reputation network technologies don't emerge. If they do, the benefits and challenges for business are further multiplied. In a reputation network version of the Metaverse, good actions are easily rewarded and misbehavior is only slowly forgotten. For many businesses, this will be akin to having a collaborative, always-available version of *Consumer Reports* tracking their every step.



Xbox Live marketplace

Even more than other media that have come before it, we can expect the Metaverse to amplify our individual, corporate and institutional winners and losers, both economically and in the theatre of public opinion, across a bewildering variety of attributes and values, and for a growing network of cultures and subcultures.

Big Questions

Privacy and Control

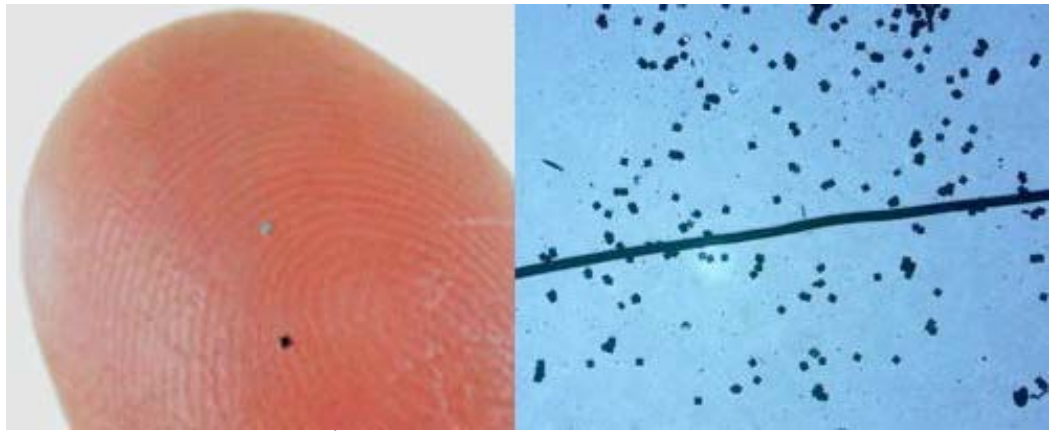
In many respects, the biggest question about the emergence of the Metaverse concerns privacy.

Abuse of privacy fears have already slowed the growth of the RFID tag industry, and remain a common response to both the expansion of official surveillance capabilities and the growing presence of camera phones; it's highly likely that "everyware" and lifelogging technologies will elicit a similar reaction. Early versions of mirror world, AR, and lifelogging technologies could be caricatured as "Total Information Access" revisited. Depending upon who is building and has access to those tools, such a characterization may not be too far off the mark.

Even if the technology works well, it may emerge in a culture where social trends point away from ubiquitous observation and relentless transparency. If people in the developed world begin to believe that their privacy has been too easily undermined by commonly-available technologies, they will be more likely to push for restrictions on those technologies rather than expansion. We could get a similar outcome if the form of social transparency that seems to be emerging is one where scrutiny doesn't cross class boundaries.

Some would say that present-day levels of social transparency in democratic societies put the lives of the rich and powerful under a far more intense public lens than that applied to ordinary citizens. Whether this is sufficiently effective to reduce corruption at the top is another question. It has been argued that it is more practical to aim accountability reforms at mid- and low-level government and business positions in the process of reform (Singapore, as one example), at least in the early stages of transparency development.

One of the more subtle engines for both centralization of power and public backlash may be intellectual property (IP) concerns. Existing IP laws are almost certain to blunt the capabilities of any technologies that record or access copyrighted content, at least in the near-term. Any but the simplest and weakest digital rights management (DRM) systems are likely to be both ineffective and obtrusive, reducing the attractiveness of many Metaverse technologies.



Hitachi's Mu Chip, an RFID "powder" small enough to put in paper currency.

Integration and Acceptance

The degree to which Metaverse technologies can be integrated into existing social, economic and political behaviors is one factor influencing the overall public acceptance of these systems.

Of the four aspects of the Metaverse we have outlined, the augmentation scenarios (augmented reality and lifelogging) seem the most like our current world, at least in their early forms: many more portable devices populating wireless networks; abundant information (if we can get to it); increasing surveillance by commercial and official entities, yet a growing gap between technologies employed in private vs. the slower government sectors. Examined more closely, however, it is clear that the networked portions of these scenarios are quite dependent upon the presence of common protocols and interfaces connecting the various information sources and points of access. They are also dependent upon public interest in abundant information clouds. Do people really want to know "everything" going on around them? If so, how rapidly will they develop a social, political, and legal consensus? In which domains will consensus emerge first, and in which will it be delayed?

The virtual worlds scenario is more complicated. The various existing virtual world-type systems, multiplayer games and social environments, have been around in some form for decades, and their partisans are the most likely to embrace the overarching concept of a "Metaverse."

Some of the most important developments in large-group remote interaction, identity creation, and object design have taken place in virtual worlds settings, and the likely near-future advances in these systems,

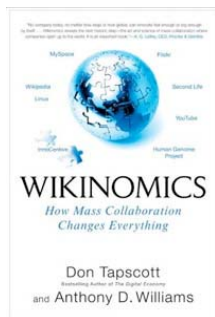


Simplified 3D Creation in Will Wright's Spore

particularly with regards to persistent identity, should lay the groundwork for even more advanced interfaces and capabilities.

At the same time, the vision presented in the virtual worlds scenario is one of a fairly substantive set of changes to everyday behavior, requiring adjustments to how we conceive of work, economic status, communities, and relationships. Such changes would experience strong social resistance in some sectors. Similarly, questions remain as to the viability of the virtual world format outside current niches. In multiplayer games, only fantasy-based environments (dragons, wizards and superheroes) have seen lasting success; with social virtual worlds, their influence and media visibility have yet to be matched by actual participation numbers. Neither form of VW has yet had the kind of breakthrough success that would broadly attract non-youth, non-early adopter communities, though either may “tip” in that direction soon.

The dark horse scenario is mirror worlds. Although it seems the least flashy of the four, as it continues to develop it might remain the most important to existing organizations even in the longer term, as a tool for learning about and an interface for competitively managing the physical world. While the underlying technologies (supercomputing, simulations, virtual Earth software, sensors, etc.) are all currently available in rudimentary form, the particular combination is ambitious in scope, and the largest professional community, the GIS community, is currently behind the development of this scenario.



No discussion of social integration and acceptance of the Metaverse would be complete without considering the mass collaborations now beginning to occur on our current “Web 2.0” version of the Participatory Web. To better understand today’s early versions of 2D and 3D Internet collaboration we recommend *Wikinomics* by Don

Tapscott (2006), *Infotopia* by Cass Sunstein (2006), and *Synthetic Worlds*, by Edward Castronova (2006).

As each of these books remind us, even in these early days the Metaverse offers unique new ways to form social groups, to model our environment (both physical and abstract), to test out possibilities and explore our options, and, ultimately, to practice safer and more positive-sum experiments with the future.

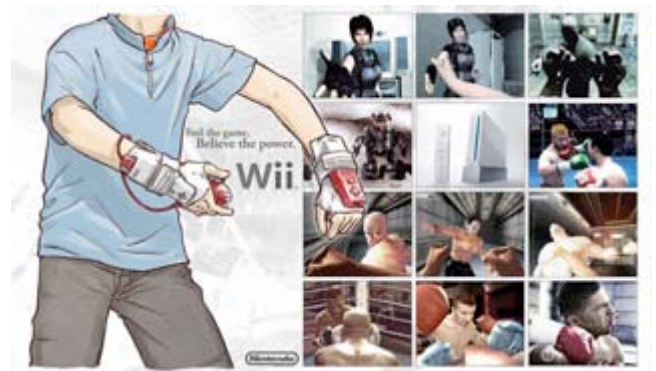


Technological Viability

In conclusion, all our scenarios assume that Metaverse technologies will work as expected.

The software aspects of the lifelogging world are a major challenge. Developing the tagging, indexing and search software necessary for a widely-usable user lifelogging system—including systems for recognizing faces and locations in images, correlating ambiguous connections for searches, and making it all accessible for non-technical users—is a sufficiently-hard problem that most MVR participants expected only rudimentary versions of these technologies during the next decade.

Similarly, the mirror worlds and augmented reality scenarios depend upon a functional array of sensor technologies distributed widely and densely enough to provide both useful details and meaningful context. Power sources, networking protocols, and universal access vs. proprietary control remain unanswered questions.



Exergames: virtual fighting with the Nintendo Wii

And both virtual worlds and mirror worlds, at least in their early stages, depend upon a popular willingness to engage with 3D information using a 2D interface. While this is fine for narrow types of work and casual entertainment, it's unclear whether such “pseudo-3D” offers a sufficiently immersive experience to trigger the necessary economic and social changes that would make our Metaverse scenarios a reality in the near or longer term. At the same time, full-immersion 3D, aka virtual reality, has its own drawbacks and technical challenges, and is likely to remain only a niche application for entertainment and training for the foreseeable future.

For more on issues and questions ahead, please see [Issues and Choices](#) (Sec. 14), [Ideas and Proposals](#) (Sec. 15) and [Key Uncertainties](#) (Sec. 16) in the MVR Inputs.

The Metaverse Scenario

Despite many open questions, it's clear that the technologies of the Metaverse are likely to change how we live, work and play over the near-term, possibly in transformative ways in the longer-term. Improving foresight in this space is both a wise business strategy and a broad social good.



While we have considered the Metaverse in four separate scenarios, the future will combine elements of each, as well as many others not mentioned here. Some near-term developments, such as cellular phone technologies, have such broad utility and extensive capital investments they must be key elements in any story of tomorrow. Other aspects, such as the use of virtual worlds for significant amounts of work and commerce, are more tentative, but serve today as useful provocations. Recurring themes such as security and crime, transparency, information access and equity, privacy, liberty, and control reflect ancient competing interests on what is simply the latest stage of technical capabilities. Social conflicts will shape the path of

Metaverse development in uncertain and divergent ways, culture by culture, even while the global advance of these technologies appears to have a number of predictable and universal aspects.

Our scenarios will be influenced by all of the broader concerns facing the planet. Ethnic strife, political instability and war, energy, water, and other resource issues, trade, globalization, economic growth and poverty, environmental degradation and sustainability initiatives, migration, scientific and engineering advances, education and the media, ancient drives for intimacy, individuation, and spirituality, our emerging digital and participatory culture, unknown surprises and catastrophes, all of these and more will shape the technology development and adoption choices in tomorrow's Metaverse.

Most importantly for each of us, at this pivotal moment in human history, there are unique opportunities for enlightened corporate, political, and social leadership in Metaverse exploration and development. We propose that the best use of the Metaverse Scenarios and Inputs in this inaugural roadmap is not simply to consider them for near-term economic potential, but to ask how these technologies might help or hinder our ability to manage humanity's larger concerns, both now and in the future. How might we use the various forms of the Metaverse to guide our response to global warming, and the emergence of "climate neutral" energy and transportation? How might we use these systems to avert a war, improve an election, reduce crime and poverty, or put an end to human rights abuses? How might we use the Metaverse, in the words of Jonas Salk, to become "good ancestors" to our descendants?

The potential is there. In just ten years (1996-2006), global Internet use has gone from 36 million to 1 billion, or from 1% to 16% of the world's population ([Inputs 8Ba](#)). Nevertheless, this is still only a fraction of the talented and passionate human beings who are patiently waiting for affordable access to tomorrow's Participatory Web. In the meantime, there are many clever examples of mass online creativity, collaboration and innovation that we can champion today, and sound strategies guiding our emerging transparency and exploding information base into useful context and social value.

For inspiring and practical statements of the 3D and virtual promise ahead, please see the [Vision Statements](#) (Sec. 5) of the MVR Inputs, provided by MVR participants. We hope you have enjoyed this Overview, and look forward to your feedback at roadmap@accelerating.org to help us prepare for the next roadmap. Please join our [mailing list](#) if you would like to be informed of upcoming MVR activities, and we wish you the best in the extraordinary journey ahead.



John Smart

Editor; Co-Author

Bridget C. Agabra

Project Manager

Jerry Paffendorf

Community Director; Co-Author

Jamais Cascio

Scenario Foresight Specialist; Co-Author

Acceleration Studies Foundation

A 501(c)(3) Nonprofit Corporation

2227 Amirante, San Pedro, CA 90732

Office: 310.831.4191 • Fax: 310.548.5304



Citation: **Smart, E.J., Cascio, J. and Paffendorf, J., Metaverse Roadmap Overview, 2007.**

2007. [Creative Commons Attribution-Noncommercial-Share Alike 3.0 License.](#)

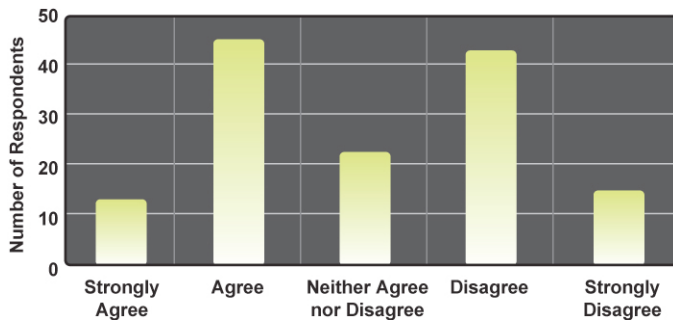


Appendix

A twenty-two question survey of key uncertainties in the Metaverse future was developed and administered to our 50 summit experts (30 responded) and also briefly posted for public input at the MVR website (115 to 136 responded).

1. In 2016, U.S. law will require U.S.-based 3D world providers to employ any of a variety of third-party 'verified' digital identity systems.

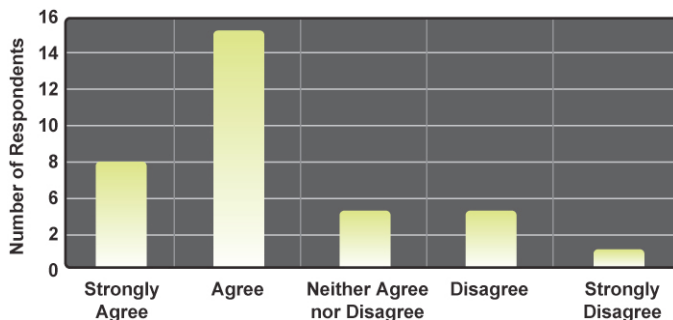
Summit Survey
N = 30
Mean = 3.10



Website Survey
N = 136
Mean = 2.99

2. In 2016, the most popular global 3D worlds (by user base) will allow the importing of user trust and reputation rating systems from a variety of other online environments.

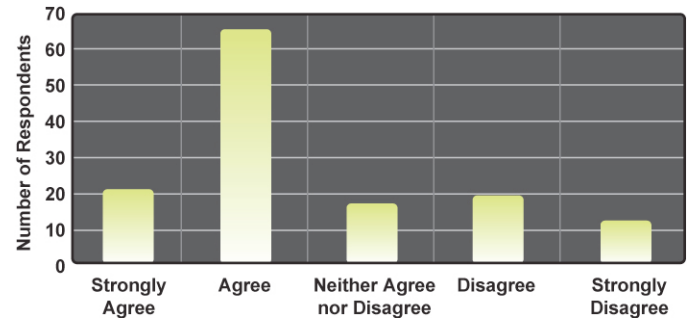
Summit Survey
N = 30
Mean = 3.87



Website Survey
N = 134
Mean = 3.94

3. By 2016, U.S. courts will rule that U.S. banking laws apply to the management and exchange of virtual economic assets in some synthetic worlds and to their related financial markets.

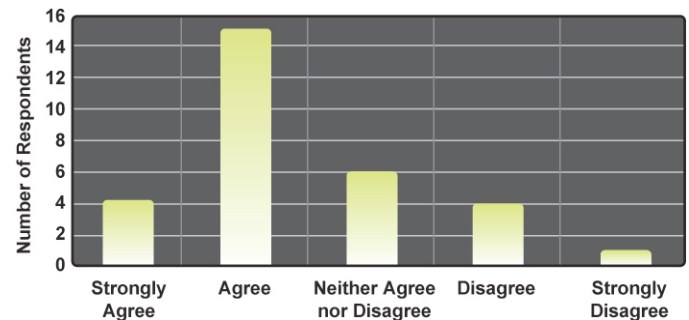
Summit Survey
N = 30
Mean = 3.73



Website Survey
N = 132
Mean = 3.48

4. By 2016, U.S. regulators will rule that U.S. securities and investment laws apply to at least some 3D world stock exchanges or investment markets.

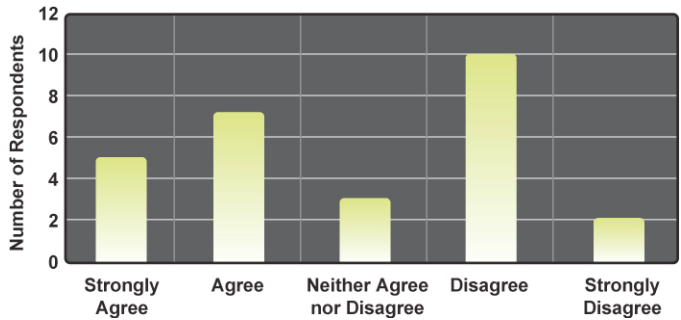
Summit Survey
N = 30
Mean = 3.57



Website Survey
N = 133
Mean = 3.35

5. By 2016 we will have seen an internet-type financial boom-and-bust cycle in the U.S., including a loss of more than 50% of stock value, occur with at least one publicly traded index of virtual world companies.

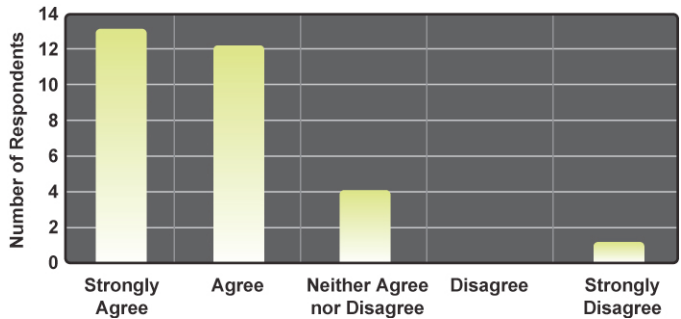
Summit Survey
N = 29
Mean = 3.17



Website Survey
N = 132
Mean = 3.23

6. Within the next five years, a leading global web company will launch, or buy and launch, a 3D virtual world where users are encouraged to engage in economic transactions and own as legal property products they create in the world.

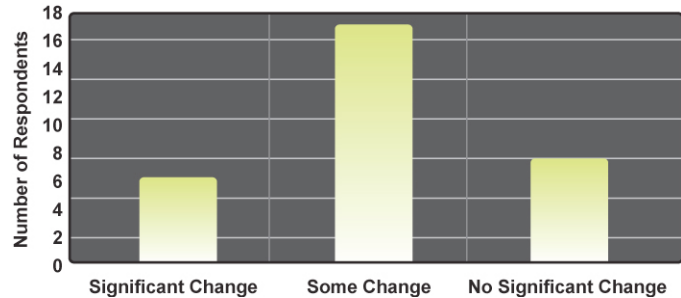
Summit Survey
N = 30
Mean = 4.20



Website Survey
N = 133
Mean = 4.18

7. In 2016, to what degree will the declaration and taxation of 3D world assets be addressed in U.S. federal, state, or local tax codes?

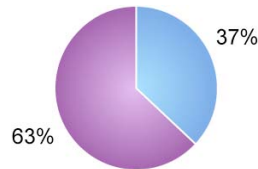
Summit Survey
N = 30
Mean = 1.90



Website Survey
N = 132
Mean = 1.73

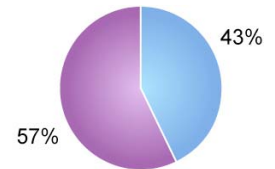
8. In 2016, what percentage of global 3D virtual world and game commerce will occur in worlds that are operated under each of the following business models?

Summit Survey



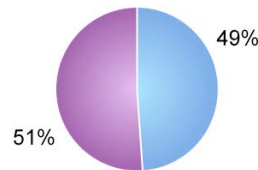
Open Source
Proprietary

Website Survey



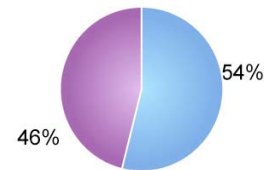
9. In 2016, what percentage of global 3D virtual world and game commerce will occur under each of the following content development models?

Summit Survey

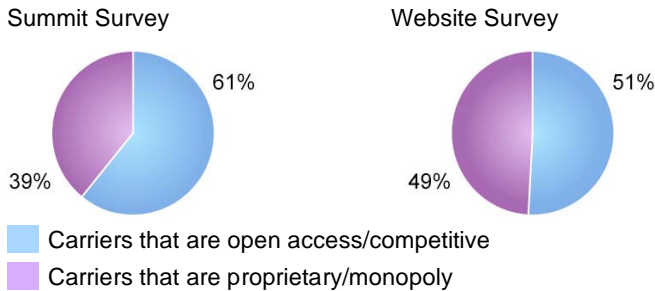


Worlds and games with primarily (by total objects in world/game) user-created content
Worlds and games with primarily (by total objects in world/game) professionally-created content

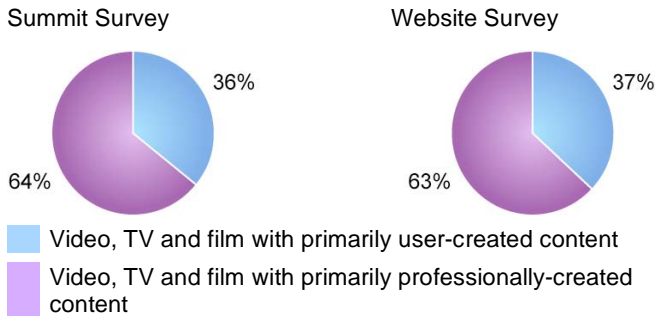
Website Survey



10. In 2016, what percentage of global video, TV, and film commerce will occur on each of the following delivery platforms?



11. In 2016, what percentage of global video, TV, and film commerce will occur under each of the following content development models?



12. In 2016, what percentage of global mobile device users will have always-on broadband internet accessibility from their devices?

Summit Survey	Website Survey
N = 28	N = 112
Mean = 81%	Mean = 79%

13. In 2016, what percentage of U.S. automobiles will have at least partially 3D automobile navigation systems?

Summit Survey	Website Survey
N = 27	N = 111
Mean = 41%	Mean = 36%

14. In 2016, what percentage of the U.S. population ages 13-30 will allow their trusted group to view 3D images of what they are doing in realtime (through wearable cameras) at least once a month, and to be able to give feedback or advice?

Summit Survey	Website Survey
N = 28	N = 111
Mean = 29%	Mean = 36%

15. In 2016, what percentage of the U.S. population ages 13-30 will use 'lifelog' systems during significant portions of their lives?

Summit Survey	Website Survey
N = 28	N = 111
Mean = 24%	Mean = 32%

16. In 2016, when distributed work groups in more developed countries (MDCs) are collaborating online, what percentage of the time will they use voice-enabled 3D applications as opposed to 2D-only collaboration software?

Summit Survey	Website Survey
N = 28	N = 111
Mean = 47%	Mean = 53%

17. In 2016, what percentage of internet users in more developed countries (MDCs) will use an interactive 3D avatar at least once a week for any purpose other than games and entertainment, including socializing, communication, creativity, education, barter, commerce, exercise, etc?

Summit Survey	Website Survey
N = 28	N = 112
Mean = 50%	Mean = 52%

18. In 2016, what percentage of U.S. households will have each of the following applications available in their home media center/console/PC?

Summit Survey

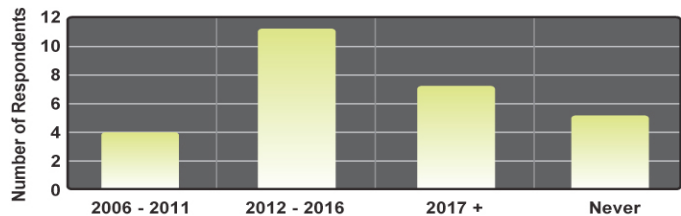
a. Interactive internet-based television/video	N = 28	Mean = 71%
b. 3D teleconferencing	N = 28	Mean = 44%
c. 3D virtual worlds and MMO games	N = 28	Mean = 68%

Website Survey

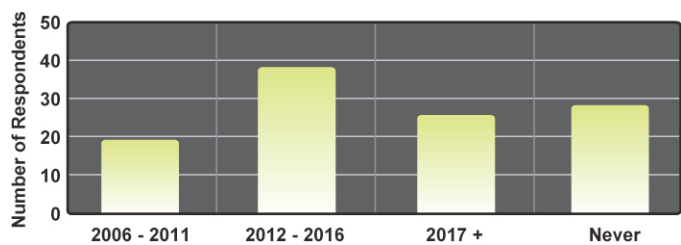
a. Interactive internet-based television/video	N = 110	Mean = 73%
b. 3D teleconferencing	N = 110	Mean = 48%
c. 3D virtual worlds and MMO games	N = 110	Mean = 64%

19. For users in the U.S., when will the average query length used in leading search applications grow to seven words (voice or text)?

Summit Survey

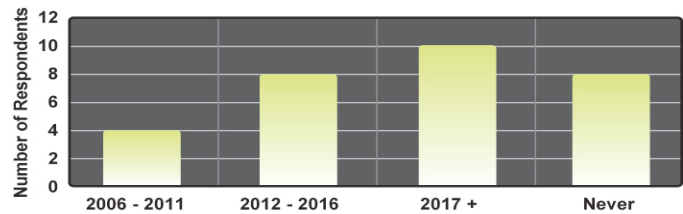


Website Survey

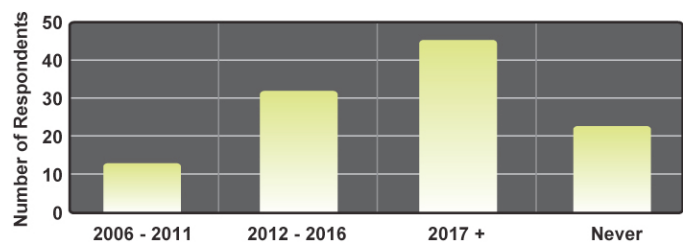


20. When do you expect to see either a leading global political or economic body advocate unrestricted access to globally shared virtual worlds as a recommended international policy or liberalization guideline?

Summit Survey

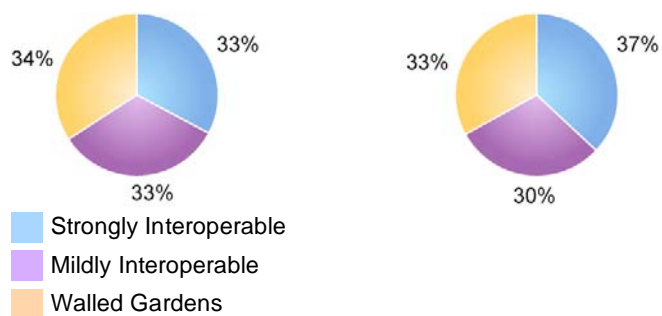


Website Survey



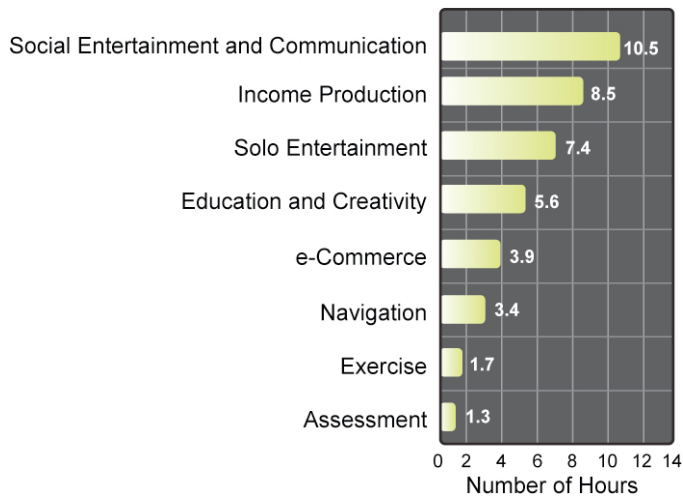
21. In 2016, of the top 100 global 3D-enhanced online environments how many belong in each of the following interoperability categories?

Summit Survey Website Survey



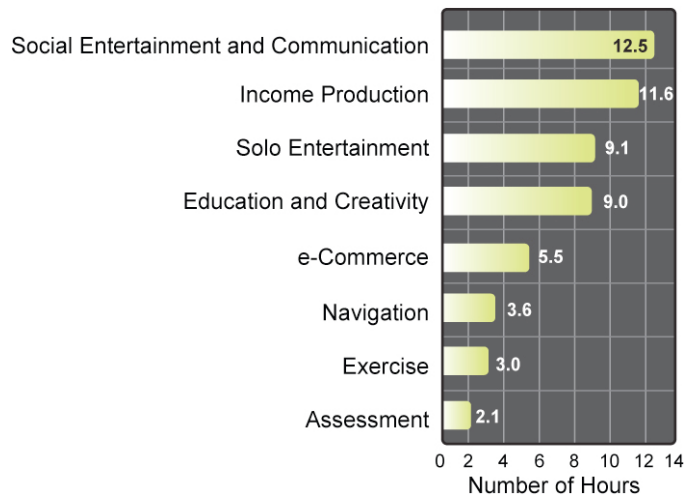
22. 2016, how many hours per week (0-20+) will a typical member of the U.S. population ages 13-30 use interactive, internet-accessing, 3D visual environments for EACH of the following activities?

Summit Survey



Social Entertainment and Communication	N = 24	Mean = 10.5
Income Production	N = 24	Mean = 8.5
Solo Entertainment	N = 24	Mean = 7.4
Education and Creativity	N = 24	Mean = 5.6
e-Commerce	N = 24	Mean = 3.9
Navigation	N = 24	Mean = 3.4
Exercise	N = 24	Mean = 1.7
Assessment	N = 24	Mean = 1.3

Website Survey



Social Entertainment and Communication	N = 93	Mean = 12.5
Income Production	N = 90	Mean = 11.6
Solo Entertainment	N = 94	Mean = 9.1
Education and Creativity	N = 91	Mean = 9.0
e-Commerce	N = 90	Mean = 5.5
Navigation	N = 86	Mean = 3.6
Exercise	N = 87	Mean = 3.0
Assessment	N = 85	Mean = 2.1