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World Game:
An MS Thesis on engineering Buckminster Fuller's unfinished computer game

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by

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Contents

List of Figures

Abstract

World Game: An MS Thesis on engineering

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My thesis explores the idea that Buckminster Fuller's World Game is really a formal calculus capable of representing world-scale sustainability problem-solving according to the fundamental principles of a (blockchain) database + (Fuller projection) map + (machine learning) simulation in the form of a game. These computational media comprise an operational formalism which embraces all effective procedures for world-scale problem-solving. If this hypothesis is true, then that would mean World Game's comprehensive use of the aforementioned fundamental principles are necessary for a sustainable Earth-scale civilization. Furthermore, the protocol for solution formation in the form of World Game "game" is sufficient for solving the problem of "making the world work for 100% of humanity in the shortest possible time through spontaneous cooperation without ecological offense or the disadvantage of anyone" — the objective of World Game. If this hypothesis of sufficiency is true, that means World Game's principles are in effect synonymous with the process of making the world work. In plain English, a problem-solving engine like World Game is necessary for the survival of humanity, period.

1 World Game

Imagine it is the year 1967. World War II is behind us. The summer of love is in our hands. The Apollo Moon Landing is within arm's reach. The University of California has a new campus at Santa Cruz, and Alan Chadwick has just started a teaching garden there. Mainframe computers have been around long enough for scientists to begin thinking about their full significance — as we see with the budding space program. The 1967 World's Fair will be held in Montreal, Canada.

Now imagine being focused on the survival of our species, and more than that, the perfected success of life on Earth. What can we do with these fresh and new computing devices? Can we do something different? Something meaningful?

Now you've got it — we will use these mainframe computers to calculate resource logistics planning such that every single atom is accounted for and allocated in the best of ways. Ah, this is a really good idea, we're going to want to do something about this. Frankly, I'm excited.

Imagine a giant computerized world map that has a visualizer on a jumbotron display screen.

Image teams of people seated around this big map.

Imagine the players had access to all historical data about the world's resources, trends, and needs.

Imagine you could, with a couple of keystrokes, know where all the people are — not only today — for all of history.

Imagine you could actually see first hand the number of trees in the world, where they were, and go back and forth in time seamlessly. A slow motion movie unfolding over time.

Imagine that we could have all data relative to all of the resources for life on Earth.

Okay, welcome back. That was no ordinary daydream. This actually did happen. R. Buckminster Fuller ("Fuller") was selected to be the architect of the U.S. Expo at the 1967 World's Fair[1]. Fifty-million people visited the pavillion Fuller designed[2]. What most people don't know, is that Buckminster Fuller, along with the design of the dome, also proposed to the United States Information Agency an exhibit for the U.S. pavilion which was not pursued. He designed the Montreal Biosphère, as it is now called, a geodesic dome, to house something he called "World Game" concerning the use of computers to streamline the huge gigantic system of the world: the design of the total human environment as an integrated system. The U.S. built the dome for Expo '67, but World Game was rejected. Even today, it seems no one is thinking about doing this, despite the obvious gravity. Today, the technical stuff is

[1] "The main purpose of his visit was to make an appearance at the Architectural League of New York, where a model of his United States pavilion at Montreal's Expo 67 was on display." Jacobs, David. "An Expo Named Buckminster Fuller." New York *Times* (p. 33). April 23, 1967.
[2] Burnett, Richard. "MONTRÉAL CELEBRATES THE 50TH ANNIVERSARY OF EXPO 67." Tourisme Montréal. 2017. https://www.mtl.org/en/experience/50th-anniversary-expo-67

challenging yet possible. In 1967, the technical stuff was challenging and nearly impossible. Instead, the US Pavilion at the World's Fair housed Americana objects from Elvis Presley, Andy Warhol, and other icons. My thesis is, fifty years later, World Game's time has come. Today, in 2017, how do we come to grips with efficiency? How do we design the effectiveness and success of the total world package?

1.1 History

Alan Turing deserves greater fame than he is accredited[3]. His contributions to computer science are engraved in the part he played toward the end of World War II (WWII), popularized by the Hollywood Film *The Imitation Game*. Turing's work in WWII is a remarkable historical fact, and is one of many accomplishments worthy of more recognition as historically important. If Einstein is the father of modern physics, Turing is the father of modern computation. Einstein's special and general relativity changed the way we think about the nature of the universe, and he won the highest prize in physics, the Nobel Prize, for his work on the photoelectric effect[4]. Turing's Turing machine and Turing test changed the way we think about the nature of what a

[3] Paraphrasing Steven Skiena, 'accreditation of fame is subject to our collective sharing of memes: meme strength.' Therefore, a read of Andrew Hodges book might be a persuasive artifact for increased fame for A. M. Turing. Skiena, Steven and Charles Ward. *Who's Bigger?: Where Historical Figures Really Rank*. Cambridge University Press. 2013. Hodges, Andrew. *Alan Turing: The Enigma: The Book That Inspired the Film "The Imitation Game"*. Princeton University Press. 2014.
[4] For more information, see the official word: https://www.nobelprize.org/nobel_prizes/physics/laureates/1921/

computer can do, and the highest prize in computer science is named after him. To top it all off, Einstein went to Roosevelt about the power of the atomic bomb, and Turing went to Churchill about the power of the bombe machine, a decryption computer. Turing's whole life work, including his, what I will call, martyrdom at at the hands of the British government, make Alan Turing worthy of more fame in terms of memetic strength. In relation to World Game, Turing's historical legacy encompases 1936 with his invention of the Turing machine[5], and 1941 in his co-designing the computer which decrypted the German Enigma code[6]. The Turing machine validated a logical architecture which set the stage for our hypothesis that World Game is necessary and sufficient for all global problems. Believe it or not, "computing machines" refers to a device which can do the work of human computers: these were people who were simply crunching numbers to support the work of engineers: see the Hollywood Film *Hidden Figures*. Turing's pivotal role in WWII marks the first precedent of computing machines used on the world stage to an indisputably effective degree. Here we see necessity as the mother of invention, and computers as the counter emergency. The use of computation to arbitrate the highest stakes on Earth will only continue from 1941, to now, and into the foreseeable future.

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[5] Here is Dr. Turing's original. For reference, the *Entscheidungsproblem* [German for 'Halting problem'] was a mathematical call to action by David Hilbert in 1928. Turing, Alan. "On computable numbers, with an application to the *Entscheidungsproblem*". Proceedings of the London Mathematical Society. Ser. 2, Vol. 42, 1937. http://www.turingarchive.org/browse.php/b/12
Petzold, Arnold. *The Annotated Turing: A Guided Tour Through Alan Turing's Historic Paper on Computability and the Turing Machine*. John Wiley & Sons, Inc. 2008.

[6] Computer History Museum. Mountain View, California. "The first Bombe is completed." Timeline of Computer History. 2017.
http://www.computerhistory.org/timeline/computers/#169ebbe2ad45559efbc6eb357207bb27

Without doubt, it was the mathematical models of mutually assured destruction which prevented the Cold War from turning hot[7], and it was the assistance of computers which galvanized the NASA space program whose impact is in our International Space Station[8]. The fact is computers have been assisting our global decision making since Turing's time 80 years ago in 1941.

Before there was an official World Game proposal there was the 1961 "World Design Science Decade[9]" that "would engage architects, architectural schools, and students in a ten-year program to re-design key elements of the world life-support systems, thereby increasing their operating efficiency from 4 to 12 percent, and thus lifting the "high" standard of living enjoyed by 44 percent of humanity to 100 percent using known world resources."[10]

Fuller realized computers could be used to solve generalized resource management problems at the world scale, yet while the technology technically existed, access was highly restricted. So in 1962[11], Fuller set up a headquarters —

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[7] Krieger, David. Nuclear Files. "Mutually Assured Destruction". Accessed 2017. http://www.nuclearfiles.org/menu/key-issues/nuclear-weapons/history/cold-war/strategy/strategy-mutual-assured-destruction.htm

[8] Tomayko, James. "Computers in Spaceflight: The NASA Experience." 1987. https://history.nasa.gov/computers/contents.html

[9] Estate of R. Buckminster Fuller put the *World Design Science Decade* documents online here in order:
1- https://books.google.com/books/about?id=vKHgDQAAQBAJ
2- https://books.google.com/books/about?id=5KLgDQAAQBAJ
3- https://books.google.com/books/about?id=U6PgDQAAQBAJ
4- https://books.google.com/books/about?id=eaPgDQAAQBAJ
5- https://books.google.com/books/about?id=MaTgDQAAQBAJ
6- https://books.google.com/books/about?id=VqTgDQAAQBAJ

[10] Snyder, Jaime. "Introduction." *Ideas and Integrities*. Lars Müller Publishers. 2009.

[11] "RBF established "Inventory of World Resources, Human Trends, and Needs" at Southern Illinois University."

"The World Resources Inventory: Human Trends and Needs" — for his "Integrative Resource Utilization Planning Tool."[12] Perhaps the main aspect of this office was to collect the information concerning all the world's resources in a pre-internet time. This meant phone calls and paperwork mostly, including field trips to various information clearinghouses like the United Nations (U.N.) in New York. The type of information desired is statistical — tons of wheat; amount of electricity generated, used, wasted; number of births, number of deaths, etc. Kind of like the ultimate census about all things. The collecting work and the calculating work was done by hand while seeking the funding to have computers do the number crunching in order to make meaning out of tons of stats.

From 1963 - 1971, Fuller and World Game associates produced the six *World Design Science Decade Documents* and the *World Game Series - Document One*. In 1966, Fuller, "inaugurates computer game at Southern Illinois University, called World Game, how to make world work in such a manner that all of humanity can become physical and economic success and can enjoy all of Earth without one interfering with the other and without any one advantaged at expense of other."[13] He actively sought funding for access to mainframe computers, though they never materialized. Each year, the project was moved forward in whatever way possible "by

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Fuller, R. Buckminster. "Appendix II." *Critical Path* eBook edition. Estate of R. Buckminster Fuller. 2015.

[12] The primary resource from the office was put online by Estate of R. Buckminster Fuller here: https://books.google.com/books/about?id=l6HgDQAAQBAJ

[13] Fuller, R. Buckminster. "Appendix II." *Critical Path* eBook edition. Estate of R. Buckminster Fuller. 2015.

hand." Then on, in 1969 with Edwin Schlossberg as his assistant, Fuller presented World Game to the New York Studio School[14]. Further on in 1979 and 1980, two sibling books were produced from the "World Game's annual research activity": *Energy, Earth, and Everyone* and *Ho-Ping: Food for Everyone*[15].

The primary contribution of World Game is as a *world-scale generalized problem solving process*. World Game has a specific win condition — "to make the world work for 100% of humanity in the shortest possible time through spontaneous cooperation without ecological offense or the disadvantage of anyone."[16] Essentially, World Game is a tool to achieve an environment where people "can enjoy the whole Earth" with a "high standard of living." The simple fact is, while much can be done by people alone, without computers the scale of global accounting becomes too large.

Beyond Fuller, many people inspired by the idea have taken the baton and run with it as far as they could. Over the decades, there has been a board game[17], several

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[14] Fuller, R. Buckminster. "Basic Biography." Estate of R. Buckminster Fuller. https://books.google.com/books/about?id=mqLgDQAAQBAJ

[15] Fuller cites Gabel in *Critical Path* (eBook edition) which is ostensibly the main World Game document:

> Seven years ago World Game's annual research activity culminated in a book written by Medard Gabel, *Energy, Earth, and Everyone* (Doubleday, rev. ed., 1980), which demonstrated beyond any argument that humanity can carry on handsomely and adequately when advantaged only by its daily energy income from the Sun-gravity system. World Game also published a second book by Medard Gabel, *Ho-Ping: Food for Everyone* (Doubleday, 1979)—this time on world food resources, which shows that we can take ample care of all human food needs. The 1979 World Game was participated in by many experts on world food matters.

[16] The origin is unknown. It is thought perhaps the origin was on an official brochure for World Game. Estate of R. Buckminster Fuller. Personal communication to author, 2014-2017. http://www.buckminsterfuller.net/

[17] See for instance: http://www.worldgame.org/

workshop series[18], a 'data manager[19]', etc. However, no comprehensive computerization has been done. My proposal is that the technology industry has at its fingertips computer capacity that is more than equal to the challenge of creating such a tool as Fuller envisioned. Given the new technology scene combined with new computer methods of dealing with enormous amounts of information, statistics, and databases, I think it's time we push World Game's envelope to its logical conclusion: it must be realized for the purposes of survival. We could engineer a monolithic software project for solving global problems. We could experience a design science revolution all around the world.

While many people have been inspired by this conception, it seems like it was just ahead of its time (i.e., the computing capacity available in the 1960's was generations removed from where we are today[20]). It seems like the computing power that's available today is readily available to rise to this challenge.

1.2 What are the salient features?

1.2.0 Objective: Make the World Work

[18] For instance: http://designsciencelab.com/
[19] Estate of R. Buckminster Fuller. Personal communication to author. 2017. http://www.buckminsterfuller.net/
[20] Markoff, John. "Moore's Law Running Out of Room, Tech Looks for a Successor." New York *Times*. 2016. https://www.nytimes.com/2016/05/05/technology/moores-law-running-out-of-room-tech-looks-for-a-successor.html. For comparison, see a decade ago. Lohr, Steve. "The Face of Computing 50 Years and 18,000 Tubes Ago". New York *Times*. 1996. http://www.nytimes.com/1996/02/19/business/the-face-of-computing-50-years-and-18000-tubes-ago.html

Ground zero for World Game is the game win condition: *to make the world work for 100% of humanity in the shortest possible time through spontaneous cooperation without ecological offense or the disadvantage of anyone*.

> Here on Southern Illinois' campus we are going to set up a great computer program. We are going to introduce the many variables now known to be operative in economics. We will store all the basic data in the machine's memory bank; where and how much of each class of the physical resources; where are the people, what are the trendings—all kinds of trendings of world man? Next we are going to set up a computer feeding game, called "How Do We Make the World Work?" We will start playing relatively soon. We will bring people from all over the world to play it. There will be competitive teams from all around earth to test their theories on how to make the world work. If a team resorts to political pressures to accelerate their advantages and is not able to wait for the going gestation rates to validate their theory they are apt to be in trouble. When you get into politics you are very liable to get into war. War is the ultimate tool of politics. If war develops the side inducing it loses the game.
>
> Essence of the world's working will be to make every man able to become a world citizen and able to enjoy the whole earth, going wherever he wants at any time, able to take care of all the needs of all his forward days without any interference with any other man and never at the cost of another man's equal freedom and advantage. I think that the communication problem—of "How to Make the World Work"—will become extremely popular the world around.
>
> The game will be played by competing individuals and teams. The comprehensive logistical information upon which it is based is your Southern Illinois University-supported Inventory of World Resources Human Trends and Needs. It is also based upon the data and grand world strategies already evolved in the Design Science Decade being conducted, under our leadership here at Southern Illinois University, by world-around university students who, forsaking the political expedient of attempting to reform man, are committed to reforming the environment in such a manner as to "up" the performance per each unit of invested world resources until so much more is accomplished with so much less that an even higher standard of living will be effected for

> 100 % of humanity than is now realized by the 40 % of humanity who may now be classified as economically and physically successful.[21]

How are we going to make the world work?

1.2.1 Database: Inventory of World Resources

The first element Fuller imagined was an *inventory* of everything from wheat to microchips to electricity to healthcare to everything. A layer of correct data transcendent from everything else — just the facts — from which players draw upon in attempts to solve problems.

Since Fuller was doing all this without computers, students would get together with him over a summer with a focus on a particular set of the Inventory of World Resources. For one example of many, here are some of the features that were collected with a focus on energy:

Inventories:

1. population of Earth and its distribution,
2. location of Earth's electrical network: generating stations, broken down into thermal and hydroelectric, and transmission lines
3. location of quantities and qualities of Earth's metals resources
4. efficiency levels in power generation and consumption
5. levels of power consumption and production

[21] Fuller, R. Buckminster. "The World Game—How to Make the World Work." *Utopia or Oblivion* eBook edition. Estate of R. Buckminster Fuller. To be published in 2017.

6. division of electrical power consumption-how much for agriculture, industry, home, etc.
7. amounts of metals involved in generation, transmission, and consumption of electrical energy
8. per-capita consumption of electrical energy by area
9. world electrical energy generation average annual rate of growth
10. metals production.
11. fossil fuel reserves.
12. total metals, scrap, mined and estimated to be mined in world. metals allocations.
13. location of, and kwh available from, potential river and tidal generating stations.
14. amounts of coal used in thermal electric generating plants.
15. amounts of pollution resulting from same.
16. amounts and types of metals required for long-distance high voltage transmission lines

Trends

1. Items 1-18 from Inventories expanded through time: 1900-2000[22]

Here is a description from *Critical Path* regarding the fundamental need for a comprehensive world database:

> World Game will become increasingly effective in its prognoses and programming when the world-around, satellite-interrelayed computer system and its omni-Universe-operative (time-energy) accounting system are established. This system will identify the kilowatt-hour-expressed world inventory of foods, raw and recirculating resources, and all the world's unique mechanical and structural capabilities and their operating capacities as well as the respective kilowatt-hours of available energy-income-derived operating power with which to put their facilities to work. All the foregoing information will become available in respect to all the world-around technology's

[22] Fuller, R. Buckminster. "World Game Series Document One (p. 107-108)." World Game. 1971.

> environment-controlling, life-sustaining, travel- and communication-accommodating structures and machines.[23]

Here Fuller predicts that not only could there be this database floating in the computer-cloud, but the information could be integrated into a system of interlocking computational media governing optimal utilization of these resources by the respective industries: much like there is an ecosystem with clouds as the harbingers of rain.

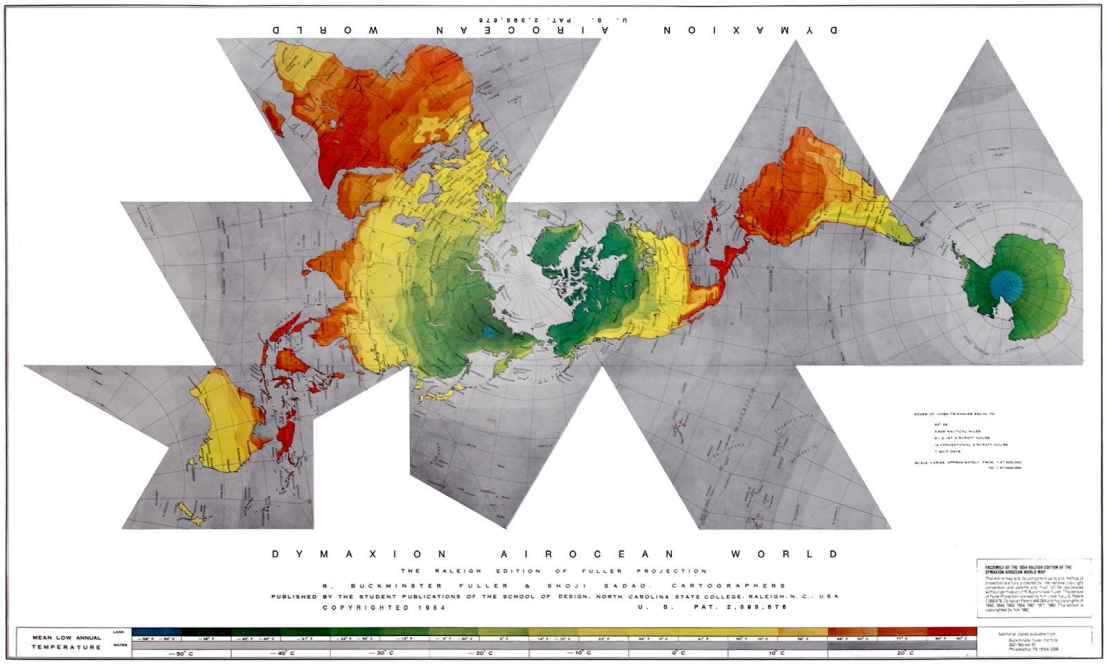
Aptly, the first document produced in 1963 regarding these co-evolving ideas was called, "PHASE I DOCUMENT 1: INVENTORY OF WORLD RESOURCES, HUMAN TRENDS, AND NEEDS." The first thing first is to get this database in action.

Layer one to World Game is the "Inventory of World Resources: Human Trends and Needs."

[23] Fuller, R. Buckminster. "World Game." Critical Path eBook edition. Estate of R. Buckminster Fuller. 2015.

1.2.2 Map: Fuller Projection & Geoscope

Figure 1: Fuller Projection Map



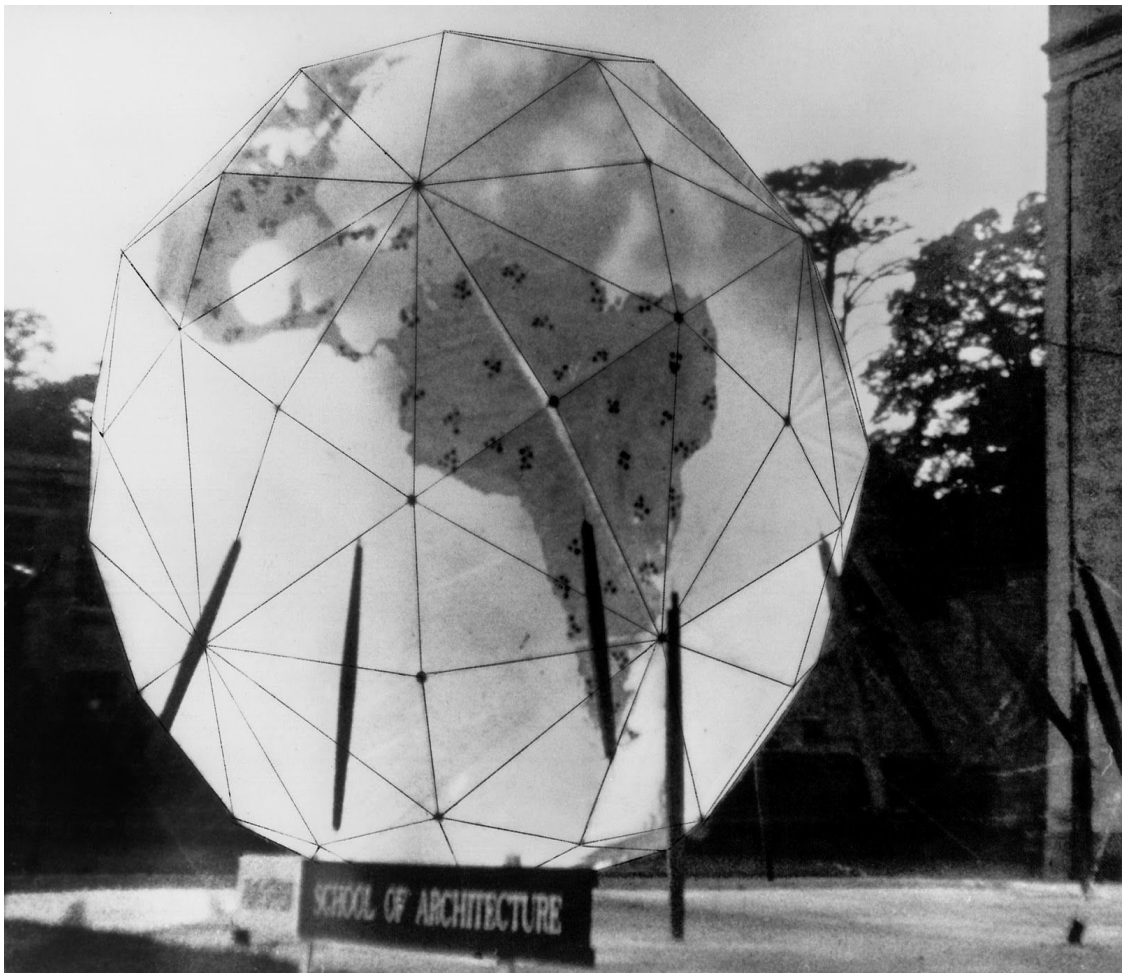
Courtesy of the Estate of R. Buckminster Fuller

Second, Fuller had been creating maps of the world quite some time before settling on the Fuller Projection map which was the logical choice as for World Game interface. Essentially, the map is the "face" of the graphical user interface. Fuller patented his Fuller projection map which is the first map to equally distribute the distortion allowing for the landmasses to be seen as an ostensibly undistorted whole[24]. What does that mean? Basically, most maps are supposed to be 2D mirrors of the

[24] Dymaxion is a term Fuller used as a kind of brand to some of his artifacts, a combination of Dynamic + Maximum + Tension. Fuller's 1936 patent for the Fuller projection map: https://patents.google.com/patent/US2393676A/en?inventor=Fuller+Buckminster&page=1. For an example of a 3 minute documentary using the Map, see here from Estate of R. Buckminster Fuller: https://youtu.be/BwpQzQoZODM

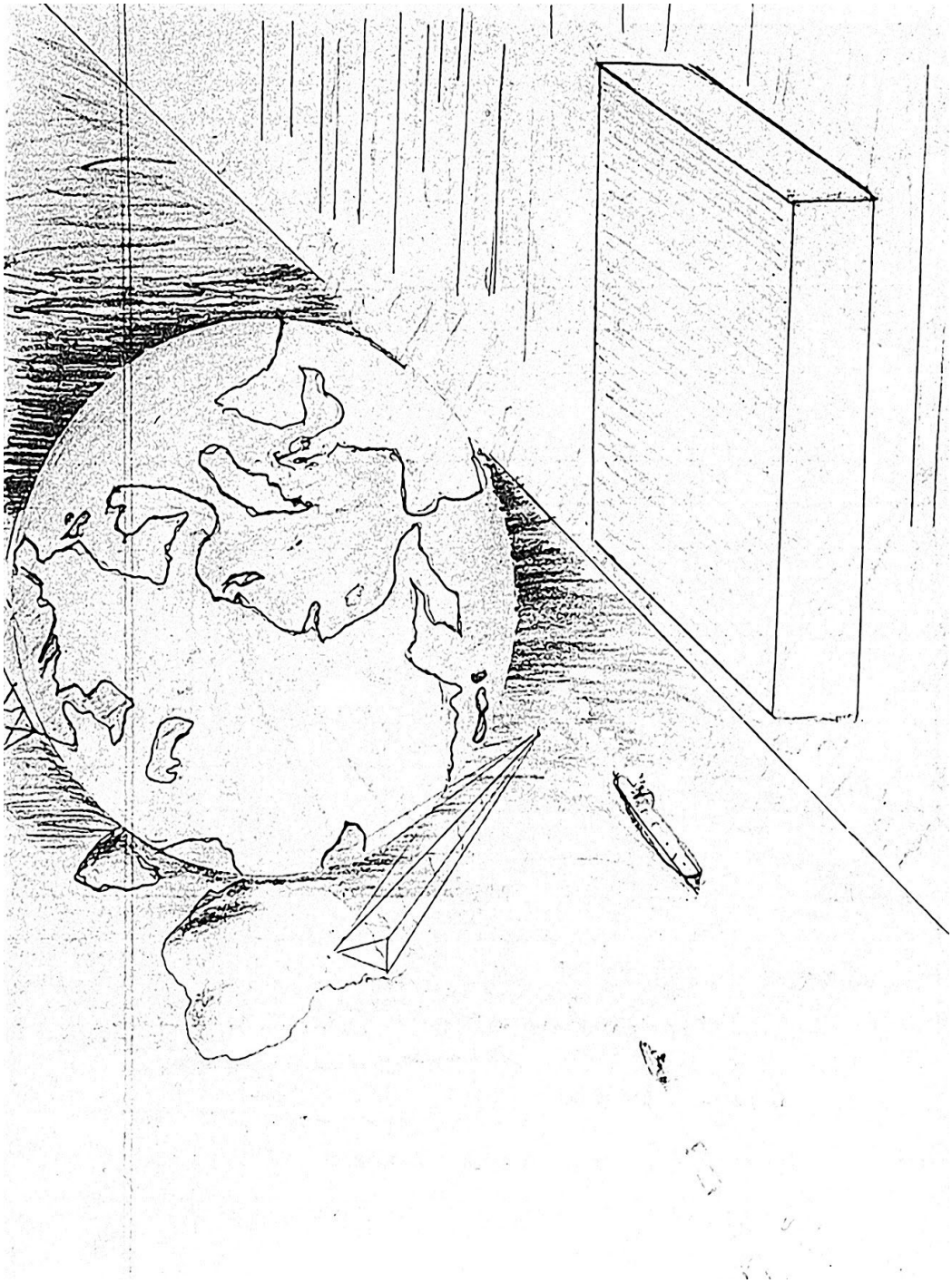
Earth. However, because of the complexity in compressing 3-Dimensions worth of information into 2-Dimensions, most maps are distorted, are inaccurate in some way; most maps are mostly good mirrors but also a little bit funhouse mirrors. The Fuller projection map has no “funhouse” distortion effect on the landmassess through a novel invention of geometrical 3D into 2D distortion distribution. It is important to have an accurate map of the world to accurately understand the facts on the ground. Moreover, the advantage a map has over a 3D image is that when looking at a 2D map, the whole Earth can be seen at once. Being able to see the whole Earth at once ensures there are no blind spots: blind spots in which unpredicted and important phenomena could be occurring in real time. Another one of the big contributions of the Fuller projection map is it encourages insight that our Earth is “one world island in one world ocean” — which was more obvious when the Earth was Pangea, yet still true today. There is also a 3D game board called the Geoscope. The Geoscope is a geodesic sphere suspended in the air of various sizes — such as 200 feet in diameter — such that it appears from the inside the center of the sphere that one is standing at the core of the Earth. The sphere would be a gigantic walk-in computer: able to see global data move in 360 degrees. A difficulty of human eyesight is the limited field of vision — the Geoscope seeks to address this problem by giving a new way to see the world as it is almost all at once from the inside-out.

Figure 2: Geoscope Prototype



Courtesy of the Estate of R. Buckminster Fuller

Figure 3: Geoscope at U.N. Artist Rendering



Courtesy of the Estate of R. Buckminster Fuller

Both game boards are useful for various pros and cons of 2D vs 3D in terms of logical information transmission. Of course, all is welcome, including VR, tablet apps, any and everything whatever works. **Layer Two of World Game is mapping the Inventory of World Resources Human Trends and Needs onto 2D and 3D Maps.**

1.2.3 Simulation

> The World Game refers to a strategy or a combination of strategies, with their documentation, as a "scenario." The scenario encompasses a logical sequence of events (the strategy) which shows how, starting from the present, a future evolutionary condition might evolve step by step; "longhand," it is a synergetic synoptic view of as many developments as can be grasped and as may appear relevant to the experimental simulation of the proposed possible reality. "Shorthand," or through computer simulation, all relevant variables and their omni-interaction will be automatically displayed—both visually and through computer read out. - Buckminster Fuller[25]

Here, Fuller is making a distinction between playing this game without computers, longhand, and with computers, shorthand. In the same train of thought, the document admits shorthand World Game has never been played, and that, "Until the ultimate World Game facility is realized, there will be no World Game. But moves or strategies of resource utilization that will enable humanity to be successful can be tested and evolved 'long-hand' until then."[26]

[25] Fuller, R. Buckminster. "World Game Series Document One (p. 97)." World Game. 1971.
[26] Fuller, R. Buckminster. "World Game Series Document One (p. 95)." World Game. 1971.

One of the core capacities of the human brain is to model events that have not yet happened, and simulation extends this capacity. Even with contradictory results from differing simulation labs, as we have with climate change, the value simulation offers outweighs the negatives, and in fact such value is atomic in nature to arbitrary problem solving. It is for the players to use intuition to grapple with unprecedents. It is for the simulation to assist the players' intuition, and offload cognitive load such that the intuitions are fresh and their best.

> Operations of thought are like cavalry charges in a battle — they are strictly limited in number, they require fresh horses, and must only be made at decisive moments." An Introduction to Mathematics (1911)

Fuller saw that having a database is super, having a map is fantastic, however, having a simulation gives life to the clay. An example of "longhand" is Fuller's proposed "world energy electric grid." In effect, if humanity connected the various electric grids together, there would be a doubling of power due to peak-load use and storage[27]. To come to this conclusion, Fuller had to use a database regarding the electrical usage, had a map to see where the lines could be connected most efficiently, and simulate what would happen if various scenarios were to be implemented in reality.. Of course the proposal was not implemented, but the overall process of finding new "moves" to make in order to "make the world work" through these three computational media tools is essentially valid through their atomicity to generalized

[27] Fuller, R. Buckminster. "World Game." *Critical Path* eBook edition. Estate of R. Buckminster Fuller. 2015.

problem-solving, particularly obvious at large scales. Fuller drives the message home in all caps:

> THE WHOLE STRATEGY OF WORLD GAMING IS ACCOMPLISHED BY SIMULATED EMPLOYMENT OF MY COMPREHENSIVE, ANTICIPATORY DESIGN SCIENCE WHICH ALONE HAS SHOWN ME HOW TO PROGRESSIVELY ALTER THE FUNDAMENTAL CONDITIONS UNDER WHICH HUMANITY EXISTS AND TO DO SO BY FEASIBLE AND LOGICAL MEANS.[28]

Layer Three of World Game is using our total global information system to illustrate trends over time, and using simulations to make conscious choices about changes we might make as a planetary civilization.

In Sum:

1) Gather information about the world into a database.

2) Take these abstract statistics and map them to physical locations.

3) Create educational visualizations to deliver information powerfully, and create simulations to consider problem-solving scenarios.

1.2.4 World Game "game"

> Major world individuals and teams will be asked to play the game. The game cannot help but become major world news. As it will be played from a high balcony overlooking a football field-sized [Fuller Projection map] with electrically illumined data transformations, the game will be visibly developed

[28] Fuller, R. Buckminster. "World Game Series Document One (p. 6)." World Game. 1971.

> and may be live-televised the world over by a multi-Telstar relay system. - Buckminster Fuller[29]

Let's look closely at World Game's objective. The game is dedicated to "make the world work for 100% of humanity" — which is defined by preventing "ecological offense or the disadvantage of anyone." The way in which we achieve "making the world work" "in the shortest possible time" is through "spontaneous cooperation," and it is my conjecture that the simulation[30] based on an accurate database, mapped unambiguously, is what will engender spontaneous cooperation — spontaneous cooperation also being a fundamental characteristic of games.

Fuller seemed to be interested in making this a game for a few reasons. Firstly, games are a natural outgrowth of simulation — since simulation is essentially sophisticated pretending. "Let's imagine it this way, now that way, oh this is definitely the best way." Secondly, games are a good way to distribute labor, "Let's race to see who can wash dishes the fastest." One theme which emerges is the principle of distribution. The database needs to be distributed to ensure flawless record-keeping; the map is the Fuller projection map, which distributes the distortion

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[29] Fuller, R. Buckminster. "The World Game—How to Make the World Work." *Utopia or Oblivion* eBook edition. Estate of R. Buckminster Fuller. To be published in 2017.

[30] Professor Yuval Harari has a similar notion that imagination (i.e. simulation) enables large-scale cooperation in humans as distinct from other primates. He indicates this as a major fact of history, dubbing it the "Cognitive Revolution."

"Biology sets the basic parameters for the behaviour and capacities of *Homo sapiens*. The whole of history takes place within the bounds of this biological arena. However, this arena is extraordinarily large, allowing Sapiens to play an astounding variety of games. Thanks to their ability to invent fiction, Sapiens create more and more complex games, which each generation develops and elaborates even further." Harari, Yuval. *Sapiens* (p. 38-39). Harper. 2015.

optimally; the simulation distributes our errors so players are less likely to make a mistake in reality: steering the patterns of the past into the preferred patterns of the future; and the game itself distributes the workload between groups of people in teams, and also in distributing the workload to computers to assist problem-solving capabilities. It makes sense, World Game distributes the load of any planetary sized problem in a theoretically equal manner (everyone could play). Thirdly, Fuller spent much of his time engaged with university students, and he thought university teams might be a strong class of interested parties. Finally, the mechanics of games, the way games are played, lend themselves to solving problems with time constraints:

> The general-systems-theory controls of the game will be predicated upon employing within a closed system the world's continually updated total resource information in closely specified network complexes designed to facilitate attainment, at the earliest possible date, by every human being of complete enjoyment of the total planet earth, through the individual's optional traveling, tarrying, or dwelling here and there.[31]

[31] Fuller, R. Buckminster. "The World Game—How to Make the World Work." *Utopia or Oblivion* eBook edition. Estate of R. Buckminster Fuller. To be published in 2017.

1.3 World Game Hypothesis

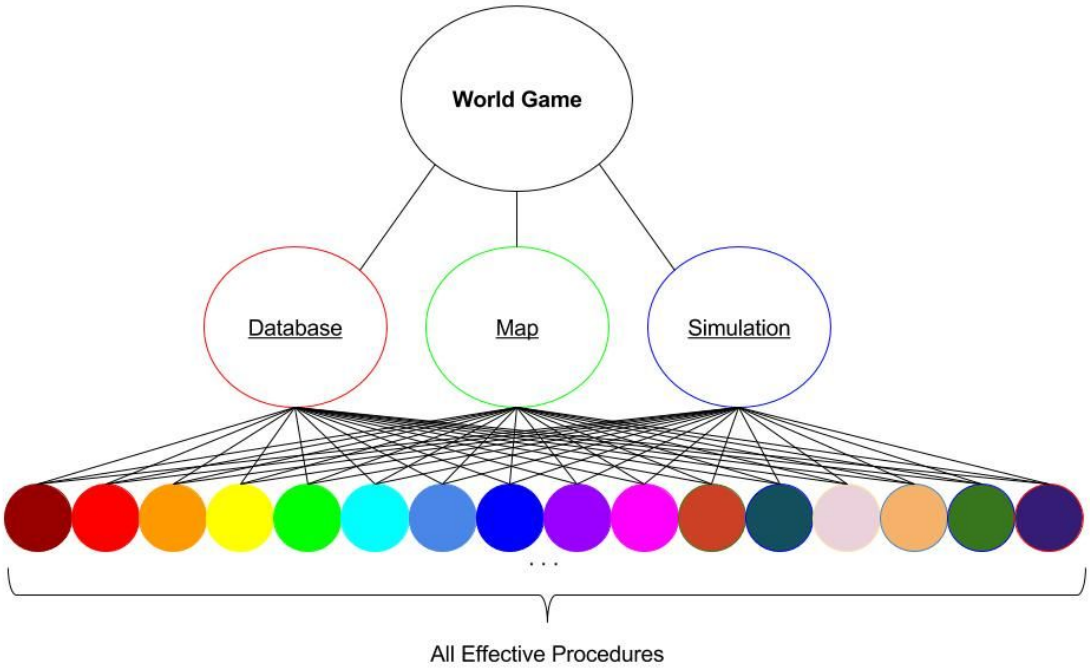

Figure 4: Completeness Theory

Database: A "world resources inventory: human trends and needs" database which is secure, precise, and would serve as the apex of planetary bookkeeping. Map: A world map projection without visible distortion of the relative shapes and sizes of Earth's continental contours, that allows for the global display of geometrically-accurate world data. Simulation: In the thesis I make the distinction between visualization and

simulation: visualization is reserved for animating known data (e.g. showing population growth over time from the past to the present); simulation is reserved for animating data that extrapolates historical data to predict future data (e.g. weather prediction).[32]

In logic there is an architecture for the limits of computation, otherwise known as Turing Completeness. Turing Completeness, from our friend Alan Turing, defines a set of capabilities a computer can do. A computing language is really a formal calculus capable of representing 'universal' computation according to the rules of some formal language, explicitly described through a metalanguage characterizing language categories and expression formation.[33] Turing Completeness is such a metalanguage. It is a language that defines a language. All the wonders of the modern world stem from such formal languages. We are meant to believe that the wildest of claims can be substantiated through a reference to a proof of Turing Completeness[34].

It is from these kinds of architecture that I derive my hypothesis that World Game is an operational formalism which embraces all effective procedures for

[32] I use the visual cue of underlining and the "+" sign to facilitate memory: database + map + simulation

[33] My syntax style for describing Turing Completeness comes from Dr. John Kadvany.
Kadvany, John. "Pāṇini's Grammar and Modern Computation," Journal of History and Philosophy of Logic. 2016. Also see by same author:
http://johnkadvany.com/GettingStarted/Kadvany_Design/Assets/Downloads/IndistuinghableFromMagicKadvanyMindsMachinesFeb2010.pdf
Further, I did work on Kadvany + Pāṇini in a UCSC Logic and Computer Science course:
http://tinyurl.com/cmps217

[34] I am trying to distance myself from wild claims, yet am using the same possibility space to prove a point. Sack, Warren. *The Software Arts* (p. 338). 4 May 2017 manuscript version.

world-scale problem-solving, and thereby being necessary and sufficient for an Earth-scale civilization. I now introduce the notion of "World Completeness" to distinguish between models of computation like Turing Completeness and models of world-scale problem-solving I am proposing. There seems to be a synergy that occurs when dealing with the total planetary system which requires a model like World Completeness in order to comprehend. We have other Completeness models such as NP-completeness to help humans cognize these large conceptual spaces in a way that is scientifically acceptable. In this sense, World Game is World Complete as a formalism. The key is in the phrase "all effective procedures[35]" for which the database + map + simulation extend universal problem-solving skills covering all effective procedures in principle, but as we all know humans can be self-contradictory, so the World Game "game" aspect embraces the unpredictable human element: hence in effect *all effective procedures*. The idea that World Game is World Complete means that any other planetary problem formulation or solution formation from any other conceptual system could be translated into an equivalent formation through World Game and *vice-versa*. The fact is, there may not be that many other total-planet conceptual systems for problem-solving.

In plain English, my claim is there is literally no way to handle the complexity of the entire planet right now without utilising a database, a map, and a simulation.

[35] The circular reasoning of what constitutes "all effective procedures" between Donald Knuth and Alonzo Church is disputed from being air-tight in light of actor-network theory. I am using this ambiguity to my advantage in order to secure an intuitive argument that World Game is non-negotiable going forward. Sack, Warren. *The Software Arts*. "Algorithms." 4 May 2017 manuscript version.

Which would therefore also mean no one is handling the total complexity of the total planet right now (emergency alert). Finally, we can get people to actually go along with reason and the truth by making a game out of it. Everybody loves games…

How far can we push our informal use of formal logic? Whereas it is easy to argue for the necessity of a database, a map, and a simulation for big picture problem solving — as these computational media[36] extend generic problem-solving skills, much as a hammer is an extension of the first — there is no known consensus regarding humanity's capability to achieve a world that works for all by any means due to the "meta-problem of humanity's self-contradictory behavior." Even if a world that works for all is handed to us on a silver platter, we might reject it, so goes the common argument. It is arguably unprecedented "to make the world work for 100% of humanity in the shortest possible time through spontaneous cooperation without ecological offense or the disadvantage of anyone."

There is a gap between necessity and sufficiency. In plain English, necessity means a required ingredient, and sufficiency means the thing will work. I submit that games are a reliable way to curb human irrationality through objective numerical feedback. Games are a favorable environment which encourage people to behave favorably[37]. "Spontaneous cooperation" can't be manufactured, but it can be

[36] Wardrip-Fruin, Noah and Michael Mateas. "Envisioning the Future of Computational Media." Center for Games and Playable Media. 2014.

[37] "I said, 'How do we find out how to use our minds and experience to the highest advantage of others in the shortest possible time?' That was the challenge. Out of this, in due course, came a great many designs, because I said to myself, 'I must commit myself to reforming the environment and not man; being absolutely confident that if you give man the right environment he will behave favorably.'"

facilitated, inspired, and games are well-documented to encourage teamwork. I think a database + map + simulation are necessary and sufficient in and of themselves; however, since we are all acting in real time, the time it might take for the three to prevent the Earth's collapse "in the shortest possible time" is dubious. World Game "game" acts as a catalyst, as a facilitator for the three ingredients, and because of the nature of real time, I am suggesting the game provides sufficiency with reference to speeding the adoption and compliance of the other computational media tools. Various contemporary problems such as climate change need solving fairly quickly, and my hypothesis is a game gives sufficient speed to a database, a map, and a simulation in order to make the world work. No matter the stakes, even U.S. presidential elections, people generally abide by the tally of objective numbers in a non-violent manner: be it vote count (Elections) or batting average (Major League Baseball) or basket count (National Basketball Association), or even bank account (Capitalism). The database + map + simulation are information gathering tools, and the game is a vehicle — without which we would not make it to our destination in time "on foot" — to use these tools for problem solving altogether making World Game the kind of problem-solving engine required for the coming critical years.

What do I even mean that everything can be solved? The game's objective — "to make the world work for 100% of humanity in the shortest possible time through spontaneous cooperation without ecological offense or the disadvantage of anyone"

Fuller, R. Buckminster. Robert Snyder, editor. *Buckminster Fuller: An Autobiographical Monologue/Scenario* (p. 39). St. Martin's Press. 1980.

— is the best answer. Stated another way: "to make it possible for anybody and everybody in the human family to enjoy the total earth without any human interfering with any other human and without any human gaining advantage at the expense of another."[38] Normally, for a scientist to become excited about a big picture idea, these claims require a rigorous proof. One such type of proof is called proof by contradiction. As your World Game tour guide, I want to introduce the types of thinking that go into proving something in formal logic to get a sense of the excitement a scientist feels when they can definitively grasp something by the syntax and semantics of a proof. I call this section a 'hypothesis' within the thesis. Like arguments about God, it is difficult to prove or disprove hypotheses as they take on more and more dimensions. So I don't think the hypothesis can be proven or disproven until we try and build the planet-sized structure. I offer my intuitive proofs as an offering since the hypothesis begs the question for some comment on the feasibility of the hypothesis. Here is an intuitive argument for the necessity of my claim:

In general, if our goal is the survival of our species, it is a contradiction to say we could do without any one of the computational media of a database, a map, or a simulation. Consider if we left out any of those three components. Without a

[38] Fuller, R. Buckminster. "BUCKMINSTER FULLER Presentations To Congress THE WORLD GAME" (p. 9). HEARINGS BEFORE THE SUBCOMMITTEE ON INTERGOVERNMENTAL RELATIONS OF THE COMMITTEE ON GOVERNMENT OPERATIONS UNITED STATES SENATE NINETY-FIRST CONGRESS FIRST SESSION on S. Res. 78 TO ESTABLISH A SELECT SENATE COMMITTEE ON TECHNOLOGY AND THE HUMAN ENVIRONMENT. 1969.

database, we have no record, and would fall apart instantly — it would be like having constant amnesia. Without a map, we would be swimming in a sea of numbers — it would be like having total sensory loss. Without simulation, we would be risking everything at every juncture — it would be like a game of chance instead of a game of strategy. World Game would essentially be a World Brain[39], as essentially a brain is a storehouse of memories (database), a brain processes sensory input, especially vision (map), and a brain imagines different scenarios of reality through thinking about stuff — my thought of an apple is a simulation, it is not a real apple (simulation). Humanity is the mind directing the world brain. Think of it like this: science itself is a kind of metalanguage that says you must be able to reproduce an experiment carried out by the scientific method if you wish to possess the truth. World Game is a kind of metalanguage that says you must use these computational media components if you wish for the human species to continue satisfactorily surviving and evolving. Beyond this intuitive sense, it is not within my scope to provide a formal proof from the discipline of logic or mathematics. I think common sense is enough here. Here is an intuitive argument for the *sufficiency* of my claim:

> Many forms of Government have been tried, and will be tried in this world of sin and woe. No one pretends that democracy is perfect or all-wise. Indeed it

[39] "Our world game will be in effect a world brain. It will free world mind from occupations of brain slavery. Human minds employ the world brain to solve the problems of all humanity thus escaping the previous recourse only to the individual opinions of too myopically preoccupied ill-informed men." Fuller, R. Buckminster. "World Game Series: Document One." World Resources Inventory, Southern Illinois University. 1971.

> has been said that democracy is the worst form of Government except for all those other forms that have been tried from time to time.… - Churchill[40]

In this world of sin and woe, it is not sufficient merely to have the tools, in this case the three computational media components, in order to achieve sustainability. We can lead a horse to water, but we cannot make it drink: even if everything we need is handed to us on a silver platter, we might reject it, so goes the common argument. It is in the way solutions are formed through World Game's protocols that we attain sufficiency. We attain sufficiency through World Game's comprehensive use of computational media, in particular World Game "game." The *de facto* sufficiency *lemma* is Jane McGonigal's *Reality is Broken*, where she argues games give people a sense of purpose, and purpose gives people the will to win in the face of impossible odds; also see *Superbetter*[41].

We all know there are as many differences of opinions as there are nations, and cities, and people. Having a game based in reality in which global players can get numerical feedback about the success of any given proposal they make regarding changing the way we do business on Earth is by far the best chance we have for "not fighting forces, using them."[42] Human nature has been a certain way for a long time, and gameful competition is a channel to route our rowdy energies into finding

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[40] Churchill, Winston S. 11 November 1947. "Quotes." The International Churchill Society. 2017. https://www.winstonchurchill.org/resources/quotes/the-worst-form-of-government

[41] Dr. McGonigal autographed my copy of *Superbetter* with the note "Play with purpose". Her note has accelerated my thinking on the matter.

[42] Fuller, R. Buckminster. *Critical Path* eBook edition. Estate of R. Buckminster Fuller. 2015.

optimal designs. The Olympics have been used this way, the World Cup. We are willing to come together for games world over. Now, we make a game out of making the world work. Whoever finds solutions that work at scale will find, in a word, glory. And I think more than that, unprecedented glory.

Fuller provides much more than just World Game "game" in *Critical Path*, which is ostensibly his World Game thesis, though he does not make as strong academic claims as I am making regarding World Game. There is also a whole slew of comprehensive use of computational media components including algorithmic distribution of resources through credit card tracking, computational democracy through online voting, education automation through video chatting and network encyclopedias, etc. The total net synergy of Fuller's World Game is sufficient in the only way things are sufficient for human cultures: by getting basic needs met, including the need to demonstrate competence through games, and especially the thirst for knowledge:

> I am certain that none of the world's problems—which we are all perforce thinking about today—have any hope of solution except through total democratic society's becoming thoroughly and comprehensively self-educated. Only thereby will society be able to identify and intercommunicate the vital problems of total world society. Only thereafter may humanity effectively sort out and put those problems into order of importance for solution in respect to the most fundamental principles governing humanity's survival and enjoyment of life on Earth.[43]

[43] Fuller, R. Buckminster. *Critical Path* eBook edition. Estate of R. Buckminster Fuller. 2015.

2 Technical Analysis

> The one-pointed focus for my thesis is the inception of World Game as a modern software computer program. To do this, I have collected all the salient features Buckminster Fuller envisioned. These in hand, I will correlate Fuller's vision with a survey of modern algorithmic methods and how they apply to World Game. It seems clear to me blockchain is capable of securing a database of the World Resources Inventory: Human Trends and Needs; and, machine learning is capable of doing the simulation tasks Fuller imagined. Furthermore, while modern technology has swayed away from the mainframe computers which so resemble Fuller's unbuilt Geoscope — I do think translating World Game as a distributed software is necessary and would have been obvious to Fuller — the value a Geoscope would have for the general public is still active with things like stadiums or planetariums: clearly the Geoscope's scale is achievable. Current technology is capable of creating World Game.

What are the missing pieces for realizing this capacity as an important planetary resource? World Game is a strategic, tactical, and logistics planning game using simulation as the primary feedback loop for the player. World problems are inherently complex. It is my hypothesis that the greatest gift the software industry could give to aid our planet's current predicament would be to engineer this global problem solving framework as a support to whatever holds our world-civilization together. I like to think of World Game informally as a problem-solving engine in contradistinction to a search engine. Much as Silicon Valley rescued the Obamacare

website[44], the leaders of the technology sector could rescue Earth from the problem of administration in the epoch of scale.

First, the high-level is a transparent global database concerning the state of our planet. Blockchain is the state of the art today as a trust system: something that is "secure" and "verified in a distributed way."[45] More in section 2.1.

Second, we can use this database to create visualizations which illustrate global problems and help inspire solutions — like climate change playing out over time. The graphical user interface (GUI) would essentially map the database on the globe. The Fuller projection map is the state of the art today. More in section 2.2.

Third, we can leverage this database-visualization capability and create simulations which dramatize what *would happen* if we decide to take this or that action — like putting geodesic domes over our cities to help combat climate change: seeing that play out. Machine learning is the state of the art today. More in section 2.3.

Finally, we continually update the database and increase the accuracy of the simulation capability. All this is the challenge for the software industry. This is why this is so timely. Our capability is completely different from 1964. At a high level, the main difference for World Game now is that the software will be translated across

[44] Bump, Philip. "How Silicon Valley Saved Obamacare, and Obama, and the Democratic Party." The Atlantic. 2014. https://www.theatlantic.com/politics/archive/2014/02/how-silicon-valley-saved-obamacare-and-obama-and-democratic-party/358593/

[45] Wardrip-Fruin, Noah. Personal communication to author. 2017. https://games.soe.ucsc.edu/people/noah-wardrip-fruin

platforms instead of merely running on mainframes. Today, we live in an IT (information technology) universe.

2.1 Database Technology

> I say, wouldn't it be amazing if everyone's medical records were available anonymously to research doctors? And when someone accesses your medical record, a research doctor, they could see, you could see which doctor accessed it and why, and you could maybe learn about what conditions you have. I think if we just did that, we'd save 100,000 lives this year. - Larry Page, Where's Google Going Next?[46]

> At some other level, your project has some similarities with Wikipedia, in the sense that you will have to catalog and curate pretty much everything. This is certainly not something one individual could see through. - Phokion Kolaitis, Distinguished Professor, Computer Science Department, University of California, Santa Cruz[47]

Databases are one of the oldest and most established forms of computer science. There's tons of data now. Databases are ubiquitous. They are a fact of our lives. From a technical analysis point of view, establishing a single source of planetary information is in effect less of a technical problem, and more of a problem of implementation due to scale and organization. The challenge is primarily in

[46] Page, Larry. *TED* conference. Interview with Charlie Rose, "Where's Google Going Next." Transcript available from link https://youtu.be/mArrNRWQEso
[47] Kolaitis, Phokion. Personal communication to author. 2017. https://users.soe.ucsc.edu/~kolaitis/

stitching data together in a coherent and user-friendly way[48]. It is as if there were all kinds of barometric pressure informations spread out on the web, but nowhere to distill the essence and see "Oh, it's 90 degrees outside." Information could be woven together into discrete messages, and it'd be nice if we could design this tapestry elegantly. The U.N. has much data, the CIA World Factbook, various monetary flows show data, companies have data, countries have data — who doesn't have data, these days? In any event, collecting all the world's logistics planning information into a coherent form will be a feat of planetary cooperation. Ultimately, the challenge is not just in building the database, not just in populating it, nor in maintaining it, it is also in designing an interface that gives the numerical data expressive power. The database needs to be both a unifying framework, and also have a set of tools for formalizing and studying resource management tasks. It is not enough to have all the numbers, though having all the numbers is perhaps the lion's share. At the end, we need a simple interactive GUI visually mapping the big picture — truly, is it the best or worst of times? That said, a simple corralling of all the precise numbers in one place means dataset dinner is served for data scientists.

In this world we live in, often bots are used to collect and maintain information, as is done on Wikipedia[49] and elsewhere. One major difference between

[48] Kolaitis, Phokion et al. "Efficient Querying of Inconsistent Databases with Binary Integer Programming." Proceedings of the VLDB Endowment, Vol. 6, No. 6. 2013. http://www.vldb.org/pvldb/vol6/p397-tan.pdf

[49] For more information about Wikipedia, see The Computer History Museum's Exhibition, "Make Software." http://www.computerhistory.org/makesoftware/exhibit/wikipedia/

Wikipedia and the World Resources Inventory is it seems to me Wikipedia is essentially a lot of words, and the trouble with words is that they are difficult for computers to process generally, IBM Watson aside. Wikipedia is primarily human-readable, and only secondarily machine-readable. I see the World Resources Inventory in the age of Machine Learning as first and foremost about numbers: primarily machine-readable, and only secondarily human-readable. What's needed is a big account ledger of relevant information. The gift of numbers is that they are easy for computers to process, and simulate therefrom: find the well-tuned weighted-sum. Adding in maps, visualization, and other graphic design, as well as words, obviously would be in concert with the accounting database of numbers in order for the masses of people to better understand. Why would we give humanity anything but all the best for total education for total survival?

One computationally secure way to ensure there's no funny business — such as fraud — is through the new database technology of blockchain[50]. Blockchain heralds a major obstacle overcome in database security. More or less, blockchain is a "trust-system" in which each member of the community keeps a long chain comprising the record of all transactions that have ever taken place in the community. I like to think of blockchain technology as the ultimate Wikipedia. Wikipedia stores all the edits and a collaborative work can be seen transparently at each step. Blockchain is the furthest logical extension of this, having all actions being

[50] Iansiti, Marco and Karim Lakhani. "The Truth About Blockchain." Harvard Business Review. 2017. https://hbr.org/2017/01/the-truth-about-blockchain

notified to all participants, and not just within a single domain of an article or a single domain within the community. We would need such oversight so that the database comprising all Earth's wealth cannot be tampered with, and is transparent, and the distribution of wealth is on public record for all to see. Blockchain is also well suited for the option of anonymity, which is nice for citizen privacy rights. The prime directive of the world's database must be the prevention of polluted information, in terms of fraud and in terms of accidental introduction of information known to be false. We cannot base a society on anything but the truth. Because of the immense distributed redundancy, and publicly transparent nature of the ledger, it is very difficult to break the integrity of blockchain. Some form of blockchain technology, or a similar fail-safe record-keeping system, will have to be put in place.

Fuller's unusual focus with unpolluted information can best be seen in his "Dymaxion Chronofile" in which he attempted to document his life in what is considered to be the most extensive archive of any human[51]. He aimed to include nearly every and anything, artifacts ranging from the mundane to the scandalous to the famous ones like the geodesic dome.

[51] "The Stanford University Libraries announced last week that it has acquired the R. Buckminster Fuller Archive one of the most extensive known personal archives in existence. The collection comprises the personal papers and working records of Fuller architect, engineer, inventor, philosopher, author, cartographer, geometrician, futurist, teacher and poet as assembled during his lifetime and maintained since his death in July 1983." Stanford Report, July 28, 1999. http://news.stanford.edu/news/1999/july28/fuller-728.html

2.2 Map Technology

Maps have been in existence since writing existed, and ostensibly before that through mental maps and the giving of directions. At least since Lucas Film in 1971[52], computer graphics has been rapidly developing and is today is a well developed field. There is not a need to generate whole swaths of new knowledge in order to concurrently map the world resources inventory database onto the Earth. Since flat computer display screens are so ubiquitous, this bodes well for the use of the Fuller projection map as the game board — able to see the whole Earth at once. The fact that World Game's map is the Fuller projection adds little to nothing in terms of computational complexity for the technology. GIS has a technical friend in Google Maps, something we all know of, and Google Earth would also be a very nice connection. With all the innovation in augmented reality and virtual reality, there will be new and exciting ways to have a database be experienced visually. There's no reason a Google Glass type overlay couldn't have information about any given thing in the field of view — "Looking at an orange? Here's the number of all the oranges that have ever been eaten." Or whatever wants to known. SIGGRAPH[53] (the computer graphics olympics) I'm sure would love to eat World Game GUI for breakfast.

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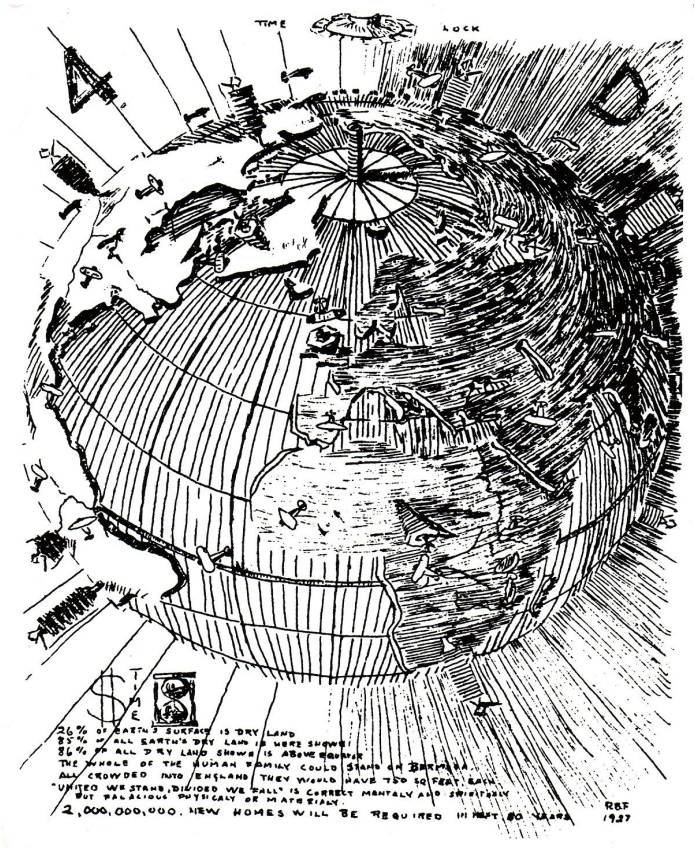
[52] Lucasfilm was founded by George Lucas in 1971 - http://lucasfilm.com/our-story

[53] "Special Interest Group on Computer Graphics and Interactive Techniques" - http://www.siggraph.org/
Many readers might now know the culture of computer science research. Essentially, they are conference-centric. Get a paper published in one of several reputable in-house conferences, and doors will open. To learn more, see Justin Zobel's *Writing for Computer Science*.

Unfortunately, no one can eat the Geoscope for breakfast. It's too unprecedented to be trivial. There is the CAVE automatic virtual environment[54] — essentially a room which projects information onto all sides — which is a stepping stone. The Geoscope would be the CAVE on LSD steroids. There is also The Elumenati[55] who do work on inflatable dome projection systems. Fuller's interest in maps goes quite far back, all the way to 1927 at least, see Figure 5:

Figure 5: "One World Town"



Courtesy of the Estate of R. Buckminster Fuller

[54] CAVE is a recursive acronym for "CAVE automatic virtual environment." For more information, see the original article: http://dl.acm.org/citation.cfm?id=129888.129892

[55] David McConville is currently a co-chair on the board of the Buckminster Fuller Institute, and a founding member of The Elumenati - https://www.elumenati.com/

2.3 Simulation Technology

Simulation is a universal problem-solving skill, used in everything from training pilots to crash test dummies to the video game industry. Take the planet's "Inventory of World Resources: Human Trends and Needs" database and move them around the Fuller projection map using a sophisticated simulation to find increasingly optimal world resource configurations based on human trends and needs (projecting future scenarios): hence the name of the database.

Simulation is the ability to animate and articulate the trends in the life of our resources through modelling and deciphering patterns: visualize inventories in time. There are limits to computer power, but the difference between computers can do and what humans can do is relevant to world-scale problem-solving. Assumptions are requisite in order to simulate, and yet we know from precedented use of simulation, such as in flight training[56], that the principle could be used in our global decision making.

Through the game as described, players are in winning positions as they discover how to do more with less in the way materials flow with increasingly less waste. "Do more with less"[57] is a principle applicable to any system, e.g. the

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[56] Computer History Museum. Mountain View, California. "Project Whirlwind begins." Timeline of Computer History. 2017.
http://www.computerhistory.org/timeline/1943/#169ebbe2ad45559efbc6eb35720dd5ad
Also see the exhibit on car crash simulation for more information:
http://www.computerhistory.org/makesoftware/exhibit/car-crash-simulation/

[57] Fuller coined the word "ephemeralization" to mean doing more with less. Fuller, R. Buckminster. *Nine Chains to the Moon* (p. 256). Anchor Books 1973, reprint ed. 2000.

ephemeralization of telecommunications technology—or almost any technology. Ephemeralization is certainly a fundamental strategy of design science and hence world game moves in any domain. The intelligence behind the efficient, ephemeral designs of the aero-space program need to be applied to everyday lives. No one is homeless in space — that's impossible because of oxygen scarcity. Society could organize and integrate resource utilization through this planning tool. Simulation is a generic problem-solving tool and can be played around in "What If" scenarios — "What If society allows driverless cars on the road; What If society shifts to renewable resources; What If [insert here]." Play these scenarios all the way through in the gaming simulation; then the best strategies will be adopted in the real world due to the principle of optimality.

While databases and maps have a stronger technical foundation, simulation is the most technically alien concept to everyday life in terms of trustworthiness for global decision making. So, how does one build World Game simulation? The word of the day today is "Machine Learning (ML)." Yesterday's word of the day was "Algorithms." Tomorrow's word of the day is "Artificial Intelligence (AI)." To recap: algorithms was special because the computer community reached a point where they could churn out casual ways of programming computers to do anything imaginable using a new way of writing programs called pseudo code — instead of taking months to write one program, we could get the basic idea out over tea. That was a big moment, and so algorithms was the talk of the town for a time.

Today, machine learning is a special way of reinforcing an algorithm effective for large data sets. Let's try a metaphor. An algorithm is like a recipe, and someone who writes an algorithm is like a cook. With machine learning, we go from mere recipe writing to being able to *tailor make* a recipe. In fact, people who write machine learning algorithms are like doctors and their ML algorithms are like *tailor made* prescriptions for powerful and targeted medicine specific for individual problems. A doctor is like a chef in that they both write these little instruction books — "take two pills a day with food" versus "crack eggs in cast-iron on high heat." More or less, the computer industry went through a renaissance when machine learning was invented, much as the modern lifespan went through a renaissance when modern medicine was invented[58]. Now, we use machine learning on practically everything we do in computers. It's been a pretty big leap, and I don't think most people get it because the huge gain in power is very technical and nuanced, yet it is as real as the whole of Silicon Valley.

Since today we are in the era of Machine Learning and on the cusp of the era of Artificial Intelligence, let's look at the technical details of what Machine Learning can do to create precision simulation at the core of World Game.

[58] Sundar Pichai CEO, Google, Inc., says in a YouTube linked below at 48:45 that "Machine Learning is an inflection point" for the computer industry. Furthermore, at 35:24 and also at 52:02 asserts his company is not playing a "zero-sum game" and is comfortable sharing with competitors. They in fact give away certain parts of their Machine Learning technology ostensibly to make the world a better place. Transcript available from link - Pichai, Sundar. "Alphabet 2016 Q3 Earnings Call." Alphabet Investor Relations - YouTube. 2016. https://youtu.be/xPvUegxXk8A

In 2004, DARPA put up a self-driving car challenge. Of the 40 participants, not a single one finished and quite a lot of them did miserably. Only a year later, in 2005, five cars completed the entire race course and there was overall much improvement. Such an improvement was due to machine learning[59]. So what exactly is machine learning? Let's back up one step and say that we live in an era of "big data [60]." There are respectable people alive today who remember when a floppy disk was a big deal[61]. Today there is something called a petaflop which is a number with a lot of zeroes behind it. We used to have really small numbers, now we have really, really big numbers. This is convenient for pretty much everything. What we do is we take these really large amounts of information and we clean it up, organize it, put it in its sunday best, and now we call the shiny new data "training data." So basically we take an algorithm that wants to do something — anything — let's say this self-driving car challenge. We feed the algorithm this training data — data in the form of examples of every possible driving situation and exactly what steps to take in that situation optimally — and it has so many examples of what to do in various situations that it can sort of get by on brute memorization force of optimal moves: even though in

[59] Launchbury, John. "A DARPA Perspective on Artificial Intelligence." DARPAtv - YouTube. 2017. https://youtu.be/-O01G3tSYpU

[60] "Problems that involve interacting with humans, such as natural language understanding, have not proven to be solvable by concise, neat formulas like F = ma. Instead, the best approach appears to be to embrace the complexity of the domain and address it by harnessing the power of data: if other humans engage in the tasks and generate large amounts of unlabeled, noisy data, new algorithms can be used to build high-quality models from the data."
Halevy, Alon et al., "The Unreasonable Effectiveness of Data (p. 8)." IEEE Intelligent Systems, Vol. 24 Issue 2. 2009.

[61] Hertzfeld, Andy and Susan Kare. Folklore.org. "The Original Macintosh." 2013. https://www.folklore.org/html/about.html

some ways it is still going blindfolded through a maze, it sort of simply has stumbled around for so long it has perfected pathfinding. And it can make a guess for new events based on past events — this guesswork done by the algorithm is a big frontier. This guesswork is essentially simulation. A lot of the work in machine learning has to do with cleaning up the initial data to make it into good training data[62]. Obviously we could pay people to help assist in the training data annotation: Mechanical Turk — Amazon's crowdsourcing platform — is the canonical example of this trend[63]. University students are another excellent source of data cleaners.

Furthermore, companies already track our behavior and use this data to drive their advertisements and recommendations[64]. The internet, and computational media in general, are increasingly becoming pipelines for pumping out training data for commercial purposes. It would be nice to take advantage of this giant training data farming in reference to World Game, and to do so in a way that empowers people: their clicks become little training data votes, an exercise of personal agency, and an opening to be rewarded for energy expenditure. Facebook's emotional contagion experiment on uninformed participants, in which they made unwitting guinea pigs out

[62] Skiena, Steven. *The Data Science Design Manual*. Springer. 2017.
[63] Desoto, K. Andrew. "Under the Hood of Mechanical Turk." Association for Psychological Science. 2016.
http://www.psychologicalscience.org/observer/under-the-hood-of-mechanical-turk#.WS7uPjOZORs
[64] Varian, Hal. "Search - Google AdWords - Hal Varian explains." Toronto SEO Company - YouTube.
https://www.youtube.com/playlist?list=PL28D81F8088CD3D88

of 600,000 people, provides an important reference point for the power of algorithms, and the need for oversight[65].

There are other cool areas in computer science like hierarchical task network planning, genetic algorithms, distributed programming language primitives, all kinds of stuff. Yet, knowing a bit about machine learning is enough. For World Game, huge amounts of training data means creating accurate and beautiful simulations of what's happening to Earth compressed into a little hologram you can put in your pocket, a little jingle that's hard to forget. What is $E=MC^2$ other than a compression of a huge amount of information you can put in your mental pocket? Certainly millions of people have memorized Einstein's famous equation.

Simulation is the area that needs the most improvement. While on the one hand we have interesting classes of algorithms to learn about life from various datasets, on the other hand we have never had a singular coherent global dataset to reason over and simulate therefrom: call it the global graph[66]. For examples of simulation we need look no further than weather prediction. Weather prediction is based on simulations[67]. All forecasting is based on simulation — "here's what I think

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[65] Ross, Michael. "Do research ethics need updating for the digital age?" American Psychological Association. Monitor on Psychology. Vol 45, No. 9. 2014.
http://www.apa.org/monitor/2014/10/research-ethics.aspx

[66] "Graphs are one of the unifying themes of computer science… That so many different structures can be modeled using a single formalism is a source of great power to the educated programmer."
Skiena, Steven. *The Algorithm Design Manual*. Springer. 2008.

[67] "Numerical weather prediction models are computer simulations of the atmosphere… The output from the model provides the basis of the weather forecast."
"Weather forecasting." *Science Daily*. 2017.
https://www.sciencedaily.com/terms/weather_forecasting.htm

things will be like, and here's what I can conclude from that intuition." Over time, we've gotten pretty accurate about the weather, even able to extend our forecasting further and further into the future: from 7 to 10 days ahead we more or less know what's going to happen thanks in part to good training data and a fine-grained understanding of the mechanics of fluid dynamics. In the same vein, the reason political polling works so poorly is because participation is quite low and skewed[68] — the training data is inadequate. Incentivising participation, perhaps paying people, could ensure accurate training data to accurately predict the future.

It is for the open problem of accurate simulations that machine learning is so helpful. Like blockchain for databases, ML for simulation is a modern scion that World Game could be made today. We're using ML to drive cars, play the stock market, make big on both — it is only logical to apply this to solving other of our world's problems[69]. A specific computational problem that needs to be solved is collecting the blockchain database and analyzing the time-stamped transactional ledger as training data for a machine learning algorithm to simulate the flow of resources, and make predictions on more efficient ways of using our total resources through something like neural net prediction[70]. World Game simulation capability

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[68] For more information on predictive analysis, see:
Silver, Nate. *The Signal and the Noise*. Penguin. 2012.

[69] Author of *The Big Short*: Lewis, Michael. "Is the stock market rigged?" *60 minutes*. 2014.
http://www.cbsnews.com/news/michael-lewis-explains-his-book-flash-boys/

[70] "[Neural Networks are] a technique for building a computer program that learns from data. It is based very loosely on how we think the human brain works. First, a collection of software "neurons" are created and connected together, allowing them to send messages to each other. Next, the network is asked to solve a problem, which it attempts to do over and over, each time strengthening the connections that lead to success and diminishing those that lead to failure. For a more detailed

could become the world's most complex and advanced simulation program. Simulation is simply a universal problem-solving principle. Perhaps dreams are a simulation tool given to us by Nature. Perhaps language is a simulation tool we use to abstract objective reality for problem-solving. Perhaps all of thinking is in effect simulation? Any sufficiently complex society such as our own must use simulation simply for the problem of scale. When one wrong move means uncountable dominos fall, using simulations to prevent one wrong move becomes necessary. Hence the claim of necessity. My argument is that anyone familiar with machine learning will immediately see the importance of World Game for the continued sustainability of our planet.

It seems to me I am grappling with the essential nature of problem-solving. If problem-solving were easy, there'd be no need for a World Game thesis. Yet, we somehow manage as a planetary body to keep surviving day by day, and have averted or pushed through some horrible stuff. My intention for World Game, and this thesis, is to aid humanity in problem-solving, and — yes — the aid my thesis currently provides is highly limited. My good news is there is great potential in World Game as presented in the thesis. If World Game were adopted over time, the aid could become more and more reliable, consistent, and available for a large class of problem-solving. As the game gets into higher gears, there could be a tangible feeling for where to

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introduction to neural networks, Michael Nielsen's Neural Networks and Deep Learning is a good place to start. For a more technical overview, try Deep Learning by Ian Goodfellow, Yoshua Bengio, and Aaron Courville." Smilkov, Daniel and Shan Carter. TensorFlow Playground. "Um, What Is a Neural Network?" 2016. http://playground.tensorflow.org/

apply computation globally, and where to apply intuition, and how to deal with the gap. I admire the *mantra* as described in *The Software Arts* — "mind the gap!"[71] I sometimes admire it literally — "use the mind to address the gap!" And it seems fair to say World Game is predominantly about using the mind to address the gap between problems and solutions: by using computational media which extend essential principles common to all types of problems and solutions. Over time, the gap will trend toward shortening, so the mind will be freed to look beyond solved problems of the world.

One technical challenge is seen in the problem of bioinformatics — that computer scientists can get stuck as 'constant middlemen' between the biologists and the algorithms. There is a risk in World Game of having computer scientists remain as constant middlemen between the players and the the database + map + simulation. If a sociologist wants to simulate potential future pattern if universal basic income is introduced, since the dataset is global in scale, it might require nontrivial algorithms with a computer scientist at the wheel. It would be best if we create simple to use tools that can be given to specialists so that the algorithms expert is not stuck as the constant middleman. The technology interfaces like in modern video games would be an excellent way to enable usability.

[71] Sack, Warren. The Software Arts (p. 30). 4 May 2017 manuscript version.

2.4 Game Technology

World Game "game" is the computational media vehicle through which the information-gathering tools of a database + map + simulation are made to be applied to problem-solving. Fuller's proposed World Game "game" could drive innovation through a proposal protocol for solutions formation to global problems of sustainability. Using the package of these computational media tools comprising World Game, teams would find solutions to global problems and, when satisfied, publicly propose the solution using the evidence base of the database, map, and simulation to prove their point. The game is a way of using the computational media tools in a human-centric way. It is hard to imagine people not being interested in the outcome of such a problem-solving process on such a scale. The ability for a given person to 'play' World Game with all the work done for them by the proposing team, and see the very same same solution scenario for themselves, will make decision-making well informed. It is nice for people to feel like they are "on top of the world" in both the sense of having fun, and in the sense of feeling competent in addressing Life on Earth.

Like in professional sports, there could be several layers to the intensity of team concentration — with amateurs and experts. Given the way the world works currently, World Game could become a centerpiece in the education system: graduating people to be eligible to play on the more advanced teams. Play World Game on a university team and thereafter play at the Olympic level. These teams

could be the subjects of film documentaries as examples of history in the making. Jane McGonigal is right — billions of more gameplay hours will save the world[72].

The way Buckminster Fuller imagined a World Game "game" is that the game becomes possible with the creation of a database + map + simulation tool and hence before adding the semantic sugar of a "game" game. Creating the game first would be putting the cart before the horse. With a compelling theme like World Game, one could certainly invent a compelling game around that theme. However, World Game's nonfiction theme gives a singular focus on reality, rather than on creative fictions based in reality. The three principles comprising the World Game computational media tool helps ensure nonfiction; the semantic sugar of a game-type game will help open the door to a broad audience.

There is a constellation of particularly relevant games to World Game. *SimCity*[73] is a sort of fictional version of World Game — a little bit like a mock trial versus a real trial; here is a nice quote regarding their simulation engine:

> The new SimCity delivers unprecedented depth of simulation thanks to the new GlassBox engine, where everything you see is simulated – from city-wide systems all the way down to the individual Sims in your city. View the consequences of your actions and dig in to see how the systems work. See the impact of your decisions by clicking on individual Sims to learn about what they're doing, their wealth and happiness. Manipulate power, water, taxes,

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[72] "Three billion hours a week is not nearly enough game play to solve the world's most urgent problems. In fact, I believe that if we want to survive the next century on this planet, we need to increase that total dramatically. I've calculated the total we need at 21 billion hours of game play every week."
McGonigal, Jane. "Gaming can make a better world." TED. 2010. https://www.ted.com/talks/jane_mcgonigal_gaming_can_make_a_better_world/transcript?language=en

[73] *SimCity*. Electronic Arts. 2017. http://www.simcity.com/en_US/game/info/depth-of-simulation

> pollution, education, unemployment and much more! New data visualization tools add incredible depth that is quickly accessible to the player -- click on the power layer for an instant snapshot of how electricity is distributed throughout your city.

Foldit[74] is a non-fiction puzzle game about molecular protein folding which regular folks flocked to; here is a nice quote which illustrates the importance of being a game:

> The number of different ways even a small protein can fold is astronomical because there are so many degrees of freedom. Figuring out which of the many, many possible structures is the best one is regarded as one of the hardest problems in biology today and current methods take a lot of money and time, even for computers. Foldit attempts to predict the structure of a protein by taking advantage of humans' puzzle-solving intuitions and having people play competitively to fold the best proteins.

The main challenge seems to be popular games are based in fiction, and nonfictional games get low production values. High production value games like *World of Warcraft* or *StarCraft* are in the class of games which are classically thought as computer gaming, "Multiplayer games created online communities, which then became real-world communities. World of Warcraft's (WoW) unprecedented popularity and interaction revolutionized the way players relate to each other."[75]

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[74] *Foldit*. Center for Game Science at University of Washington and UW Department of Biochemistry. 2017. https://fold.it/

[75] Both made by Blizzard Entertainment, Inc. A nice overview of Warcraft can be found at: Computer History Museum, Mountain View, California. http://www.computerhistory.org/makesoftware/exhibit/world-of-warcraft/

World Game's game genre would certainly be nonfiction, and the identifiers of Real-Time Strategy (RTS), Resource Management, and Massively Multiplayer Online (MMO) could all apply. Pseudo code for the core game loop might look like: 1) receives input in the form of an imbalance in the database, or an opportunity to increase efficiency [conveyed by the map perhaps]; 2) determines a response in the form of a strategic plan; 3) provides this plan to the simulation for prediction of success probability.

Furthermore, Fuller suggested at one point prizes be given for winsome solutions[76], and that serves in a feedback-reward loop associated with games. World Game was inspired in part by war games, and common sense is that real 'situation room' war games are not designed to be fun for a popular audience, but they certainly could be designed that way, since *StarCraft* — an outrageously popular "e-sport" (people have died from refusing to stop playing)[77] — is a fictional war game. I think selling the fun of it deserves not all that much attention, as people who volunteer for Wiki articles do so for intrinsic goodness which would be similar here. An easy audience is academic, and the tough world-wide audience will be very expensive to please.

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[76] Fuller, R. Buckminster. "BUCKMINSTER FULLER Presentations To Congress THE WORLD GAME" (p. 11). HEARINGS BEFORE THE SUBCOMMITTEE ON INTERGOVERNMENTAL RELATIONS OF THE COMMITTEE ON GOVERNMENT OPERATIONS UNITED STATES SENATE NINETY-FIRST CONGRESS FIRST SESSION on S. Res. 78 TO ESTABLISH A SELECT SENATE COMMITTEE ON TECHNOLOGY AND THE HUMAN ENVIRONMENT. 1969.

[77] "S Korean dies after games session." BBC News. 2005. http://news.bbc.co.uk/2/hi/technology/4137782.stm

All this would be the "game" flesh on top of a skeleton of database + map + simulation. Because ultimately World Game addresses "wicked problems[78]" — problems which are entangled with political, cultural, social, and other non-numeric systems — using teams to divide labor amongst themselves in non-zero-sum (i.e. win-win) competitive/cooperative play will find working solutions for the public means World Game is a framework for solving global problems. As described, the software seems to be rely heavily on "resource management logics" as a type of gameplay. Other types of operational logics could be used to make the game[79].

Within the operational logics, it makes sense to have global leaderboards which show variously optimal configurations. Ernest Shackleton has been preserved in history for leading a cursed expedition to the antarctic, between 1914 - 1917, suffering through the whole of Murphy's law, and at the end of it all all crewmen survived with attribution to Shackelton's captaining — a good example of the far flung lengths people are willing to go for attaining being the first, being *primo*[80]. Shackleton's leadership is not unique, with countless other feats of superhuman prowess, such as Louis Zamperini[81]. When there is a clear goal, and a chance at fame or survival, people are able to transcend normal 'human' limits. World Game

[78] Zimmerman, John et al. "An Analysis and Critique of Research through Design: towards a formalization of a research approach." Proceedings of the 8th ACM Conference on Designing Interactive Systems. 2010.
[79] Mateas, Michael and Noah Wardrip-Fruin. "Defining Operational Logics." Proceedings of DiGRA. 2009
[80] Alexander, Caroline. *The Endurance: Shackleton's Legendary Antarctic Expedition*. Knopf Doubleday. 1998.
[81] Hillenbrand, Laura. *Unbroken: A World War II Story of Survival, Resilience, and Redemption*. Random House. 2014.

provides measurable, achievable goals as a call to action: rise to the occasion. Make history in real time.

The other side to the software of game technology is the hardware. Fuller designed the Geoscope as a globular computer framework to play World Game in complete immersion. While virtual reality could do many things, there's something special about real reality which Geoscope taps into. Why do people go to the movie theatres when they can watch everything online? One reason is there is a synergetic effect of people together, a synergetic effect of human energy — the crowd. It's a communal thing. The University of California at Santa Cruz has a museum dedicated to the Grateful Dead — people really did follow them around in a world tour: deadheads. Gathering in groups is a whole different experience and thrill. There is a collective going on, a happening. Having structured, curated opportunities for people to come together is a business model and what drives many industries. Having unusual business models is sort of the usual with a case in point of Google — who gives everything away to the people for free, yet the crowds create a revenue stream. Fuller's Geoscope conception of a giant walk-in planetarium computer would be good for business.

Unlike computers, people are definitely not operating by normal logic at all times. This can make our job difficult. There are patterns which we already know work with the way people work — I call these "fire and brimstone" patterns. While unfortunately it is easy to argue about climate change, there's no doubt everyone gets

spooked during strong storms. While it is difficult to rationally discuss the ultimate value of a place like Disney World, there's no doubt we know everyone loves aspects of the spectacle. These are important facts that we could use in our slow transformation of civilization. I think making Geoscopes available around the world would be an effective way to reach a mass audience.

While of course World Game software would make it's way onto a large variety of mobile computing devices, having a giant spectacular shining sphere game space totally immersing players inside will make the fun of the game come alive: this would be priceless. Children could enjoy field trips, and get a chance to see game players who are using the full power of the software — Geoscope would be a huge supercomputer afterall, able to do a lot of complex calculations not always readily available. The Geoscope addresses both the irrationality of the public through fire and brimstone, and it also allows serious players a chance to wield a tool reserved for special occasions. The tourist value alone will pay for itself. Geoscope would be like unto the "Wonders of the World" — any city which houses a Geoscope would immediately supercharge culture. Think of it as a dynamically changing industrially reproducible computerized museum-planetarium-IMAX for serious game playing. I say, as was a part of Fuller's original *Critical Path*, that having a Geoscope installed outside the U.N. headquarters (Figure 3), would stand as a constant visual reminder to our quasi-meta-representatives to think globally, and would act as a sort of magic charm to bring a positive energy to that particular situation which could use a lot of

help right now. I am confident that the connection people make to games includes *having fun* and these giant disco-ball glow-in-the-dark party globes will definitely convince people that playing World Game is fun if for no other reason than to use Geoscope, or just watch Geoscope. People like telescopes, they like microscopes, they will love Geoscopes. The success of games like *The Sims*, *Civilization*, and others shows that people are interested in simulations, silly or serious, as long as they are high-end, well-crafted game designs: designs that supports play ("incremental exploration, ability to form intentions based on incomplete mental model of the system, clear feedback from actions, etc."[82]). The time sequencing of events like the Superbowl and the Olympics encourages a type of team competition, and Geoscope would be the perfect stadium for these final "World Championship" rounds. Talk about dropping the New Year's Eve sparkle-ball. What a way to celebrate! All of this not to lose sight that the goal of the game is to make the world work, so we're talking about a game of good clean fun — an attitude the world desperately needs. Having a very big reminder for people of all ages that the world is trying to get its act together would be a visible, functioning monument to peace on "Spaceship Earth[83]". It would be an excellent spot for meditation, contemplation, prayer, and other positive activities. Geoscope would clearly be a masterwork of digital art. We might as well install one at Burning Man, why not? Or have a travelling version that follows major

[82] Mateas, Michael. Personal communication to author. 2017. https://users.soe.ucsc.edu/~michaelm/
[83] A term associated with Fuller. Fuller, R. Buckminster. *Operating Manual for Spaceship Earth* eBook edition. Estate of R. Buckminster Fuller. 2015.

events. It would make the invisible visible. A mini-Earth will help people wrap their arms around the planet. Hug the Earth. We want people to relate to the whole world. We want people to play with the whole world, and we want the whole world to play with people. After all, the world is the greatest show on Earth.

Another major advantage of using game technology is Game AI. World Game AI could play the game at incredible speeds and become better at solving world problems as in the case of Chess AI. The word simulation does not imply a hierarchical reasoning function operating 'meta-cognitively.' An AI could make proposals transcendental to a simulating function. It is important to note the best practice is to design systems such that humans always have control over our own affairs through separating the function of playing the game through simulation set apart from any control mechanism — like democratic voting — which enact proposed changes *in situ*. There's nothing wrong with AI making proposals, providing suggestions in a polite manner, however. Even today, the class of AI called narrow AI is something computer science has a handle on[84]. A narrow World Game AI would know how to make the world work, how to balance resources optimally, but would not know how to flirt, or be an artist, or do yoga. While on the one hand, computers can memorize every proposal and outcome, on the other hand, we humans could use the classroom to have students learn about canonical examples to foster novel

[84] "Not long after its inception, artificial intelligence abandoned its original aim of reproducing human level intelligence in favor of developing highly practical systems that behave intelligently in narrow, however important, domains." Franklin, Stan. Personal communication to author. 2013. Stan is the author of *Artificial Minds*, a good reference about AI. http://stanfranklin.com/

solutions to novel problems without memorizing every example ever. And of course, while computers can be connected to make a vast logic calculator able to iterate and permutate simulations at the speed of electricity — it is an unsolved computer science theoretical problem if computers could ever be creative in the sense humans are creative (in a sense, computers are purely left-brained with no known right-brain option[85]). Therefore, while computers may displace us as left-brain players, as calculators, humans will always have a seat at the table as some solutions cannot be abstracted from prior knowledge — it requires an intuition with no known computing surrogate — computers literally cannot do out of the box thinking. Indeed, while computers provide scale, humans provide synergy. The complexity of information is a great asset, yet so huge, the net synergy of all the human relationships with the world is this very complex global infrastructure. We're doing billions of iterations through which a small percentage drops out as being useful. The world scale is beyond our ability to cope with alone, and so we absolutely must employ computers as we have not done so before in order to merely survive in our time of daily high-speed changes. In the process, we might also do quite a bit better than mere survival.

Further, the state of our global media channels seems to clearly indicate that a majority of people — perhaps even most people — are confident that they have some

[85] We don't really know how the brain works, but it's a convenient metaphor for the point I'm making. Taylor, Jill Bolte. "My Stroke of Insight." *TED*. 2008. https://www.ted.com/talks/jill_bolte_taylor_s_powerful_stroke_of_insight

"true knowledge" of the world, that they fundamentally grasp how the world works and therefore their opinion is valid rather than an uneducated guess. This seems prevalent with politics. Imagine all the people on social media or television who are willing to admit "I don't know. I don't know." People often criticize what they don't understand. The keynote of science is measurement, and therefore, without the assignment of measurements, opinions will always be just that: mere opining. With World Game, discrete, objective, measurable, numerical feedback could be provided about all kinds of things like the success or failure of a simulation, iterations of previous Game results, the feedback of numbers through democratic voting or polling or what-have-you — with this we can see for the first time who in fact gets things done, who in fact is a competent designer, a competent team, a competent leader. As every game player knows, it can feel really good to 'crush the numbers' as it were. There will be the occasional lone genius who will innovate against major established teams. This is what makes games great — the ability for a crowd to see players go above and beyond the call of duty. I predict annual global holidays to be created in celebration of World Game successes solving what had been intractable problems plaguing humanity. We could all use a little more celebration in our lives. We could all use a little more space.

What the public does post-simulation is predominantly separate from the software. There is a before and an after. In the before, the simulation provides information. In the after, people do stuff regarding the information. How people

choose to use information provided by the simulation is not entirely separate from the meta-game, and not something that itself can't be meta-simulated; however, *a priori* accurate simulation is inherently good, as accurate information is inherently good: even if accurate information is literally unbelievably bad news about a total planetary crisis. Like all popular games, there is also a metagame of play styles, administrative organization, international competitive events, etc. Tiering the game into rounds would allow for what amounts to global negotiations. Various teams may do better in different rounds based on the global feedback that occurs. One thing is for sure, there are revolutionary breakthroughs waiting to be made which by their very nature are totally radical and unlike anything anybody has ever seen before. A game is a decent way to facilitate such breakthroughs.

How does a person play World Game? In the broadest terms, World Game is a framework for solving generalized classes of problems which benefit from the use of databases + maps + simulation in problem-solving (which encompasses all problems at world scale is my hypothesis). World Game is a problem-solving engine driving a game. First, the player has access to the abstract database, "the ultimate spreadsheet." See all the world's resources from a bird's eye view. So many tons of wheat, so many pregnancies, so many nuclear arms, etc. The database must be strictly kept as a record, and only altered to improve accuracy. Thereafter, the database information is mapped onto the Earth, and able to be played around with. Part of the game is just getting a sense of what's really going on. Scout it out. Okay, so there is so many tons

of wheat. Where is it all being grown, how is it being transported, etc. What about the people who are eating the wheat, are they healthy, or is the wheat making them sick for some reason? We can see who is eating wheat by who is buying wheat right now. Seeing this on a map is part of the graphical user interface. Here's what happening. Finally, after getting a strong feeling, people can start making strong proposal prototypes of how to do it better through simulation. Education, wealth, population distribution, housing — any and everything we can account for — use simulation to play around and explore new ways of optimizing the world system. In some sense, Fuller alludes to the MMORPG genre in suggesting World Game would become this centerpiece of university life[86], ostensibly universities world-round working together through computers to make the world work. That is not so far from guilds working together to take down a final boss in *World of Warcraft*. One final boss we might tackle is to make a standardized curriculum for primary subjects so that everyone on Earth has access to a minimum of education about a set of critical topics: such a microbiology, etc. Eventually, all humanity could work together to make the world work in all ways as the maximum multi-user team. Using game technology we can tap into an international cultural literacy surrounding modern video games:

> I sort of think at some point we have all this literacy in consoles — we're gonna start using console controllers more and more as a form of interaction with, you know, highly complex visualizations. So like, that might be part of your job at some point: because we have this literacy in our culture — so

[86] "It could be that the World Game which I've been developing here may become the whole curriculum of the university itself." Fuller, R. Buckminster. The World of Buckminster Fuller. Masters and Masterworks Productions, Inc. 1974.

> many people have grown up and have these skills it will make sense to use them, you know?: To sort information rapidly or kind of understand visualizations that are spatial, that kind of thing.[87]

Fuller also intimates we could hook into these main event games a voting protocol to allow the public to express their interest in solutions which they would want to have implemented in their lives[88]. For an example already being played out, look no further than the quest to make internet available for all humans. Alphabet and Facebook are both building flying machines to beam internet so that all people have access to the world's tree of knowledge, as it were[89]. One doesn't really need to ask if people want free internet as a rule of thumb. It would be nice to have an operational formalism to allow for maximum synergy as competing/cooperating teams vie for the honor of supporting life on Earth successfully.

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[87] Isbister, Katherine. "Episode 48: Gaming and Emotion - Katherine Isbister." Literate Gamer. 2017. https://media.zencast.fm/literate-gamer/episodes/48

[88] Fuller actually goes quite a bit further in *Critical Path*, he seems to suggest we could just "read people's emotional vote" from satellites as an automatic "tamper-proof" democracy; this is an excerpt,

> We now find that every human being generates a self-surrounding, ultra-ultra-ultra-high-frequency electromagnetic field—exquisitely ephemeral but exquisitely real. Each individual's field alternates between positive and negative. When an individual is feeling predominantly negative mentally, the field is negative, and vice versa. The sensitivity of the satellite-mounted, electronic, spy-sensing equipment developed by both Russia and the United States is such that satellites, dynamically space-stationed around the world, can take continual readings of the sum-total proportions of positive and negative electromagnetic field reactions of all humanity in respect to world-numbered "proposals"—to be broadcast at given times all around the world—regarding computer-discovered solutions to each and every world-human-affecting problem. The computer will make it quite possible to continually confront humanity via the electronic media with its own world's nonpolitical, professionally trained, and examination-qualified management's successively evolved human-problem-solution proposals...

[89] Alphabet is using balloons — https://x.company/loon/ — Facebook is using solar-powered airplanes — https://info.internet.org/en/story/connectivity-lab/ — and SpaceX is using satellites — http://www.latimes.com/business/la-fi-spacex-satellites-20170504-story.html
Masunaga, Samantha. "SpaceX plans to launch first satellite prototype for its Internet constellation this year." Los Angeles *Times*. 2017.

Voting is the state of the art for many contests. Over time, perhaps one ultimate goal would be to get all humanity to participate in World Game final events by voting for solutions which will ostensibly be enacted on the Earth. Since World Game is not associated with a particular political party, there's nothing in the way of using the internet to get people of the world to make decisions internationally. Like unto the endgame mantra — "*to make the world work for 100%...*" — it is worth thinking about the principle of democracy in this regard. A total planetary democracy would be the world's largest conversation. It is engineeringly possible. It is in principle socially possible. There's no law of the universe which says we can't all embrace democracy. It's a choice, and a choice we make together. And, a species-scale democracy would mean a new relationship to our global village and to each other. This is certainly desirable. At some point in the future.

A recent article on "Aggregation of Votes with Multiple Positions on Each Issue" contending with Arrow's Impossibility Theorem[90] appeared in a computer science conference, and shows that I am not alone in assuming objectivity can be brought to the way we govern ourselves[91]. It may sound silly to say that inside some computers there are little leader elections with nodes who vote democratically, but it is true. There is a whole branch of computer science dedicated to creating consensus

[90] Arrow's Impossibility Theorem basically says more than two choices is impossible to make perfect harmony: author's translation into plain English.
[91] Kolaitis, Phokion et al. "Aggregation of Votes with Multiple Positions on Each Issue (p. 209–225)." 16th International Conference, RAMiCS. 2017.

and to voting theory[92]. We could take another page from the computer science playbook here and apply these principles to our own self-governance. In the end, perhaps we just use the simulation itself as the judge, as a risk-analysis measure. It is not for me to know the answer to these questions. It is for me scout the unknown and to find these questions to ask.

There is a major tension between *engineering the game* — building the computational media tools — and *what people do with the game*. This thesis is concerned predominantly with engineering the spirit of game as described in 1967 with 2017 technology. Whatever happens, numerics give context to content. Larry Page when discussing Google search real time analytics on Charlie Rose explained, "you can see down to the second, pretty much, what the world is thinking about."[93] Furthermore, here is a conversation with Eric Schmidt, the executive chairman of Alphabet, Inc.,

> Larry Page: You will have a Google in your pocket.
> Eric Schmidt: Yeah, and so the ability to ask questions when you have that amount of computing power with all the telemetry and knowing everything going on in the world real time is tantalizing, absolutely tantalizing what will be possible.

We are losing the forest for the trees without such world-scale data analysis. If we use votes, we can count votes. If we use experts, we can count their scores. The

[92] The canonical paper on algorithmic consensus is Paxos, here made 'simple':
Lamport, Leslie. "Paxos Made Simple." ACM SIGACT News (p. 51-58). 2001.
https://www.microsoft.com/en-us/research/publication/paxos-made-simple/
[93] Page, Larry. "The Beginning of Google." Charlie Rose. 2001. https://charlierose.com/videos/6277

computer prediction of accuracy is a numeric, as in "98% likelihood of success." And the lion's share of the database will be largely numeric. Whatever it is, assigning numerical values to aspects of life on Earth will allow us to optimize systems, to objectively solve problems, to predict future outcomes probabilistically through simulation, and to eliminate huge amounts of unnecessary suffering. Video games engage people through visually-stimulating numerical feedback. In a game, the mastery is demonstrable: such as in any sport. The numbers show the score. Let's close this chapter with Jon Stewart talking about the level of mastery it takes for excellence.

> I think what I tried to come out of [*my experience at The Daily Show*] is: excellence is hard, and competence is hard, and the pursuit of that is [*a*] process … whether it be satire, or whether it be interviews, or whether it be news … Every artist that I've ever really admired—[*when*] … I delve into their process, it's always the same: it's always deconstructive, somewhat obsessive and intentional. And I think you can translate that ethos not just to satire, but to any profession that people would go in[*to*] ... if your aim is to challenge yourself and be excellent and improve and truly try … you have to be able to handle and synthesize constructive criticism because that's what makes you better. All processes are drafts—first draft, second draft, third draft revision—and that's what I feel like: it's just a methodology that you could apply to anything that's done. That's why I have such great admiration for people who excel at what they do; because I know what goes into it. Nothing is an accident.[94]

[94] Stewart, John. Charlie Rose."THE DAILY SHOW" (52:07 - 53:37). 2016. Transcript available from link: https://charlierose.com/videos/29499

3 Realization Discussion

> What is dawning even at this early stage of production is that indeed, *Fuller's original 1967 Expo conception is not merely feasible, but increasingly technically trivial and primarily limited financially*. It therefore is necessary to include in the audience of my thesis the types of organizations which are already operating at the scale Fuller foresaw. These are the usual suspects: public, private, academic, etc. While Linux and Wikipedia are examples enormous collaborative efforts, and I would advocate for including open source and crowd source as much as possible, it seems likely given the urgency of our planetary situation that the computer industry would ideally be a part of the process. The entirety of my research shows World Game fits the bill for most mission statements. At the end, my hope is my research will make modern World Game clear in written form such that it becomes a baton that can be passed to the computing industry as a whole.

3.1 Critical Path exploration

Everybody would agree that this is a huge endeavor. However, we live in an era in which these relative orders of magnitude are highly precedented. The conclusion to draw from this is that World Game is highly feasible, while 50 years ago it was merely the seed of an idea now in bloom. Remember, the Apple II in 1977 — 39 years ago — had the storage capacity of 140 kilobytes of data for approximately $5,000 in 2017 money[95]. Today, Google Drive gives away 15 gigabytes for free — that's about a million-fold increase in capacity, and a 100% decrease in price.

[95] Computer History Museum. Mountain View, California. "Apple II." Personal Computers: The Apple II. 2017. http://www.computerhistory.org/revolution/personal-computers/17/300/1047

In Part 1 we did a guided tour of World Game's salient features. In Part 2 we did a technical analysis of where technology stands today in relationship to the salient features Fuller envisioned all those years ago. In Part 3, we will take the technological analysis and ask the question, "if this is such a great idea, how do we get from here to there?"

The following is a brief triangulation of where the world stands in terms of the realization of the salient features. Here are some examples of different endeavors and their costs in order to put in perspective the earlier point — "*World Game is increasingly technically trivial and primarily limited financially"*:

For our database, the World Resources Inventory of Human Trends and Needs, we need a "one stop shop" where the world's official datasets can all be accessed from a singular verified source. While there is data at the U.N., World Bank, CIA World Factbook — data exists — the need for a comprehensive authoritative source is paramount. From the information clearinghouse datasets, computer scientists all over the globe could run research computations at their own discretion. Whenever there is a wellspring of good information, data scientists want access. In effect, this would be the global wellspring, the mother lode. It is the logical conclusion, especially in light of the huge amount of data we are talking about, to formalise dataset research by designing a state of the art simulation framework which would provide a standard form of exploratory research: much like we have in

open-source platforms such as TensorFlow — Google DeepMind's standardized framework for machine learning.

As far as precedence goes, Dr. Kolaitis' earlier comment points to Wikipedia as a precedent database for World Game. Wikimedia — basically Wikipedia — operates within the $50 million dollar range, and they employ around 200 people[96]. According to Jimmy Wales, Wikipedia was birthed by a "ragtag band" of unpaid volunteers[97]. So there's precedent from all walks of life. Of course, in a world of cloud computing server farms — such as Google's new Tensor Processing Units[98] — and WalMart logistics: databases are tried and true. Something like blockchain could be utilised to create trust in our world of disquiet. Assembling the data into the database will be the challenge.

For our maps, the Fuller projection map, Geoscope, etc. we need to be able to see our whole Earth at once, in effect working from the whole to the particulars. We already have computer maps in our everyday lives in things like GPS. Correlating the datasets onto maps designed in human-readable ways in a GUI is non-trivial. And yet, GIS is a fairly well-developed software platform capability. ESRI "has a 43 percent share in the geographic information system (GIS) market, compared to just an 11

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[96] Non-attributable. "Wikimedia Foundation." *Wikipedia*. 2017. https://en.wikipedia.org/wiki/Wikimedia_Foundation

[97] Wales, Jimmy. "Jimmy Wales: How a ragtag band created Wikipedia." TED - YouTube. 2007. https://youtu.be/WQR0gx0QBZ4

[98] Sato, Kaz et al. " An in-depth look at Google's first Tensor Processing Unit (TPU)." GOOGLE CLOUD BIG DATA AND MACHINE LEARNING BLOG. 2017. https://cloud.google.com/blog/big-data/2017/05/an-in-depth-look-at-googles-first-tensor-processing-unit-tpu

percent share from the second-largest supplier"[99], and ESRI "had $1.1 billion in sales in 2014, and Forbes estimates its value at $3 billion."[100] It costs within the thousand of dollars range to be involved with ESRI software. Google Earth can simply be analyzed thusly: Alphabet acquired the company KeyHole which then produced Google Earth. KeyHole was purchased for $35 million in 2004[101]. In reference to Geoscope, the Hayden Planetarium at the American Museum of Natural History in New York City cost approximately $120 million in 1995[102]. The design of the interface is the challenge here.

For our simulation, we need to be able to explore new ways of arranging the variegated infrastructures of our world, rooted in the database, and visualized on our map. In war games, this is the equivalent of playing out all kinds of scenarios: if we send tanks here, what will happen? In World Game, this is the equivalent of playing out all kinds of scenarios: if we send windmills here, what will happen? In both examples, the simulation's mathematical models in effect tell us what will happen. In both examples, the reality of war and the reality of life has to be handled with care by the human players. I think one way to reduce the problem-space for our simulations is to divide problems into order of magnitude classes in a similar manner as to how

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[99] Alban, Sarah. "Independent Report Highlights Esri as Leader in Global GIS Market." ESRI. 2015. http://www.esri.com/esri-news/releases/15-1qtr/independent-report-highlights-esri-as-leader-in-global-gis-market

[100] Helft, Miguel. "The Godfather of Digital Maps." *Forbes*. 2016. https://www.forbes.com/sites/miguelhelft/2016/02/10/the-godfather-of-digital-maps/

[101] Counts, Laura. "The Man Behind Pokémon Go: John Hanke, MBA 96." BerkeleyHaas. 2016. http://newsroom.haas.berkeley.edu/man-behind-pokemon-go-john-hanke-mba-96/

[102] Barron James. "Its Stars Eclipsed, Hayden Is Cleared for Demolition." New York *Times*. 1995. http://www.nytimes.com/1995/11/22/nyregion/its-stars-eclipsed-hayden-is-cleared-for-demolition.html

computer scientists classify algorithmic problems in P, P-Space, NP, NP-Complete, etc[103]. At some point, we may reach a point, like in algorithm design, where we squeeze out fractional improvements in already well known procedures. Moreover, using computational satisfiability solvers, we can logically prove the safety of various world systems, "This combination of enormous computational power with 'magical brute force' can now solve very hard combinatorial problems, as well as proving safety of systems such as railways."[104]

As far as precedence goes, we need look no further than TensorFlow, which is a publicly-available platform for Machine Learning. TensorFlow is the result of work done from Google X's "Google Brain" which, to put in perspective, "It would be fair to say Google Brain (now called the Neural Network Project) is producing in value for Google something that would be comparable to the total costs of Google X — just that one thing we've spun out.[105]" Alphabet purchased DeepMind for $650 million[106]: showing the purchasing price of the technical capability necessary to build good ML simulation. In 2016, AlphaGo executed at approximately 1,000 simulations per

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[103] Fortnow, Lance. "The Status of the P Versus NP Problem." Communications of the ACM, Vol. 52 No. 9, Pages 78-86. 2009. https://cacm.acm.org/magazines/2009/9/38904-the-status-of-the-p-versus-np-problem/fulltext

[104] Heule, Marijn J. H., and Oliver Kullmann. "The Science of Brute Force." Communications of the ACM, Vol. 60 No. 8. 2017. https://cacm.acm.org/magazines/2017/8/219606-the-science-of-brute-force/fulltext

[105] Dougherty, Conor. "Astro Teller, Google's 'Captain of Moonshots,' on Making Profits at Google X." New York *Times*. https://bits.blogs.nytimes.com/2015/02/16/googles-captain-of-moonshots-on-making-profits-at-google-x/

[106] Gibbs, Samuel. "Google buys UK artificial intelligence startup Deepmind for £400m." *The Guardian*. 2014. https://www.theguardian.com/technology/2014/jan/27/google-acquires-uk-artificial-intelligence-startup-deepmind

second per CPU thread on an empty Go board with a total capacity of 40 search threads, 48 CPUs, and 8 GPUs[107], which approximates to 40,000 simulations per second. AlphaGo used TensorFlow in the 'man versus machine' showdown against Lee Sedol[108]. The cherry on top is the new TensorFlow Processing Units, which are new computer hardware designed to optimize neural network machine learning.

Furthermore, there is precedent with sophisticated simulation through the BlackRock Aladdin system — which is the risk management division of the largest investment management corporation who oversees $15 trillion. Aladdin is a computer system which provides simulations of economic markets in order to assess cost/benefit analysis i.e. risk management, "Armed with insights from these simulations, traders managing large, complex portfolios can tweak their holdings accordingly." In total, the computer is providing simulated risk information, "on almost 7% of the world's $225 trillion of financial assets. This is unprecedented—and it means flaws in the system could matter to more than just BlackRock, its investors and its customers.[109]" The technical engineering of a simulation is the challenge here.

For our game, we need to be able to capture the public's imagination. Both as a way to crowdsource solutions, and as an educational strategy, having a "game"

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[107] Silver, David et al. "Mastering the game of Go with deep neural networks and tree search." Nature, Vol 529. 2016. https://storage.googleapis.com/deepmind-media/alphago/AlphaGoNaturePaper.pdf

[108] Miller, Paul. "Google reveals the mysterious custom hardware that powers AlphaGo." *The Verge*. 2016. https://www.theverge.com/circuitbreaker/2016/5/19/11716818/google-alphago-hardware-asic-chip-tensor-processor-unit-machine-learning

[109] "BlackRock: The monolith and the markets." The Economist. 2013. https://www.economist.com/news/briefing/21591164-getting-15-trillion-assets-single-risk-management-system-huge-achievement

game is essential: competitive events, online play, all the tickertape parade of modern video games.

As far as precedence goes, according to The Entertainment Software Association, in 2016, the video game industry generated $34.4 billion in revenue[110]. However, to put this in perspective, Apple posted quarterly revenue of $46.9 billion in Q4 2016[111]. The estimated cost of maintenance for *World of Warcraft* over four years is $200 million, and it is estimated that a generic big name game costs $60 million to create[112]. E-sports, the realm dedicated to videogames, is projected to reach $1.3 billion in 2020[113]. Jane McGonigal's analysis that humanity spends three billion hours a week playing online games is relevant here. Of course, her thesis is we need to be spending 21 billion hours a week[114], and if given some of those hours go to World Game, I agree with her. People expect a lot of bells and whistles in a modern video game. World Game "game" needs to be electric. The design of a fun core game loop is the challenge here.

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[110] "Industry Facts." The Entertainment Software Association. 2017. http://www.theesa.com/about-esa/industry-facts/
[111] Huguet, Kristin et al. "Apple Reports Fourth Quarter Results." Apple. 2016. https://www.apple.com/newsroom/2016/10/apple-reports-fourth-quarter-results/
[112] superannuation. "How much does it cost to make a big video game." *Kotaku*. 2014. http://kotaku.com/how-much-does-it-cost-to-make-a-big-video-game-1501413649
[113] "Esports 'set for £1bn revenue and 600 million audiences by 2020.'" *BBC*. 2017. http://www.bbc.com/sport/39119995
[114] McGonigal, Jane. "Gaming can make a better world." TED. 2010. https://www.ted.com/talks/jane_mcgonigal_gaming_can_make_a_better_world/transcript?language=en

So what are we going to do? What are the possible models/scenarios for approaching the realization of a tool with this potential magnitude/ramifications? It seems there are four fundamental pathways: private, academic, corporate, and governmental. 1) The startup model: a small team with minimal funds constructs a mock-up. 2) The academic model: universities collaborate to build the game in an open source manner similar to Wikipedia and Linux. 3) The supranational model: there are large technology companies which employ software engineers who could construct almost anything. 4) As we have seen in Franklin Delanor Roosevelt's New Deal, or to a lesser extent the Marshall Plan, governments can rewrite the rules of society in a way no one else can.

Sorting the salient features by relative complexity in a stack data structure is helpful for defining the problem of realization, especially for prototyping. Here is that order:

Figure 6: Realization Complexity

0 database — Some amount of info

1 Database — Asymptotically all info

2 Map — **1** + Geolocation and GUI design

3 Simulation — **1** + **2** + Sophisticated ML + computational evaluation models

4 Game — **1** + **2** + **3** + All kinds of automatic user feedback mechanisms

Figure 6 illustrates there is an intuitive sequential order in constructing World Game. At step 0, some kind of proof of concept database which demonstrates the look and feel of the project as a visualized world resources inventory interface. Historically, architects have used miniature houses to get an idea across; this would be similar. A quantum leap later, a complete database could be built at step 1. Routing that through GIS type software in step 2 is another leap. Step 3 is a relatively large hurdle, with machine learning being a fairly new field, and achieving simulation which can actually assist in global problem solving is technically challenging. Step 4 would take the most since this would need all the previous steps already in place, and designing a game around real life data requires finesse.

The sequential order is reinforced by thinking that: without the database of resources, a map is blank, without the map, the simulation is blind, without the simulation, the game is impotent, and without the best of the best solutions proven and derived from a lot of work, like when people play games, we won't actually achieve sustainability. Achieving sustainability becomes possible when we have, not just a dashboard, but a customizable comprehensive computational analysis of features which have been number crunched.

In the startup model, the challenge is to get the thing off the ground with a small team: perhaps a GIS person, a professional researcher, a design person, a software engineer, etc. What a single individual can do to move this project is limited in scope to something akin to this very thesis; we would need a team for any type of

prototype. Anything at world-scale is a bit mind-boggling, and making these complex concepts simple is part of the work. A database and map mockup could probably be tackled reasonably with a grant for funds in a year's time allotment. While TensorFlow does exist for anyone to use, the scope of getting even primitive simulation presentable is dubious. The history of the computer industry is wrought with tales of humble beginnings inside a garage. There's no reason the same could not be said here. On the other hand, as with Wikipedia, sometimes people rally together around an idea. Kickstarter and other crowdfunding platforms enable a new kind of resource distribution. World Game is compelling, and this could be an advantage for the startup model.

In the academic model, we use the academic setting of research institutions. The recent publication *Drawdown* edited by Paul Hawken managed to enlist large numbers of mostly PhD researchers to create a set of World Game-like moves to 'drawdown' the carbon sources of climate change with virtually no budget[115]. *Foldit* is also an example of the academic model. I think it is very easy to imagine a graduate-level class which uses World Game as the subject matter. Like what Fuller did 'longhand' only this time around focusing on the use of computer tools: gathering the data sets, getting familiar with machine learning, reading the original documents and seeing how they apply to the modern world, etc. Steven Skeina's work on the QuantShop — a series of data science videos using ML to predict various future

[115] Hawken, Paul. *Drawdown*. Penguin Books. 2017.

events — serves as a model[116]. Reading, writing, projects: all of these could immediately go into furthering the students' understanding of the planet, and could immediately go into further the actual implementation of such a game. Pitting campuses against one another has previously been discussed. Go Banana Slugs! I see no reason why the UC System, or other networks of campuses couldn't create a canonical class form, or a syllabus, or even the software itself — like our friend The Human Genome Project — and be working together internationally. Graduate students are excellent farm hands for just this kind of work.

In the supranational model, an enormous organization would simply get the job done.

The governmental model exists, and has tendrils in organizations like the National Science Foundation.

There is no reason that these models could not blend together at various stages of completion. I do think it is important this project remains communicable with the public. The recent race to privatize versus publicize the human genome project comes to mind. In brief, a private company and a public organization raced to see who would crack the code first and earn the rights to share freely or license through fees[117]. I feel safe in commenting that science would have been set back had the human genome been privatized. A little later on, I make the case that it would be similarly

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[116] Skiena, Steven. *Quant Shop*. Stony Brook University. 2016. http://www3.cs.stonybrook.edu/~skiena/quant-shop/

[117] Chial, H. "DNA sequencing technologies key to the Human Genome Project." Nature Education. 2008. https://www.nature.com/scitable/topicpage/dna-sequencing-technologies-key-to-the-human-828

inappropriate to commercialize World Game. It is one thing to get people to play World Game — already it is a challenge to face reality and cooperate in large groups — it is an entirely other thing to get people to pay to play World Game.

* * *

It's possible to make a browser game with huge cloud-infrastructure backing. Or a downloadable app which puts more onus on the personal central processing unit. These are engineering choices to be made by engineers. There obviously could be multiple phases. Ostensibly, corporate giants could steamroll the whole endeavor by rolling out a finished product. Or, a small team could build momentum incrementally stitch together scaffolding. Or, variously many campuses could work together on a shared code base. Each of these different scenarios will mean different abilities to scale the database, the design of the map interface, and the simulation capability.

By now, we have seen the software feasibility due to the computer industry's mastery of blockchain, computer graphics, and machine learning. Fuller's concept to bring together cross-cultural humanity in the US Pavilion of 1967 Montreal World's Fair in a great logistics game played on a giant mainframe computer is not only possible, but today we can do much more through the release of World Game software to the public on their personal computers being so ubiquitous, etc. In fact, the World Fair was chosen to emphasize the global nature of the game at an event where people world-round would be in attendance. Today, the internet is ostensibly a 24/7/365 World's Fair, and so we might in a way realize even the vision to have

World Game be playable at the World's Fair by making World Game playable on the internet. Moreover, given the economics of the computing industry, there is funding available for this kind of project.

All this to say, my hope is it is clear World Game is something we are capable of doing. My intention is to make the context for World Game so clear the thinking becomes something like, "World Game is as necessary a chore as mere survival." Even children seem to understand certain things simply must be done.

3.2 Global Problem-solving Tool

A big piece of news that I think went unrecognized by the popular press is that Google recently publicly announced what could have otherwise been a bit of a trade secret: the size and structure of their algorithm[118]. Turns out, "The Google" is a giant tree 2 billion lines of code tall. What I'm saying is that Google's software is this giant monolith. So we know we can make giant monoliths, and they can be extremely powerful / efficient, ostensibly never going offline. World Game will be such a monolith. It is inevitable. Sharing a giant codebase would be good for transparency, oversight, and for allowing comprehensive thinking by having the whole artifact in one place. A giant codebase is similar to blockchain in eliminating blind spots.

[118] Potvin, Rachel and Josh Levenberg. "Why Google Stores Billions of Lines of Code in a Single Repository." Communications of the ACM, Vol. 59, No. 7, Pages 78-87. 2016. https://cacm.acm.org/magazines/2016/7/204032-why-google-stores-billions-of-lines-of-code-in-a-single-repository/fulltext

Google represents the best of the best when it comes to searching thanks large in part to a number of factors, including the self-titled PageRank[119][120]. It was inevitable that with the rise of the internet — remember the dot com bubble — we would need powerful search engines: thus emerged Google. It is inevitable that with the rise of machine learning — in concert with big databases — we will need powerful problem-solving engines to grapple with the logistics of humanity's life on Earth: thus emerged World Game. The Human Genome Project was a similar endeavor in many ways, including a race against time to complete a gargantuan technical task. And what is the human genome other than the "Biological Resources Inventory: Human Trends and Needs"? Indeed, the principle of databases is as fundamental as life itself. Indeed, the need for a complete database in order to even begin thinking about problems is a fundamental fact.

* * *

None of this is intended to be a theoretical exercise in thought experiments. It seems obvious we will need people who are operating at the scale of the whole world, hence the correct diction in calling the software World Game. We do have examples of world-girdling entities such as supranational corporations, governments, religions, and so on. Unless there is some grassroots revolution in computer science

[119] Brin, Sergey and Lawrence Page. "The Anatomy of a Large-Scale Hypertextual Web Search Engine." Seventh International World-Wide Web Conference. 1998. http://infolab.stanford.edu/pub/papers/google.pdf

[120] Page, Lawrence et al. "The PageRank Citation Ranking: Bringing Order to the Web." Stanford Infolab. 1998.

competencies, these organizational giants are who will be necessary to engineer the platform; which can then be turned around to resolve arguments between these corporate giants: make them all be players in the game.

World Game could easily be extensible into any type of world-scale problem-solving scenario: most everything needs a database + map + simulation to handle world-scale. If hunger was easily eradicated, it would have been. Using these tools to focus and find new strategies can support complex solutions which span multiple dimensions of socially-entrenched problems. Beyond that, a major benefit of World Game is as a standardized form of communication about problem-solving. There is a parenting strategy that comes to mind, which is if broccoli is placed on the child's plate, even though it is known the child won't go for it, after so many times getting used to seeing the broccoli stalk, it becomes easier to actually try it. After so many times of seeing a database + map + simulation, after getting used to the idea of expecting to have these tools be a part of decision making, it will become easier to get people on the same page and actually try new things in the world.

In fact, what we already do with technology regarding drones, spy stuff — as we have seen with the NSA, Wikileaks, and so forth — our technology is frankly godlike, and scary. We very much need the collective wisdom of a democracy because we very much need seven billion brains working together in order to solve the problems of the environment. **We very much needs tools powerful enough to grapple with the total world's infrastructure in order to safely handle the great**

challenges today. While in the last era, nuclear bombs were the question for giant organizations — one mutually assured destructive bomb — today, we have trillions of tiny microchips which could be weaponized and deployed everywhere. While previously agreements such as fiat money backed by law enforcement have allowed humans to cooperate at a large scale, we are increasingly empowering 'fiat algorithms' back by 'compiler enforcement' of social laws through operating systems which are vulnerable to manipulation. We've gone from the era of weaponized dinosaurs in the form of nukes to the era of weaponized bacteria in the form of drones. The ability for foul play when harm can be carried out remotely through microscopic objects **indicates the increasing importance that we have very accurate bookkeeping regarding our world's account of resources and technology.** With accurate bookkeeping of all manufacturing and other logistics, i.e. our giant blockchain database, we could more easily isolate and identify constructors and deployers of viruses, drones, etc. Because of cash, because of black markets, for so many reasons: law enforcement do not know, and have to resort to fishing for rogue agents in the form of sting operations. Mutual disarmament is probably one of the only exclusively-human-centric problems whose solving would lead to quantum leaps in survival. There is no reason in principle we can't remove the threat of military armageddon. It is within the scope of my thesis to say that I think World Game could aid in mutual disarmament. The gods have given fire to man, we must be careful lest we burn our world to ash.

All the things I've been discussing sufficiently addresses many if not all known global problems because it is a framework which can handle all problems regarding finite resources because of the fundamental nature of databases (a record of reality) and maps (a visual compression of reality) and simulation (an arbitrarily manipulatable mathematical model of reality) as **world-scale problem-solving tools** in conjunction with a protocol for implementing solutions in a way that is aligned with human nature: games. This is my hypothesis. The only proof I can provide is intuitive logic. How else could it be done without these atomic components? Alfred North Whitehead quipped, "It requires a very unusual mind to undertake the analysis of the obvious."[121] The conversation regarding the survival of our species on our planet is everyday increasingly serious. The major unknown is how serious the conversation needs to become before we all are willing to cooperate with one another. My hope is that this document will help the planetary conversation and — to be perfectly honest — save lives by doing so. **Computers represent the counter emergency**.

Ultimately, what I am trying to do is make a humanitarian case. I'm challenging the technology industry to put their attention on something that can do good rather than on figuring out how to monetize all human affairs.

> There is no alternative to peace. - Eisenhower
> The world is now too dangerous for anything but Utopia. - John R. Platt

[121] Whitehead, Alfred North. *Science and the Modern World* (p. 4). Free Press. 1997.

> The armaments race is an accelerating downward-spiral to Oblivion. - Jerome Wiesner[122]

* * *

There is a moral responsibility for any computer scientist, to be embraced by the Association for Computing Machinery and all others, in reference to a political reading of computational media: we need to engineer the first conscious software object dedicated to making the world work. Google's motto might be said, "Find anything;" Amazon's motto, "Buy anything;" World Game's motto, "Solve anything." The procedural rhetoric[123] — the message the system of the software ultimately sends, even sometimes despite itself — for at least one computer program on Earth must be "to make the world work for 100%" — and yet we do not have such a software. Therefore, if we think we want the world to work, we must at some point have such a program in place given the nature of increasingly ubiquitous technology. Facebook has the procedural rhetoric to connect the whole world[124], Google has the procedural rhetoric to organize the world's information[125], World Game has the procedural rhetoric of "making the world work." World Game clearly fills a gap in the technology industry as the pioneering **problem-solving engine**. Under all governments, for all types of society, employing the universal problem solving

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[122] All three of these quotes appear in *Utopia or Oblivion*.
Fuller, R. Buckminster. "Summary Address at Vision 65." *Utopia or Oblivion* eBook edition. Estate of R. Buckminster Fuller. To be published in 2017.
[123] "The art of using processes persuasively." Bogost, Ian. *Persuasive Games* (p. 3). MIT Press. 2010.
[124] "Mission: Give people the power to build community and bring the world closer together." "Facebook." *Facebook*. 2004. https://www.facebook.com/pg/facebook/about
[125] "To organize the world's information and make it universally accessible and useful." Brin, Sergey and Larry Page. "Our story." *Google*. 1998. https://www.google.com/intl/en/about/our-story/

principles of databases, mapping, and simulation to coordinate societal needs is requisite for the sustainability of civilizations at scale, and a game will drive the message home from nice idea to everyday reality (Go Golden State Warriors!).

* * *

> Sometimes people say, 'he just believed that the world, everybody could be trusted' — well I'm not sure I believed it or not but I thought it was worth a go — that was really more accurate. And then it proved over time, you know, yea, there is a tiny percentage of people who are incredibly annoying, but most people are basically decent and won't wreck things and you find ways to work together.[126] - Jimmy Wales, *Wikipedia*.

Open source crowd source cloud engineering is a beautiful thing. The heuristic I will use to explain the process is just that wherever we can maximize public participation, we maximize public participation. There are places where we just cannot. On *Wikipedia* the canonical example is that the article on Jesus[127] is locked from random edits, called "semi-protection."[128] Generally, the technicality required for World Game software engineering is limited to a very small percentage of the population who probably are already involved in industry. In any event, this project can use all the help it can get.

One very important point is in Wikipedia's self-admitted rocky reputation in the academic world[129]. How will people know if the database or simulation is correct?

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[126] Wales, Jimmy. "Jimmy Wales, co-founder of Wikipedia." *Make Software, Change Software*. 2017. http://www.computerhistory.org/makesoftware/media/
[127] "Jesus." *Wikipedia.* 2017. https://en.wikipedia.org/wiki/Jesus
[128] "Wikipedia:Protection policy." *Wikipedia*. 2017. https://en.wikipedia.org/wiki/Wikipedia:Protection_policy#semi
[129] "Wikipedia:Academic use." *Wikipedia*. 2017. https://en.wikipedia.org/wiki/Wikipedia:Academic_use

Professional standards, the incorporation of fact-checking, and having the code publicly available will do a lot to cover reputation. Blockchain seems to be the ultimate reputation management system in terms of recordkeeping.

As I said before, one way to include maximum public participation is to *pay people* for various crowdsourcing options. Take for example Amazon's Mechanical Turk: in which people are paid to do anything you can get them to do with a mouse, keyboard, and microphone. This would gain further credence if we form a computational democracy in which eventually 100% of humanity could vote in World Game matches thus fulfilling the spirit of the game *to make the world work for 100% of humanity in the shortest possible time without ecological offense or the disadvantage of anyone*. Pay people to vote. And if you're worried about Arrow's Impossibility Theorem — where any more than two choices creates chaos — then fine, give people only yes/no binaries: we already do that in computers! In terms of democracy, I agree with two-time Academy Award Winner William Goldman, "*nobody* knows anything"[130] — yet, maybe *everybody together as one knows something.* The primary tool of anthropology, ethnography, is captured in the form of electronic voting. Computational democracy is ethnography in total.

> Democracy certainly couldn't work so long as you really have an illiterate group who don't really know what's going on and are leaving it to a power structure which has all the intelligence information and makes decisions without people really knowing why. So I said we're coming into an absolutely new moment when it could be that a phenomenon like democracy really might work. There are logical things that can be and should be done for all humanity

[130] Goldman, William. *Adventures in the Screen Trade*. Grand Central Publishing. 2012.

> which a democracy might really seem very spontaneous and it's what you just do. Now, with the information proliferation thats going on around the world this could become a possibility and I think that is the moment we're really coming into.[131]

3.3 Critical Moment

In order to finish R. Buckminster Fuller's unfinished computer game — "World Game" — this thesis clearly shows the mandatory nature of using computers as a counter emergency. No further prototypical convincing is necessary. It is a coherent fact out in the world, and has been a fact since 1964 at least. In order to secure future survival, we will need the total world database. Without an objective record of civilization nothing else makes sense, and no toy prototype efforts are worthwhile versus earnestly attempting maximum information-gathering for the database as fast as we can. And in order to do productive things with the global database, we will need a map and simulations to deal with the flood of information.

There is a planetary crisis. This crisis is not being adequately addressed. Climate change promises to usher in a dark age. Civilization is not in an advantageous position to stop it. The economy, perhaps the current problem-solving engine, is driving the problem, not solving it. In the end, if my hypothesis of the necessity and sufficiency is correct, we have no other choice than to construct World Game or something like it, and we have no other choice than to construct such

[131] Fuller, R. Buckminster. *The World of Buckminster Fuller*. Masters and Masterworks Productions, Inc. 1974. Clip available from Estate of R. Buckminster Fuller: https://youtu.be/NIBRDmEHMQU

software within an approaching time limit. This thesis shows humanity currently has the technical knowledge capable of creating sustainable civilization. However, it is possible humans could fail to implement minimum changes, and thereafter lose the technical knowledge necessary to prevent further collapse. Historically there have been civilizations which have failed due to a technical detail, "For the Sumerians, rising salt levels in the soil—the result of a flaw in their irrigation system—brought down wheat and barley yields and eventually the civilization itself."[132] Buckminster Fuller deeply understood the nature of our emerging emergency, and invented World Game as a process to turn this very emergency into an emergence[133] of lasting sustainability.

* * *

The question of survival is all too serious. My thesis is that World Game is an answer to our collective survival. We need a way to cooperate at scale. Having a database, having visualization, having simulation — these are the basic ingredients any solution will need to deal with the cross-cultural state of civilization. These are principles of science that can be translated into any language and circumstance. And we are in a position to do this with technology we already see everyday on the internet, and technology we don't see but know about through whistleblowers.

Computer science is married to logic. I would say it is a happy marriage. I have a lot of general trust in computer science by and large because merely being able

[132] Brown, Lester. *Plan B 4.0: Mobilizing to Save Civilization*. Earth Policy Institute. 2009.
[133] Fuller, R. Buckminster. *Nine Chains to the Moon* (p. 215). Anchor Books 1973, reprint ed. 2000.

to program a computer at scale requires comprehensive, anticipatory logical thinking — "comprehensive anticipatory design science"[134] — and among scientists there is no doubt that our petroleum fueled world is in massive danger. My thinking is that database + map + simulation are the necessary components going forward on Earth. Period.

Let's look at a canonical case example: climate change. How would World Game and climate change interact. First let's define climate change: a disruption of a complex ecological equilibrium due to human-controlled or human-controllable sources of airborne carbon, and other greenhouse gases. Certainly we need a database concerning all the relevant gases on Earth — how much is in the atmosphere, what and where are every single production site and the statistics about the entire operation. We need a map so we can watch in real-time the solution — to reduce greenhouse gas emissions and whatever else — play out in success and in failure. What is so critically needed now is the synergy of these tools together with simulation capability to quickly analyze potential moves — the ability of a global problem-solving tool to give us much more rapid feedback about which moves are going to be the most effective. Humans can think of so many possibilities, and so can a computer. For example, AlphaGo has become its own teacher, playing millions of high level training games against itself to continually improve. Shi Yue, 9 Dan Professional and World Champion said the games were "Like nothing I've ever seen

[134] Fuller, R. Buckminster. "A Comprehensive Anticipatory Design Science (p. 357)." Journal - Royal Architectural Institute of Canada, Vol. 34. 1957.

before - they're how I imagine games from far in the future."[135] This is especially important, because if the simulation posits we are missing minimum goals: we can come to a consensus and choose, indeed, sometimes business interests will have to pay the price of productivity instead of the planet paying the price of further disruption[136] — the planet who cannot afford to pay anymore. With the database we can be efficient as to how we configure resource flows optimally according to what's necessary and sufficient from the simulation.

* * *

> I heard first about design science as a just beginning architectural student — I just finished the first term of the first year in AIA [American Institute of Architects Conference]. [Fuller] was in London giving a talk to — I didn't know him or know of him — he was giving a talk to the Association of British Architects students of architecture and I happened to be there and he was talking basically about this program he had just launched to have all the architectural schools in the world, all the architectural students collaborate in a ten years program to design the world. And of course to me architecture meant Corbusier or Frank Lloyd Wright — a building, spaces — and here's someone saying, 'The object of design is not a chair, it's not a building — it's the planet as a whole.' And that's the way we need to think about the thing and that's at the essence of the sustainability challenge. - Michael Ben-Eli[137]

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[135] Hassabis, Demis and David Silver. "AlphaGo's next move." Deep Mind Blog. 2017. https://deepmind.com/blog/alphagos-next-move/

[136] One example of a good use of databasing regarding Climate Change: Riley, Tess. "Just 100 companies responsible for 71% of global emissions, study says." *The Guardian.* 2017. https://www.theguardian.com/sustainable-business/2017/jul/10/100-fossil-fuel-companies-investors-responsible-71-global-emissions-cdp-study-climate-change

[137] I transcribed this from the short clip: Ben-Eli, Michael. "Michaelbio_about.mp4" *Sustainability Labs*. 2017. http://www.sustainabilitylabs.org/michael/home/

Finally, there is the challenge for society. The majority of the impediments to making World Game actually be used to manage the resources of a global civilization are social, political and cultural, not technological. There's a strong line of "if we build it, they will come" throughout this writing, but solving the “build it” technical/engineering problems (which are still considerable) is far less than half the challenge. It is important at the outset to decouple the challenge for society from the challenge for engineering. Even now, it is clear through repeated explication that the three ground truths of database + mapping + simulation is inevitable if civilization is to continue at scale. What is not clear now and will continue to not be clear even at the end of this thesis is how we are going to use this threefold framework — World Game — to solve the challenge for society: social, political, and cultural irreconciliables — anything not technologically automatable. We do not know how the landscape of social life will change in the coming years. I have argued again and again that making computer science education available and friendly to everyone is a requirement for an enlightened society[138][139]. I can imagine a final examination for whatever form of educational system in which the student must demonstrate some understanding of World Game computer code in order to participate in some higher aspects of social life. In any event, a definitive case is made that World Game is necessary, and a substantial case is made that it is sufficient — sufficiency implies the

[138] Pang, Josh. “Pseudo Code.” 2015. https://github.com/joshua0pang/Pseudo_Code/blob/master/Pseudo_Code.java
[139] Pang, Josh. “Golang - Planetary Programming Language.” 2016. https://tinyurl.com/joshlang

social problem. If indeed people behave favorably given a favorable environment, including World Game in the environment may be the missing ingredient for favorable behavior.

In my hypothesis, I posit the game aspect of World Game is the optimal artifact for getting people to cooperate: cooperation being the ultimate problem in the challenge for society. Why do we rarely see visualizations of data mapped on our globe to illustrate a point on our news channels? Where is the public-square ticker-tape twitter-feed of vital things going on all around the planet? Even if we are presented with the solution we need from the computer industry, humanity has demonstrated that it might just throw it all away for arbitrary reasons. It is the public excitement from the game upon which my hope rests that we will all choose collective survival at the cost of our collective egos. All this is the challenge for society.

Elon Musk, in conversation about PayPal, described money as simply a way to allocate labor, and money is just a number in a database[140]. Labor must be allocated toward important tasks which need to be done. Mark Zuckerberg recently described a computational democracy by "voting online" and advocated for embracing a "universal basic income" while couching his claims upon his success in computer

[140] Musk, Elon. "Elon Musk Speaks About Tesla and SpaceX at Vanity Fair's New Establishment Summit." Vanity Fair - YouTube. 2014. https://youtu.be/fPsHN1KyRQ8

science[141]. Rearranging the metaphysical structures of society is being discussed on the record by serious market players.

> Transparent government has been a democratic ideal at least since the Enlightenment. We need to have access to the codes and workings that govern us. Today, those include software algorithms too. We must see the source code of software algorithms. But, we need to do more than see: we need more than a window. We also need a door: a way into Facebook's algorithms so that we can critique and change them. If we work on this together, we will have a chance to make algorithms match our democratic ideals.[142]

I think World Game is the technological bridge we need for the simple act of global cooperation let alone actually tackling the largest problems facing all of us like proper disposal of nuclear arms and waste. Through the medium of software code, the programmers of the world would be able to verify the machinations of World Game, and therefore trust the information in delicate situations like mutual disarmament. Similar to familiar systems such as escrow, World Game could act as an objective third party in global affairs: a very logical objective third party.

It is my philosophical stance that society could operate like a computer science operating system. I argue that a national constitution already is a technically primitive implementation of logical principles used in operating system designs; already the laws which govern our legal actions are the same as programming code

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[141] Zuckerberg, Mark. "Facebook Founder Mark Zuckerberg Commencement Address | Harvard Commencement 2017." Harvard University - YouTube. 2017. https://youtu.be/BmYv8XGl-YU

[142] Sack, Warren. "Democracy in computational conditions." Réseau français des instituts d'études avancées. 2016. http://fellows.rfiea.fr/dossier/democratie-et-numerique/article/democracy-computational-conditions

which defines executable actions in software. If we define computer science as "the study of algorithms," then the discipline of optimization is a mature and well-oiled science with discovered principles of applied logic awaiting to be applied in social structures. Approximation, consensus, producer/consumer — there is a whole suite of protocols which could be useful in our thinking about the expected 21 billion meals every single day (feeding breakfast, lunch, and dinner to all humans).

Our old friend Alan Turing provides a final precedent, and a closing thought. During WWII the Germans were convinced that their Enigma cryptographic machine could not be broken because of the vast number of word-scrambling — 150,738,274,937,250 possible rearrangements of a coded message[143]. This was an astounding complexity at the time, 'uncountable,' yet here is Turing saying in fact it was countable just not humanly countable. His machine could do it, he said. Given he was working for what the British termed 'ultra intelligence' it was worth trusting Turing. Here is an excerpt from his letter to Winston Churchill:

> We realise that there is a tremendous demand for labour of all kinds and that its allocation is a matter of priorities. The trouble to our mind is that as we are a very small section with numerically trivial requirements it is very difficult to bring home to the authorities finally responsible either the importance of what is done here or the urgent necessity of dealing promptly with our requests. At the same time we find it hard to believe that it is really impossible to produce quickly the additional staff that we need, even if this meant interfering with the normal machinery of allocations.[144]

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[143] Hodges, Andrew. "The Military Use of Alan Turing." 2003. http://www.turing.org.uk/publications/mathswar1.html

[144] Turing, Alan. Jake Copeland, editor. "Letter to Winston Churchill (1941)." *The Essential Turing*. Oxford University Press. 2004.

Turing's sentiment is also my own. His claim would normally seem extraordinarily bold, but because of extreme pressure, the claim was investigated and proven correct. The extreme pressure today is less tangible than during Turing's day, but I say no less urgent. Indeed, World Game would also take 'ultra intelligence.' But isn't that a kind of easy thing to acquire in our internet age? I mean for my World Game hypothesis to be provocative, and invite anyone to prove it wrong. If it is not proven wrong, we are looking at a breakthrough that could change everything. This is the nature of my claim.

Upon reading Turing's letter, Churchill replied: "ACTION THIS DAY. Make sure they have all they want on extreme priority and report to me that this had been done."

A fellow cryptographer said of Turing: "I won't say that what Turing did made us win the war, but I daresay we might have lost it without him."[145]

My total thesis thought experiment and historical evidence combine to show how and why modern sustainability requires technology extending generic problem-solving skills associated with blockchain databases, the Fuller projection map, and sophisticated ML simulations in order to function at world-scale. I have substantively argued World Game, or something like it, is necessary for the foreseeable future. I further hypothesize that a game is a sufficient mechanism to

[145] Copeland, Jack and Diane Proudfoot. "Alan Turing: Father of the Modern Computer." The Rutherford Journal, Vol. 4. 2012. http://www.rutherfordjournal.org/article040101.html

incorporate humanity and persuade ourselves to use these necessary tools for survival. All this to mean World Game is necessary and sufficient for time going forward.

3.4 Concluding Remarks

> Over time I've learned, surprisingly, that it's tremendously hard to get teams to be super ambitious. It turns out most people haven't been educated in this kind of moonshot thinking. They tend to assume that things are impossible, rather than starting from real-world physics and figuring out what's actually possible. It's why we've put so much energy into hiring independent thinkers at Google, and setting big goals. Because if you hire the right people and have big enough dreams, you'll usually get there. And even if you fail, you'll probably learn something important.[146] - Larry Page, Google.

Hollywood is alive in the public imagination regarding big budget productions. Traditionally, the role of producer is to bring together projects which employ hundreds of people. My thesis does not provide computing encodings to power World Game. It does provide a feasibility study in blockchain databases, machine learning, and other aspects of computer science and computational media which conclusively shows — how about we say definitively shows — "it's worth giving a shot."

In this thesis I have walked through the highlights of creating a software to address the planetary crisis of scale.

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[146] Page, Larry. "Foreword." *How Google Works* eBook edition. Grand Central Publishing. 2014.

First, we went over the immediacy of 2017 and World Game. I presented the hypothesis that World Game, or something like it, is required for the basic survival of modern humans.

Next, we went over the main features of the game, including the core loop of database + map + simulation along with other relevant facets.

Then, we went over the technical gloss of creating a database, mapping the database, and generating simulations from this data.

Finally, we went over the computing industry combined with the notion of World Game necessity.

I separate the engineering problem of creating World Game software from the social problem of using World Game software to solve problems. I bridge this gap through my hypothesis that the game "game" will fill the void. The engineering challenge is straight-forward enough, and the social problem is quite unwieldy. I have made the case for allocating labor to engineer the game. There seems to be little alternative. However anti-climactic, the social problem — which is more than half the challenge — is not within the scope of my thesis to adequately address beyond my hypothesis regarding sufficiency. I'm not sure if anyone can really say what humanity will do: what can one individual say about the planet sized family tree we have as ourself? I will say, at the end, that concurrent with our modern times, the rise of education maybe will assuage social problems of many kinds, along with social services such as World Game and other free, public resources for the good of society.

How it will look? No one knows. It seems perfectly viable to me that *given a favorable environment, people will behave favorably*. First, let's engineer the favorable environment. Then, I suppose we wait and see. With a little luck, it might just work. Isn't it time?

It's been 50 years since the 1967 World's Fair which birthed World Game's conception. Why aren't we using big data and computers in a direct way to solve the problems of big hunger, big shelter, big war, etc? This is a question for history to answer. In the meantime, the rhetorical nature of asking the question is to point out, really, we need to be using computers in this way. We need to get our heads in the game, pun intended.

I, Joshua Hanners Pang, known as यशस्वी in Sanskrit, of sound mind and body, do hereby *thesize* that in order for humanity to achieve global sustainability, we must create an easily accessible database which stores the account of world resources.

Furthermore, we must create simulations regarding resource use patterns in order to aid our decision-making processes in the limited time we have to reverse negative-feedback loops hastening environmental destruction.

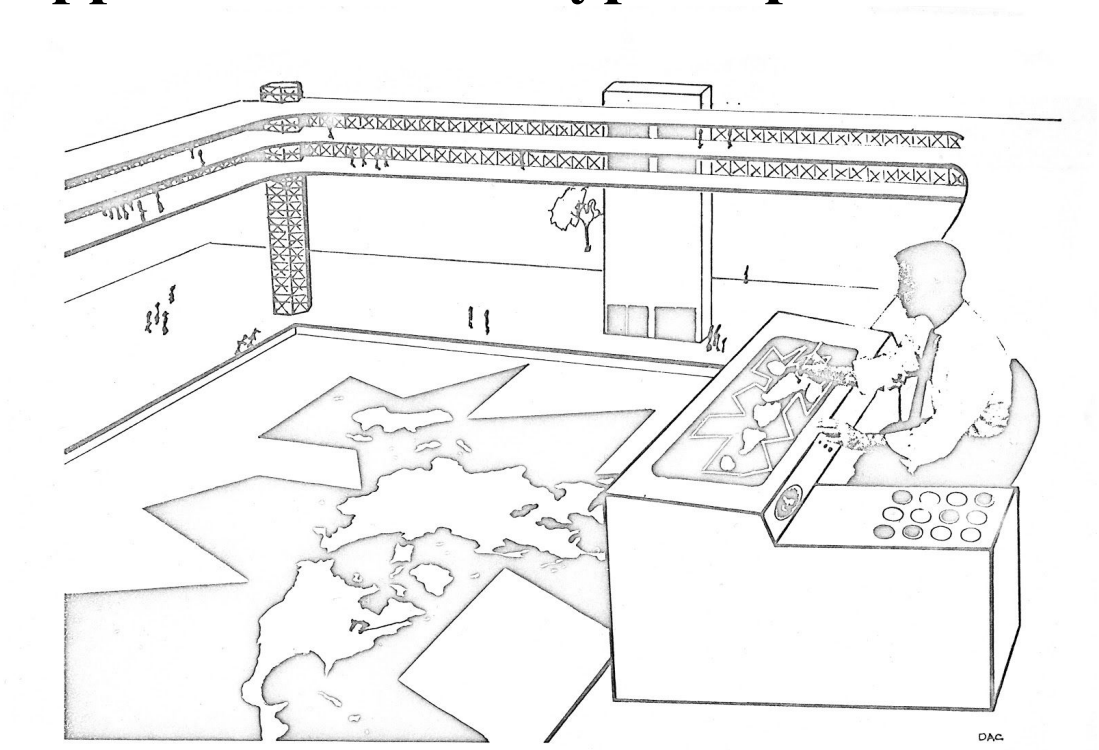
Finally, there is a game to be played between this database and this simulation feature with a map of the earth as the graphical user interface. This game is Buckminster Fuller's unfinished computer game "World Game."

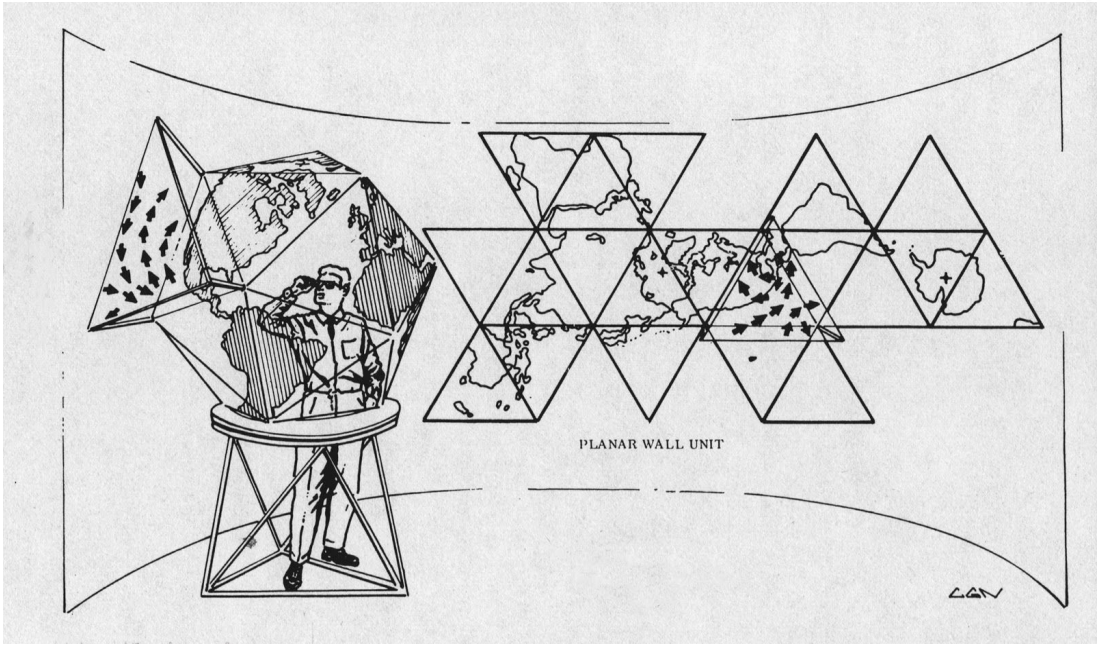
Appendix I: R. Buckminster Fuller

Primary Sources on World Game

1. *Critical Path*, "World Game" & "Geoscope" chapters.
    - ❏ The strongest document on World Game. In Paperback and eBook.
2. *World Game Series: Document One*
    - ❏ A useful guide prepared by Fuller's students "longhand" World Game. On Google Books.
3. *Utopia or Oblivion*, "The World Game—How to Make the World Work"
    - ❏ Transcribed from spoken lectures
4. *Education Automation*, "Emergent Humanity: Its Environment and Education"
    - ❏ World Game in the context of an vision of future education.
5. *Earth Inc*, "Ten Proposals for Improving the World — Theoretical Exploration Through World Game"
    - ❏ One of ten highly compressed global recommendations.
6. *World Design Science Decade Documents*
    - ❏ The World Design Science Decade was a challenge issued by Fuller to all the world's universities regarding giving credit for classes aimed at making the world work through design science.
7. *Energy, Earth and Everyone* & *Ho-Ping: Food for Everyone*
    - ❏ Two books prepared by Medard Gabel "longhand."
8. The 1969 New York Studio School seminar recordings
    - ❏ A series of ten episodes showing longhand classroom World Game.
9. It is possible Stanford could eventually digitize the entire Buckminster Fuller Archive, somewhat like Einstein's. This would be a huge windfall of World Game scholarship. There are currently 454 hits when searching for "World Game" at the Guide to the R. Buckminster Fuller Papers M1090.
    - ❏ http://www.oac.cdlib.org/findaid/ark:/13030/tf109n9832/

Appendix II: Prototype Report





[1] These images, Figures 7 & 8, are from the McHale Archives. They depict imagined (unimplemented) World Game prototypes as artist renderings. John McHale was the series editor for the *World Design Science Decade Documents*, and Fuller's right-hand man on the project for a number of years.

Introduction

"It could be that the World Game which I've been developing here may become the whole curriculum of the university itself."[2] - R. Buckminster Fuller

I remember first encountering this quote freshman year of college, when I watched *The World of Buckminster Fuller* DVD over and over on a tiny little screen someone gave me as a gift—hoping to get a sense of direction now that I was living away from home in a dorm room. And, I wondered, was Fuller was serious when he said his computer game could be completely integrated with academic life?

Fast forward ten years later to me as a graduate student. For some reason, this World Game idea had really got a hold on me—I applied to UC Santa Cruz with the explicit intention of doing my thesis on the subject—and all the sudden I found myself with an opportunity to explore this so-called "World Game" with a games expert as the final project for a graduate class called "Playable Media[3]." I've always loved sports, especially Ultimate Frisbee. I even played for my college team as a benchwarmer (I had fun during practice). While video games are still getting a foothold in our everyday lives, sports have always been part and parcel with my entire educational experience. So I thought to myself, "I think there's a convergence

[2] Snyder, Robert. *The World of Buckminster Fuller*. Masters & Masterworks. 1974.
[3] Dr. Noah Wardrip-Fruin invented the term "Playable Media" and was the instructor for this course, see syllabus here: https://cmpm290j-spring16-01.courses.soe.ucsc.edu/. Wardrip-Fruin, Noah. "Playable Media and Textual Instruments." *Dichtung Digital*. 2005. http://www.dichtungdigital.de/2005/1/WardripFruin/index.htm.

here worth exploring." I could be wrong about the whole thing, but where else to take risks and push boundaries than college? A little departure from Fuller, I thought, "It could be that the World Game which I've been developing may become a college sport."

There are "mathletes" and "knowledge bowls"—even *Jeopardy!*—and yet these are sports for the brain as a memory muscle. Where are the sports for the brain as a creative muscle? As a problem-solving game? Indeed, there are programming competitions for computer enthusiasts—"hackathons"—and in fact I joined my college computer programming team as is consistent with my track record of interests. However, these events are often highly specialized or about solving known problems—the "adults" know the answers—where can I go to be a part of the front lines of solving comprehensive global challenges? I think there is a gap here that needs bridging. And I think there is a unique opportunity in using the well-established channel of college sports as a way to have students and professors participate in their own self-education in gaming the host of unsolved global problems. With no other options before me, I would simply have to invent the game I've wanted my whole life. And so I gave it a shot.

Describing The Prototype[4]

[4] My prototype is given as Appendix III. Also here: https://tinyurl.com/world-game-rpg

- **World Game Prototype Overview**

So, how was I going to create a sport about world-scale problem-solving principles from nothing? Well, most sports seem to not require much more equipment other than a ball of some sort to play. And yet, people don't seem to learn a lot of world-scale problem-solving principles from ball games, or any contemporary games for that matter. Luckily, there is a kind of game, not usually thought of as a sport, which is allied with the equipment of education: pen and paper. Simple enough, these games are known as "pen and paper games." Or in this case, "tabletop RPGs."

My working motivation had been to not wait for some far off future to establish World Game as a university sport. When I took a step back and looked at the big picture, I saw academics as a bit like a pen and paper game. I wondered, "Could I take advantage of this and make a game out of the written word that would be appropriate for academics to play during their work hours?" Tabletop RPGs make a game out of language in the same way that football makes a game out of an oval-shaped ball.

Universities are a remarkable resource of problem-solving knowledge. And games are a very powerful and extremely popular way of giving people a fun way to develop those problem-solving skills. Universities also happen to be a home to a tremendous institution in the form of college sports that has been a big part of university culture for a long time.

Furthermore in games, there is always a standardization of experience which is necessary for use at world-scale. People would never even consider the possibility of professional sports in which basic rules are even slightly different from location to location. Fortunately, all university departments have one thing in common: problem-solving. A problem-solving game, with a single rule set, could unite all education disciplines and all universities. To this end, World Game could be a tabletop RPG played as a unifying university sport globally. All students and teachers could share in a common group experience of World Game according to their appetites.

If right now all I have to give is the written word, then I must be careful about the words I choose. An academic language game could become a world-scale problem-solving engine. Writing, when thought of as a cognitive technology, is "indistinguishable from magic."[5] At the same time, the written word seems to be insufficient for solving contemporary world-scale problems such as climate change. Therefore, our culture of writing must evolve such that the programmed word becomes the *lingua franca* for world-scale problem-solving wherever digital media are demonstrably superior to analog media. This could engender an enlightened society in which human needs are met in concert with the needs of the Earth. Every day I say to myself, "It will be software, not speeches, that will coordinate the

[5] Kadvany, John. "Indistinguishable from Magic: Computation is Cognitive Technology." *Minds & Machines* 20:119–143. 2010. http://johnkadvany.com/GettingStarted/Kadvany_Design/Assets/Downloads/IndistuinghableFromMagicKadvanyMindsMachinesFeb2010.pdf

necessary global harmony for this set of problems, because software is language lockstep with action." World Game has been entirely verbal—without much of a solid form—and eventually it will take on the form of computer interfaces. However, like going from a book to a movie, World Game would need to be written in playable language—written in a prescriptive language rather than the descriptive language that Fuller left us—before being written in computing language. Simply put, World Game needs a rule book for pen and paper play. And like books and movies, an ecology would exists between a computer World Game and a 'human' World Game.

I thought to myself, "We have with us today all the components for creating a synergy that could solve critical problems before us. Language is evolving. Games are increasingly everywhere. Universities are already everywhere. Global university education allows for the possibility of generalized problem-solving at world-scale. And the internet ties it all together. Today."

- **A Game Of The Language Arts & The Software Arts**

  The computer revolution can be envisioned as a rewriting of the world. [*The Software Arts*] is an examination of computerization as a work of rewriting or, more specifically, as translation. Increasingly, in academia, industry, and government contexts, ideas are exchanged as software, rather than as printed prose documents. Software now constitutes a new form of logic, rhetoric, and grammar, a new means of thinking, arguing, and interpreting. *The Software Arts* is a study of information technology as a technology of language and an understanding of software and software composition as a language art. The argument is that the foundational ideas and practices of computing come from

the arts -- specifically, from a coupling of the liberal and the mechanical arts.
- Dr. Warren Sack[6]

In designing my game, I wanted to see if language was as magical as I thought it was. Today, the world is dependent upon the written word as a means of formal consensus. Birth is made formal through the birth certificate. Legal documents make formal agreements between individuals and society. Humans "sign their lives away." The dominance of the written word is inarguable. However, this fact is evolving. Tomorrow, the world will also be dependent upon a new form of written word. Programming language takes the written word and enforces a meta-layer of unambiguous grammar through the medium of the compiler, which ensures a level of objectivity unattainable in a world without computers.

The written word has had such dominance because the written word can create objectivity between parties—the words on the page are the words on the page—and the main room for error lies in the subjective interpretation of the words on the page: demanding good diction and maximally unambiguous language. Our thoughts are abstract and invisible: for multiple parties to come together and have their thoughts fit together "geometrically[7]" we need a medium to act as the ground truth, the wellspring of reality. For the written word, parties must "be on the same page" about their interpretations in order to find mutual satisfaction. The fact is: programming

[6] Sack, Warren. "Introduction." *The Software Arts*. May 4 manuscript version. 2017.
[7] This sentence references Fuller's *Synergetics: Explorations in the Geometry of Thinking*. Online Edition. Estate of R. Buckminster Fuller. 2017. http://www.synergetics.info/

languages can add stronger objectivity by removing the room for error in the interpretation of the words on the page—a compiler acts as a neutral, objective 3rd-party which rigidly adheres to a singular, unambiguous representation of information in the form of a computer grammar.

Therefore, I supposed programming language must come to see dominance over formal consensus protocols requiring strict adherence to terms of agreement. Given the power of writing, establishing World Game in natural language could be useful in making this software transition overall. We must use the written word in order to adopt the computed word. My quest for World Game the word game could make possible World Game the programming word game.

- **World Game Tabletop RPG As A Playable Medium**

  On a rather different note, to return to the idea of role-playing, I've also been talking recently with Pat Harrigan - my coeditor for *First Person* - about the fact that computer-based role-playing games don't capture much of what we most enjoy about tabletop role-playing games. This is true both for the single-player adventure games on computers and the massively-multiplayer games. It's the pre-play construction, as much as the play itself, that I enjoy about tabletop RPG systems - the thinking about the possibilities created by those systems and constructing fictional elements within them. Perhaps this is analogous to what Will Wright talks about, when he says that he came to his type of design through the realization that the terrain editor for his last traditional, pre-Sim game - *Raid on Bungeling Bay* - was more interesting than the combat-oriented play that took place over the terrain. I think there's a future in making that more construction-oriented element of RPGs something the computer provides an environment for playing in a new way. And, of course, I'm particularly interested in how this might play out in a way in which language is central. Perhaps it goes without saying, but it was the

> interaction of written and spoken language with the mechanics of a system that first drew me into tabletop RPGs when I was eight and a friend showed me a copy the *Dungeons and Dragons* rules. - Dr. Noah Wardrip-Fruin[8]

Yes, writing is powerful. Yet, a book is not exactly 'playable.' Tabletop RPGs are playable media which are uniquely suited to the rhythmic claims of freedom and discipline[9]. When I implemented my playable prototype, there were three things I kept in mind: 1) I must maintain the bar Fuller set for himself—the way I solved this was by studying the World Game source materials (Appendix I) with the benefit of the Fuller Estate's facilitation; 2) I must maintain world-scale—the way I solved this was by embracing computationally-based media experiences and imagining a meta-tabletop RPG being played on the "meta-tabletop" of the internet; 3) I must maintain playability—the way I solved this was by taking the world-scale university model of a) syllabi, b) teachers, c) students and combining this with the aforementioned world-scale tabletop RPG model of d) campaigns[10], e) game

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[8] Wardrip-Fruin, Noah and Roberto Simanowski. "Interview with Noah Wardrip-Fruin." *Digital Literature*. 2006. http://www.artificial.dk/articles/wardripfruin.htm

[9] "The only avenue toward wisdom is by freedom in the presence of knowledge. But the only avenue towards knowledge is by discipline in the acquirement of ordered fact. Freedom and discipline are the two essentials of education, and hence the title of my discourse to-day, 'The Rhythmic Claims of Freedom and Discipline.'" Whitehead, Alfred North. *The Aims of Education*. "The Rhythmic Claims of Freedom and Discipline." Free Press. 1967.

[10] A campaign is the narrative backdrop which supports the game—i.e. "there is a dungeon and a dragon, and this play session is about coming to grips with these facts." This is no different than saying, "there is physics and thermodynamics, and this class is about coming to grips with these facts." Which is no different than saying, "there is the world and there is the individual, and this play sessions is about coming to grips with these facts"—which is in brief the substance of my game. If further information is needed, here is an article designed for a mass audience, with special reference to this sentence: "a Brazilian study from 2013 showed that role-playing classes were an extremely effective way to teach cellular biology to medical undergraduates." Jahromi, Neima. "The Uncanny Resurrection of Dungeons & Dragons." *The New Yorker*. 2017.

facilitators, f) role-players. Because a university seemed to be similar to a giant tabletop RPG, and a tabletop RPG seemed to be similar to a tiny university, my idea was that World Game as a tabletop RPG could become a problem-solving college sport globally—a real "World Game." World Game could be something done during school hours, rather than as an after-school program.

Tabletop RPG mechanics are fairly simple as a set of principles. People read the documents—"a friend showed me a copy of the *Dungeons and Dragons* rules"—and decide if they want to play. In order to play, the documents are fairly self-explanatory, with the *sine qua non* being a game of the written and spoken word—"the interaction of written and spoken language with the mechanics of a system." In this case, the mechanics of World Game's prototype tabletop RPG system is as a problem-solving engine: first, get yourself together on pen and paper; second, get the world together on pen and paper; third, bridge whatever gaps with the rest of one's life. My prototype documents attempted to assist in these regards by creating a game model which is learnable and actionable:

> To be learnable, a player must be able to make inferences about a game's state and build up a mental image or model of the underlying system as they interact with the rules of the game. This may not mean that they are able to completely reverse-engineer the system. Rather, a learnable computational model is one supporting the incremental development of simplified and partial mental models that successfully provide guidance for future exploration and interaction within the game rule system. This exploration is afforded through mechanisms of engagement, that is, a means for a player to affect the state of the game in a manner consistent with his or her desires. To meet this

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https://www.newyorker.com/culture/cultural-comment/the-uncanny-resurrection-of-dungeons-and-dragons

> requirement, the game must also be actionable. Defining games as systems that employ such playable models distinguishes them from traditional systems and computational models in other disciplines such as physics or engineering, where cognitive properties of learnable and actionable are not factors.
> - Dr. Michael Mateas[11]

- **Roles to play in World Game Tabletop RPG—Avatars:**

  > अवतारः ... Descending or going down into … Any distinguished person (who, in the language of respect, is called an अवतार or incarnation of a deity) - The Practical Sanskrit-English Dictionary[12]

In many ways, the self is the most real thing for a person. And yet, the self can be physically extended beyond the body through artifacts of language, and language can run amok.

There is already a database, actually many databases, which purport to know who you are: governments maintain a database on their citizens, corporations maintain a database on their potential customers, and a social media profile is a database purporting to represent people. It would be nice if folks had total control over where "they" appear in the world, and how their appearance is managed—as they have control over their own bodies. That would be a great public service. I designed the prototype to empower players to take the already in place framework the

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[11] Mateas, Michael et al. "Advanced Game Technologies." Scacchi, W. (Ed.), (2012). The Future of Research in Computer Games and Virtual Worlds: Workshop Report, Technical Report UCI-ISR-12-8, Institute for Software Research, University of California, Irvine, Irvine, CA. July 2012. http://isr.uci.edu/tech_reports/UCI-ISR-12-8.pdf

[12] Apte, Vaman Shivaram. *The Practical Sanskrit-English Dictionary*. Prasad Prakshan. 1959. http://dsalsrv02.uchicago.edu/cgi-bin/philologic/getobject.pl?c.0:1:4947.apte

world uses to pigeonhole people—write down their name, age, marital status, generally IRS-type form-filling—and thereafter think about the successes and failures of how they are being represented in the world. This was in contradistinction to a fantasy construction. I chose this nonfictional design to emphasize the extraordinary reality of the way the world currently works (with special reference to the way the world also fails at its job of working). If players wanted a role to play in World Game, my design was to have them role play themselves, and in the process further their own self-realization. Over time and at scale, with enough correct data, it is possible humanity may discover enormous patterns of Nature are playing out in which each person is a link in the 'blockchain' of irreplaceable importance.

Furthermore, a standardized character sheet would allow for party balancing mechanics found in these more traditional games. Doing work in the world often requires comprehensive skill sets spread out among a team of people. Having some kind of at a glance format which immediately identifies the roles a person is suitable to play would allow for quick formation of groups capable of generalized problem-solving. Ultimately, it was an attempt to give players a common ground and shared language for their time in the game, and a chance to reaffirm an answer to the timeless question of "Who am I?"

- **Things to do in World Game Tabletop RPG—Problem-solve:**

I also included in the prototype a Problem-solving Guide. After having come to some terms of agreement with their internal problem-solving through the avatar, it was time for the players to step out into the world and grapple with the external problem-solving of planet Earth. In order to shoulder some of the burden for the players, I attempted to provide in the Guide a comprehensive overview of the world's unsolved problems.

World Game as a framework is meant to be a problem-solving engine, and this is also true for the tabletop RPG. World hunger, poverty, crime, war, environmental destruction, education—there are problems enough to go around for a long time. The general goal for the Problem Guide was to facilitate the player's thinking about the world. First, the player got to situate themselves in the world through the Avatar. Then, the player got to situate the world in reference to them through the Problem Guide. Between creating themselves on paper, and creating the world on paper, there was a game in the space of the self in relationship to the world which was greatly aided by the written word as an objective anchor for thinking. It is also a way to do 'statistics maintenance[13]' which is a fundamental aspect of many playable media, and also a fundamental aspect of life. Ultimately, in terms of playability, I asked the players to submit a written proposal of a solution to a problem of their choosing in the context that the planet is in a dangerously fragile state due to

[13] Statistics maintenance is essentially number juggling—juggling health points, wealth points, strength points—anything quantifiable in a game context.

the critical conditions humanity has imposed on the Earth through unsustainable resource-use patterns.

- **Start World Game With World-Scale**

With a few simple ingredients, individuals can achieve unprecedented impact with speed and scale: Language + Games + The Internet ≈ World Game Tabletop RPG Prototype. Universities already exist world-over. Using the internet and the love of games could feasibly unite all academics, as is already the case in the unity of athletics. A unified academic front could solve the world's problems.

My game was fairly simple in principle. I used the internet to upload a downloadable file on an online server. In truth, this could be accessed globally, and therefore be an around the world game. In practice, I had a group of people who had agreed to beta test my game in a controlled setting and provide critical feedback within the context of a larger graduate course. The final file on the online server was a single document consisting of thirty-one pages, and seven-thousand, eight-hundred, and four words. The document had as contents:

- ❏ Introduction
- ❏ Avatar Guide
    - ❏ Avatar Template
    - ❏ Avatar Example
- ❏ Problem-solving Guide
    - ❏ Problem-solving Template
    - ❏ Problem-solving Example
- ❏ Implementation section
- ❏ Discussion section

Besides reading the files, the main action to be done was to fill out the Avatar Template and the Problem-solving Template (or invent a new template). That's all. Just two writing exercises shared on the internet was the minimum of the game. The maximum of the game was to process the lifetime's worth of considerations that concern the self and the world. At the end of it all, perhaps a physics major would decide to install solar panels on campus—much the same as would happen in a university class project or thesis.

My prototype was an attempt to take a facet of the university experience, package it as a game, and transform the academic stakes into the stakes found in World Game's win condition: "to make the world work…" No grades were given, yet if something like my World Game writing exercise is not done, the logical extension is the world will not work for our species. The look at feel of my game was intended to be like a graduate seminar, or a situation room, or a think tank, etc. Instead of casting magical spells in a make-believe setting, I simply asked players to focus on the world and ask themselves how could they make the world work for real.

Lessons Learned From Beta Testing Prototype

It is important to note my small sample size in terms of extrapolating lessons learned. Out of nine possible players, six players in total submitted avatars. Of those

six, four players in total submitted solutions. Of those four players, three submitted written critiques. I also received a critique from the one player who submitted a written request to be excused from play in place of a critique. Two beta testers chose simply to not participate, and produced no written record whatsoever. Complaints included: insufficient time, unease at personal information requests in the documents, and general disregard for what I had to offer in the prototype and as a facilitator. Though I tried to make myself available by phone, e-mail, and in-person, I received zero inquiries for help in understanding the game.

Everyone seemed to agree rules were necessary for a game. Players submitted to me an avatar and a solution within the context of the rules. To give a comprehensive report, first I will report on the details and reflections from our playtest regarding what the players submitted, and my own experience. Then, I will report on material from the four formal critique I received in combination with some of my overall analysis. Finally, I will report on design changes to address the lessons learned.

Results and Reflections from Playtest

- **Avatar Excerpts**

Here are some anonymized excerpts from what players sent to me regarding their avatars with the prompt that:

The purpose of the character sheet is to help you develop a better understanding of who you are in reference to the world as your environment and also to expose your teammates to material that lack of time prevents us from covering in game. Please do not share anything with me that you are uncomfortable sharing. If you send me your character sheet, feel free to include other stats you think of…

Excerpt From Official Avatar Example:

● **Health**. I have no major medical diagnoses preventing my participation in World Game. I […] however, am currently patterned to be unreachable for serious work from 6:00pm-10:00am weekdays, and unreachable on weekends generally. This is often impinged upon by my own mismanagement of my time and energy, creating negative feedback cascades. This is self-corrected by hook or by crook.
● **World Game Points.** I think it would be cool to consider how to map objective feedback from culture—is it bank account stats, or twitter follower stats, or academic citations, or a combination? I eagerly pursue the day when our stats maintenance is effortless and transparent, like in MMO or Fantasy Tabletop RPG.

Player 1:

Arms: gross
Duty (Haha, Duty): 6 (-2)

Player 2:

All investable time stolen by hell bunnies
6 currently itchy mosquito bites

Player 3:

Career. Tax Dodger
Health. Eagerly awaiting the singularity to replace my body.

Player 4:

Health.
I consider myself healthy enough, but I would like to lose some weight.

Player 5:

Has no idea what's going on
Is quite possibly (hopefully) a werewolf

Player 6:

Health: 84

- **Reflection on Avatars**

I had thought taking the time to think about the nature of role-playing one's own life would be exciting, if not thrilling: the unique role of a lifetime, designed just for you, by you. It seems players did not want a contemplative game. Taking time to stop, slow down, read lengthy instructions, and write about the nature of reality was at odds with the expectations players had about my initial offering.

What is it about health that made the beta testers uncomfortable? I still don't know, but it seems like there is a cultural glitch which has inflicted upon folks some kind of body or sickness shame. This is doubly unfortunate, because by hiding health emotionally, little problems can become big ones.

When I think about what I wanted from playtest avatars, I am reminded of the song "Revolution[14]"—"You tell me it's the institution, well you know / You better free your mind instead." The point of the avatar exercise was to engage people in self-reflection, to be a more effective problem-solver, and to allow players to share themselves for conscious team coordination. One team composed of all artists and one team composed of all engineers would certainly benefit from acknowledging the subgrouping, and could possibly benefit from intermixing a bit. Tabletop RPGs often require interdisciplinary teams in order to progress through challenges designed to foil specialized teams. During playtesting, the avatar sheet was not used in this manner. While I enjoyed the humor from beta testers, I was also caught a little off guard. Next time I would want to find more give and take between us to find a happy medium for such a "Serious Game." To achieve this end, I could loosen the language in the game rules, and be a little more giving as a game facilitator.

- **Solutions Excerpts**

[14] Lennon, John and Paul McCartney. "Revolution." *Revolution*. Apple Records. 1968.

Here are some anonymized excerpts from the solutions players sent me answering the prompt:

> The purpose of the Problem Solution is the thrust of your move in World Game. Any careful read of Fuller's original vision of the game posits a simulation which would be translated to the real world in the event of a winning team. For us, the simulation must take the shape of a written document without the necessary computer tools supporting richer simulations.

Excerpt From Official Solution Example:

> My entry in World Game tabletop RPG seminar taking place Friday 5.6.16 – Friday 5.13.16, Santa Cruz, California is entitled *Golang - Planetary Programming Language*. The artifact of my entry can be found here: https://drive.google.com/open?id=0B0-XD1zvUBHZZlRrdWt5MC1MV00

Player 1:

> As designers of systems, we should resist rationalization for its own sake by weighing the structural and organizational benefits of categorization against the dehumanization that often occurs as a direct result of it.

Player 2:

> Make reusable grocery bags by knitting stripped, flexible plastic waste
> Public worm compost bins
> More public (> private) utilities + resources
> Science and tech communication through zines

Player 4:

> My solution consists of using the professor position to spread the message of equality, as much as possible.

Player 5:

> We need to go to space and find another planet, or somehow curb population growth (my mind goes to dark places, perhaps something as grim as a selective virus that kills a large portion of the current population or renders most of it sterile) because from a long-term standpoint it seems like we are completely fucked.

- **Reflection on Solutions**

In the end, I awarded Player 4 for having the most realistic solution to addressing making the world work. Here is a quote from Player 4 that leads me to believe some of what I wanted to communicate got across, "I understood that the core game loop of the game is actually doing, in real world, the solution I proposed. I'm every day working to achieve a position that I think it would make me a better person to help solving the problem." If this was a software program, I imagined Player 4's input would have had the highest probability of working.

Next time for solutions, I would want to find a way to solicit more words from players. I am again reminded of "Revolution"—"You say you got a real solution, well you know / We'd all love to see the plan." I needed words to 'compute' the feasibility of solutions, and most of the time the number of words was insufficient information for me to really grasp how players were imagining things. In order to achieve this end, I could alter the game rules to include more options for casual play rather than over-emphasizing strategies for time-consuming play. Giving options to let just

players free-write about problem-solving could invite more valuable participation: I think of this as problem-solving doodling.

- **Playtest Game Facilitator Experience**

I made many mistakes in my prototype and playtest. From May 6th, 2016 to May 13th, 2016, I conducted the only playtest of my World Game prototype. None of my intentions resulted in what I had expected. Despite my attempts to make the prototype a "spontaneously cooperative" non-adversarial game, it seemed to me like players felt like I was an adversary rather than a facilitator. I learned it is nontrivial to present a non-zero sum game.

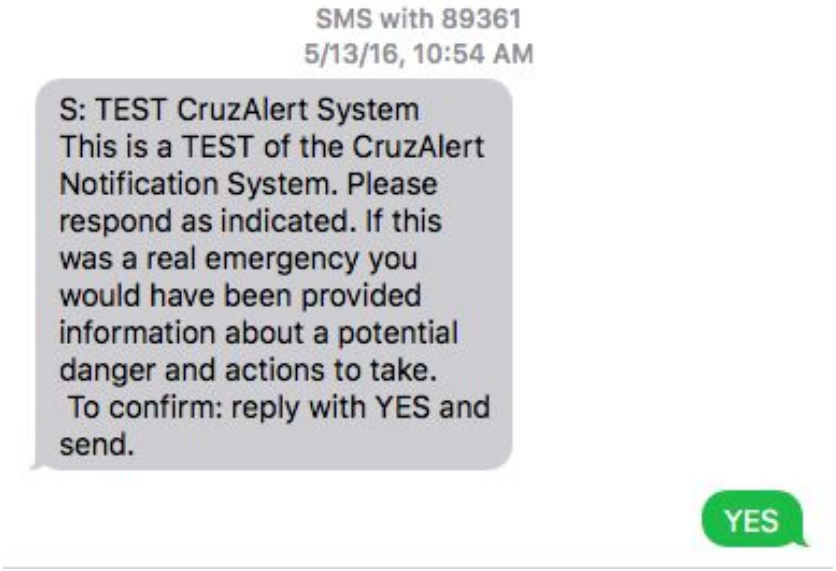
My expectation that I would learn new things by undertaking this experiment with a group of academics was fulfilled. What I thought I would learn was academic information about problem-solving principles: engineer majors and social science majors would naturally bring things I'd never seen before to the tabletop. It seems perhaps that emotions are easily stirred by the topics my game engages. And, what I ended up learning was much deeper than problem-solving principles: the players shared with me their strong emotions, emotions I was not familiar with, and I felt things I had not felt before, both good and bad. I didn't know humans could transmit emotions so viscerally through a tabletop RPG. That's a powerful lesson learned.

Another important facet is the structure of the game as a telecommunications tabletop RPG. One person commented, "Running a largeish, nondigital, multiplayer

role-playing game remotely is an interesting structure presenting interesting challenges." Normally, people play games like this simultaneously—if not literally at the same tabletop then over some kind of video-chatting software. However, given time constraints of my particular group, and people in general, I tried to make the game non-simultaneous—players did not need to be in the same room with me, however they could reach out to me, their game facilitator, over the many telecommunications networks dotting the globe at the push of a button. And, I made myself available to respond promptly during a pre-set office hours timeframe. I call this a "telecommunications tabletop RPG." In this case, given the rough-draft nature of my prototype, a hands-on, in-person, approach would probably have worked better. Ultimately, however, having the tabletop able to be run remotely through correspondences is a goal of mine.

Results and Reflections from Critiques

- **Design Challenge 1:**
  A Planet In Crisis—Issues of Tone
  I suppose the larger caution I am dancing around here is to not risk losing sight of how important this endeavor is by feeling the need to advertise it as fun, or by using the word game [*sic*] in a way that implies it is less deep in intention than it is. - A Beta Tester



I received this CruzAlert text message during the group critique of my work at the end of their playtest, and read it aloud as part of my response to the feedback. I compared my prototype World Game to the CruzAlert System: having early warning systems saves lives.

I am motivated by my research that life as we know it could collapse for all of us. How can I facilitate humanity "getting on the same page" regarding unsolved problems, that if left unsolved, will mean death and destruction? How can I do this in a way that is emotionally neutral, or uplifting? Is that possible? It is nontrivial to design a game which sufficiently addresses the global threats to survival, and yet induces play: play which is often required for creative breakthroughs necessary to solve these long-time unsolved problems.

The role-players wanted to have fun while they problem-solved. I did not get any reports that they succeeded. And yet, is it really appropriate to have fun while

solving gun violence, or any other world-scale problem? I don't know, maybe without fun nothing gets done? I am still processing what kind of tone, especially emotional tone, is optimal. I learned being a teacher, or being a game facilitator, is non-trivial.

- **Design Challenge 2:**

  Working For 100% Of Humanity—Issues of Player Base

  Definitely Game World [*sic*] is not a traditional game and I had a hard time to understand it. [...] I can say I spent about 2 hours playing the game yesterday, plus 1 hour to understand what I was supposed to do [...] Instructions were very confusing to me, I had a hard time discovering what was the game about and how to play it.
  - A Beta Tester

The number of different kinds of minds who resolve themselves to formal education in academics is practically infinite. Since this is a mental sport, the co-ed segregation normally found in college sports can be completely erased. Not to mention all the other types of physical segregations which occur for good or for ill. Therefore, the rule book must be written with diversity at its core. I strongly feel that everyone has something to contribute unique to them. That humanity is largely literate[15] means the majority of total planet Earth can play this pen and paper game. However, I also have to ask myself, "Is limiting the game to pen and paper

[15] "Globally, however, at least 750 million youth and adults still cannot read and write and 250 million children are failing to acquire basic literacy skills. This results in an exclusion of low-literate and low-skilled youth and adults from full participation in their communities and societies." *UNESCO: United Nations Educational, Scientific, and Cultural Organization*. 2017. https://en.unesco.org/themes/literacy

necessary?" And it seems the obvious answer is, "No." There are games which use Live Action Role Playing which is not encompassed by tabletop RPGs. What if someone wants to paint a picture in their playing World Game? My original prompts were not accommodative to the many different persuasions of possible World Gamers. The pool of global players does have in common a self, the world, and problem-solving. However, does the game really need to be limited only to the Avatar and the Solution? Diversity in language / arts play will foster the creativity at the core of problem-solving. My prototype was supposed to be an opportunity for players to start consciously designing the world—to feel at cause in the world, as opposed to at effect. My mistake was to limit the design parameters the original beta testers were given. Someone commented, "Fuller already did it, how does what you're doing improve or shed new light on these same aims?" The lion's share of my improvement to the game was to add prescriptive rules necessary for a playable game, however in the end it seems I was too prescriptive. Could there be multiple versions of the game manual? A formal and an informal version? For undergraduates, for graduates, for artists, for engineers, for whoever wants to play? Is there an audience for the level of prescriptions I included in the original version? Or is it a consensus that minimal prescription and maximum description is the golden ratio? These are the types of questions—questions of accessibility—which define issues of player base.

- **Design Challenge 3:**

  World Game Teams—Issues of Inducing Play

  I worry that the language and surface texture of the materials does not invite play. [...] This feeling like I'm going to be graded is a little paralyzing, and makes me not want to step into the magic circle at all. I also don't know the metrics by which I'd be judged or graded, which is even worse for those feelings of reluctance to play and uncertainty over what actions I should take. [...] I'm not in a headspace to be creative and freely, confidently express myself right after I've written a resume, and that is how writing and thinking about the avatar sheet makes me feel. Also, having to justify why you are the best person to achieve your proposed solution with the solution proposal is hard and keeps players from suggesting pie-in-the-sky, experimental ideas. The game, as it is now, does not feel like a safe space to me. - A Beta Tester

My analysis for this report is that it seems like the emotional nature of world-scale problem-solving is at odds with what people generally want from games—which is play. What ultimately mattered to me was helping people solve problems. I wanted my game to help bridge the gap between play and problem-solving. And I think the potential marriage between play and problem-solving as a cultural phenomenon is merely a flirtation of what it could be. To this end, what does seem to be helpful is giving people blanks to fill in. Effective use of space can induce play. Questions inspire answers. However, upon reflection, it seems clear I made the questions I asked of players too specific. The narrow range of avatar questions asked only for objectively precise data; and the narrow range of problem-solving questions asked only for planetary-scale solutions. This stemmed from my personal interests, and it is clear future questions need to be much broader to

accommodate the interests of any given person. I do think most people are interested in creatively answering questions about themselves, and questions about the world as a form of playful expression. And I do think answering those questions is aligned with the soul of education. I thought I knew what the players needed to think about in order to play in the world productively. But it is clear they already knew what they wanted to say and do. My job as a designer is better limited to giving a creative space to explore, rather than prescribing how to play competently. Various teams, various groups, various tabletops will play their roles as they see fit. I had only focused on hardcore teams, when casting a wide net would go much further as a problem-solving engine. In the end, without buy in, World Game doesn't work. Clearly next time the designs must induce play from broad-spectrum prompts, expanding "the magic circle" for all types of play: be it silly or serious.

Conclusion

When the dust settled after designing and testing my World Game manual, the question I had to ask myself was, "What is the story of the world." When I placed my ear to the ground, I heard the story, "Humans failed to work together in saving their environment, so they all perished together. Poetic justice." Unhappy, I thought, "is there any way to change such a huge and entrenched story?" For me at least, World Game seems like a feasible thread that could be woven into our global narrative. It could change the stories we tell ourselves, and renew the purpose of society. Literally,

through each pen and paper game, our story could be rewritten. The new story might go like this, "Against all odds, humanity banded together around World Game to solve the problems that were stacked against them." I'm in good company for such a prophecy:

> If we take everything game developers have learned about optimizing human experience and organizing collaborative communities and apply it to real life, I foresee games that make us wake up in the morning and feel thrilled to start our day. I foresee games that reduce our stress at work and dramatically increase our career satisfaction. I foresee games that fix our educational systems. [...] I foresee games that raise rates of democratic participation. I foresee games that tackle global-scale problems like climate change and poverty. In short, I foresee games that augment our most essential human capabilities—to be happy, resilient, creative—and empower us to change the world in meaningful ways. - Dr. Jane McGonigal[16]

That said, I am interested in World Game RPG "The Sequel." When I stop to think of the problems that need solving, I cannot think of a better way to solve them than World Game—if I could think of one I'd be pursuing that. I'm confident the tabletop RPG genre lends itself well to the design challenges of this game; and I'm confident the institution of college sports lends itself well to the opportunities of this game.

In large, my takeaway for improvement is with regards to how to get World Game alive in the world. And now, a year and a half later, one lesson I learned is that it is okay I am limited as a designer. I have very clear patterns which not everyone

[16] McGonigal, Jane. *Reality is Broken*. "Introduction." eBook version. Penguin Press. 2011.

responds well to. I make certain types of mistakes over and over. Certain muscles I have are weak, and for others they are strong. That's what being an individual is all about. So how am I going to get World Game going if not everyone likes my ideas about how to do things and I can't do it all alone? I think the lesson to be learned is I don't have to single-handedly save the world through designing World Game. I just have to be willing to spontaneously cooperate with others—probably a lot of others—who are more skilled in the areas where I am inadequate to the task. My imperfections as a designer invites others to step in. And I think that's great. The very things I've identified need improving in the game—that it has a limited perspective and needs more diversity—are best fixed by a diverse group of people aiming for an unlimited perspective.

When textbooks are written, often they are sent all across the world to professors at various universities. Having others help me in crafting the documents in a like manner would be effective—I would want Prototype 2 to be a collaborative work as opposed to "bearing the cross" alone. In the end, I would never want to force people to beta test my game (as was arguably the case in question)—let them ask, "Can I play World Game too?"

Appendix III: World Game Prototype

UNIVERSITY OF CALIFORNIA SANTA CRUZ

WORLD GAME©

A game submitted in partial satisfaction
of the requirements for the class of:

Playable Media, Spring 2016

COMPUTATIONAL MEDIA
with an emphasis in PLAY AND FICTION

by

Josh Pang

June 2016

Noah Wardrip-Fruin,
Instructor.

Contents

Abstract

World Game by Josh Pang

The words “World Game” provide a powerful context. Does that mean the world is a game? Or is the world not a game, but can be played like it is one? Or can we use games to do something about the world? For the purposes of the document before you, World Game is a context that is changing, and any of the above can be thought of as accurate for now. Maybe in a way they are all true at different levels.

This is a simple game. In the style of Tabletop RPGs, the main actions are a creation of a second self — an avatar — and the successful completion of a campaign — a writing exercise. All of which is meant to be in service of “making the world work for 100% of humanity in the shortest possible time without ecological offense or the disadvantage of anyone.”

To R. Buckminster Fuller,

who taught me there is joy in total reality.

Acknowledgements

I would like to thank the Estate of R. Buckminster Fuller for allowing me to explore this concept freely, and with their blessing. I love working here.

I would also like to thank the entirety of Playable Media 2016 for insightful comments and corrections on game drafts for the respective meetings. We've come a long way.

Chapter 1

Introduction

It is a thrilling time to be alive. While on the one hand we have really terrible news regarding Climate Change and the portfolio of other very real and very dangerous eschaton scenarios, on the other hand we also have really incredible technologies and renaissances of humanities arts and freedoms. It is no less true for being cliché:

> *It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season of Light, it was the season of Darkness, it was the spring of hope, it was the winter of despair, we had everything before us, we had nothing before us, we were all going direct to Heaven, we were all going direct the other way – in short, the period was so far like the present period, that some of its noisiest authorities insisted on its being received, for good or for evil, in the superlative degree of comparison only.*
> *- Charles Dickens, A Tales of Two Cities*

R. Buckminster Fuller, the man who invented this game, seemed to be a fan of tautologies. One of his definitions of Universe is, “all of humanity's consciously communicated experience to self or others.” How can that be? Well, beyond several layers of meaning that reality *is* our communication, anything anyone can *say* regarding the definition is included in the definition, hence the definition cannot be undone.

World Game is a similar tautology. The game — a context for viewing the world; a Tabletop RPG; a futuristic MMO in the works; a series of seminars starting in 1969 — is all of these things and more, and can only be won when the world works for everyone. Time for the seventh-inning stretch!

The version you are reading is primarily in the form of a Tabletop RPG. What that means is you don’t need anything to play this game other than the official documents (these are they), and a tool to write with. This is by no means an accident, as the lightweight

nature of the game box allows us to cast a broad net (we're hoping to get all humanity to play with us).

At the moment, the most popular version of the game is distributed in this sense: Normally a Tabletop RPG is played with a Game Facilitator who does the task of acting *on behalf* of the fantasy world. In our case, the world we are role playing in is the actual world, and while we may have presidents who purport to act on behalf of the world, delicacy is necessary if presumption is to be avoided.

The most popular version of the game is to merely follow the instructions, carrying out your World Game moves, and you can email me your result,

Josh Pang

Game Facilitator At Large

jpang4@ucsc.edu

You may also reach me at my office (831) 459-6301.

Eventually, communications volume may become too high for me to handle alone, at which point, in mutual interdependent arising, software is to be built in MMO form, and others can be trained to facilitate games themselves, they are welcome to do so. Contact me to receive a license to facilitate an official game. At the moment, the game is completely free start to finish.

We are aiming for brevity, so we leave the Introduction on a final note:

Chapter 2

Player's Guide

The purpose of this aspect of the game is to explore the self in relation to the world. During comprehensive playtesting, the player's guide can be extremely useful in preventing *ego-tripping*. The philosophy of Game Facilitator At Large is that every person is whole unto themselves. Mysterious, really. Perhaps one day science can bring precision to the question of "Who am I?" Until then, there's this unique individual we all are separately. There are also several layers to the self, especially with our world system's use of governments and the internet. Can the real you change? Is what your file says the real you? Is it as accurate as possible? Shall we change the file? Shall we ignore the file but change ourselves by word of mouth? Why does the self matter in relation to World Game?

World Game will be won collectively, as initiated by an individual team of one or more. This is simply how a society of minds works. It would seem many of the problems we actively maintain — we feed certain problems in our lives and globally — are due to the malfunctions of the ego. Maybe a collective ego in the form of national pride. Or simply an individual, charismatic or no. Being able to see yourself objectively, to be happy with that reflection, that second self, and to be happy to share this with others invites cooperation because of transparency. Maybe the world system seems to dislike aspects of who you are. Maybe that's a start for your playing World Game — changing the world.

Moreover, if an ego is actively malfunctioning, others may be able to gently heal the situation with the help of this tool, your Avatar you yourself make. And if everything is ship shape, an Avatar allows oneself to stand back and ask questions, "Hmm, what would [your name] do in this situation?" Eventually, with some

technological sugar, we might be able to have an AI actually perform actions in a hyper-time vacuum, and report back indeed “this is how you would probably feel if you decided to have vanilla instead of chocolate because I am a very close approximation of you and I tried both simultaneously as two separate instances in a controlled experiment and you preferred vanilla.”

In many ways, the ego is entirely a fiction. Certainly there are reputable schools of thought which purport just that. And yet, it is a persistent fiction. Therefore, if the ego is going to be our lifelong friend, let’s really role play who we are. Describe the role you are playing. There is a public record of the role you are playing. That’s your script. If you need to change your script, that’s okay too. Certainly the public and private record are best reconciled. Now may be a good time to do this, as being together personally can facilitate helping others, and the world. This is the oxygen-mask principle.

At the same time, this is a game, playable by anyone, and we encourage feeling unencumbered by expressing the role with a sense of joy. That joyful feeling may have synergetic effects!

The following documentation is a template.
It was designed as a graduate class 1 week game.
This provides the DNA for any game purporting to be World Game.
When you receive a license to host World Game, please discuss any general changes during our negotiation. We also request a final copy for our own records and to study for future games. All is subject to negotiation.
We are aiming for “good clean fun” aesthetically.
See Chapter 4 Implementation for further information.
If you have a signed agreement from Josh, and you decide to make any changes, that’s perfectly fine for an instance, or a campaign. If you’d like to go public with your changes, please discuss this with us beforehand. Otherwise, while we hand crafted

this in a precise manner, you have *carte blanche* to do as you wish (even not play the game *mes amies!*).

CMPM 290J **World Game Player's Handbook** **Spring 2016**

https://drive.google.com/folderview?id=0B0-XD1zvUBHZTXV5aEN4NlgycVU&usp=sharing

- **Game:** R. Buckminster Fuller's World Game
- **Time and Place**: Friday 5.6.16 – Friday 5.13.16, Santa Cruz, California.
- **Game Facilitator:** Joshua H. Pang; office: Cruzio Z; phone: (831) 459-6301, email: jpang4@ucsc.edu; web: https://www.soe.ucsc.edu/people/yashasvi
- **Office Hours:** Monday – Friday 10:00a.m-6:00p.m., Cruzio Z.
- **Game Manual:**

  Required *None*.

  Recommended *Superbetter* by Jane McGonigal, Penguin Press.

  Recommended *Reality is Broken* by Jane McGonigal, Penguin Books.

  Recommended *Critical Path* by Buckminster Fuller.
- **Overview and Goals:** The World Game plays a fundamental role in the lifetime's compendium of material put forth by R. Buckminster Fuller including a world democracy by electronic referendum [*remote-control voting*], cosmic accounting [*kilowatt-hour time-energy world accounting system*], theory of humanity's existence [*local-information harvesters, local-problem solvers in support of the Universe*], aims of education [*automatic learning through documentaries*], inventive engineering [*4D, Dymaxion, Geodesic, and other artifacts*], and world resources inventory [*human trends and needs*]. Familiarity with these concepts is helpful. The main goal of the game is: *to make the world work for 100% of humanity in the*

shortest possible time without ecological offense or the disadvantage of anyone. The game will be played from a strict-reality perspective with particular emphasis on designing solutions for problems arising in the world and experimenting with their implementation in our day to day lives.

- **Campaign:** The following is a tentative list of instructions.

  Personal Avatar: Objectively identify your actual subjective occasion given the logic currently in place on Earth such as your legal name, legal career title, age, current location, any time commitments set to a calendar, status of health, any programs you are subject to or are currently facilitating, access to tools, etc. What needs to be done, that isn't being done, that would benefit humanity, that am I in a unique position to do to help the world? Use your imagination.

Make an Inventory of Necessary Needs & Resources:

Assess the 'energy costs' of actions your personal avatar will make as you simulate your strategy. The distribution of objective resources is fundamental in the world. Take stock of your strategy's use of resources: such as gravity, love, winds, waves, oxygen, sunlight, water, food, clothing, shelter, vision, initiative, friendliness, industrial chemistries: e.g. *helium*, scientific chemistries: e.g. *moon rocks*. What's my optionally investible time? What are the tools I have available to me? Is there a problem I see for me to address?

Strategy: Limitations of our current World Game scenario demand that we explore strategies that describe and arrive at a conception of a set of actions that could

improve the conditions of our world. Iterate a report with tools we have at hand. Using search engines, Wikipedia, and other reliable information sources, we will look to simply start at step one with self-education, then sharing together our separate findings. What is your solution strategy? What are the needs I am in a unique position to tackle? How do I formulate a solution to a problem I want to address? What can I imagine? What would success look like? What's your conception for moving us forward toward the end goal in your campaign which ends Friday? Write as little or as much as you like; play *Minecraft* with your words.

Evaluation: Performance will be evaluated on the basis of your brief written report, and participation. In the future, the game will be evaluated in an extremely rigorous and formal fashion using computer tools.

Completing the Campaign: The normal winning condition is our total access to all the data available on Earth showing a ship-shape system and care for all on board. Given we neither have the metrics in place to measure such a thing, one immediate challenge is to get such computer databases in order to be freely human-readable, like a pilot's dashboard. Furthermore, we must consider AI assistants in our day and age. This week, I will act in place of the computer and decide on the success of your project on making the world work and who progresses to the next round.

Additional Information and Logistics

A. Important Dates:

- The handouts I have prepared for this class will be distributed on Friday May 6, 2016.

- The problem project solution is due on **Thursday May 12, 2016**.
- The problem presentation which will take all of two minutes will take place from 9:00a.m. to 11:45a.m. on **Friday May 13, 2016** (this is the designated time for the in-class campus session). In other words, read your report, then critique the game which was your call to action. What did and did not work from your vantage point?

B. Work Assignments:

- I encourage you to engage with the work of playing World Game in the spirit of good clean fun. See my examples to get a sense of a potential mood.
- We will use GoogleDrive http://www.drive.google.com/ as a tool for submitting all work assignments; for each assignment, there will be explicit instructions concerning what file or files to upload to GoogleDrive.
- Each work assignment will be received by peers in the form of your final World Game presentation. After the deadline for submitting each assignment, you can relax because this is pretty much a game about playing the armchair president of the world as a means for me to iterate on better game mechanics for the futuristic tabletop RPG and MMO.

C. Integrity:

Most forms of playful participation will be tolerated. *An incident of violently inappropriate behavior may result into the involvement of the powers that be or into an automatic no fun for anyone in the game*. Incidents of violently inappropriate behavior will also be unlikely here in our UCSC graduate setting, the full details of which can be found at https://cmpm290j-spring16-01.courses.soe.ucsc.edu/

D. Accommodations:

If you qualify for special accommodations because of a personal need, please get an Accommodation Authorization from your World Game facilitator in person outside of class (e.g. call me) within the first couple of days of the game. Contact Mr. Pang at (831) 459-6301, or http://joshpang.com for more information on the process. Feel free to stop by during Office Hours, do check in ahead of time.

CMPM 290J **World Game** **Spring 2016**

Personal Avatar 1

-- Due before you submit a Problem Guide solution

-- You do not have to submit your character sheet to me, though I would welcome it

- Consider skimming Sections 1, 2, 3, and 4 of *Superbetter* book.
- Visit the website with Story of Change maintained by Annie Leonard

  http://storyofstuff.org/movies/story-of-change/

  and experiment with the Changemaker Quiz program (you do not have to incorporate any work you do on this website; this is just for enhancing your understanding of the material).
- Consider reading/doing quests from *Superbetter* book.

Name. Please include the full legal name printed on your birth certificate, or if it has been legally changed put that. If you have strong personal preferences to be called by a separate name, include it here.

Age. If you have the exact date, time, and location of your birth, include this. Age is an important metric in life and needs to be considered.

Career. Consider what you would file on your taxes as your official career title, and use this. If you are a graduate student, use all significant classifiers, such as degree program, department, advisor, etc.

Optionally Investible Time. Budgeting time is essential to our world. Maintaining an accurate calendar and being able to share this with team mates is necessary in order to play at any level.

Note: There are several different ways to keep a calendar. By paper, Google Calendar, iCal, etc. For World Game, we ask that you use the standard Gregorian Calendar. For more calendars of this type, read - https://en.wikipedia.org/wiki/Calendar#Formats

Health. Health is married to energy, including the energy to think. It is a stat that must be embraced.

Note: You may wish to keep a separate character sheet which has more personal information than you would like to share. In the future, I would hope we can all become disembarrassed about our personal stat maintenance.

Note 1: Please typeset your homework using word processing and upload a PDF to GoogleDrive before the deadline.

Note 2: The purpose of the character sheet is to help you develop a better understanding of who you are in reference to the world as your environment and also to expose your teammates to material that lack of time prevents us from covering in game. Please do not share anything with me that you are uncomfortable sharing. If you send me your character sheet, feel free to include other stats you think of that are wed to reality. See my example. Of course, I am acutely aware that social media profiles are a bit like character sheets in the world as a game. Integrating these already in place services with World Game is top of mind, and your suggestions will be taken into consideration.

Finally, please be generous with your use of words at this stage of the game. And, feel

completely free, I am providing a set of rules and templates, and I hope someone makes a breakthrough I have not predicted.

Your Evaluation via GoogleDrive

Your character sheet will be posted for the entire class to see. You are encouraged to look at the avatars in your community. If you are working with a partner, you must share you character sheet with your partner.

If you complete any *Superbetter* exercises you may turn them in as well. The more robust your profile, the more your role in the team will organically manifest.

***Superbetter* Secret Identity:** If you produce a secret identity, consider us your allies and share with the class in the manner Dr. McGonigal recommends.

***Superbetter* Quests:** If you complete any quests, please mention which ones; using the app and taking a screenshot is an easy option.

Age: If you are not honest about your age, it will be incredibly difficult to maintain the integrity of our game.

Optionally investible time. Time is very fluid, and budgeting is often flexibly buffered. Only egregious examples of poorly managed time will be made a point of order.

Health. Health is a science unto itself. The example the military sets in routing personnel based on medical exams is cogent. While it is not *bad* if you are colorblind, you may be prohibited from piloting an aircraft. A desk job may be necessary versus a job of being with the public body.

CMPM 290J **World Game** **Spring 2016**

Pang Personal Avatar

- **Name.**

  Joshua Hanners Pang

- **Age.**

  27. Born March 9, 1989 at 10:54 PM in Memphis, TN at the now defunct St. Francis Hospital.

- **Location.**

  Santa Cruz, California, 95061

- **Career.**

  Part (a): I am a computer science masters student studying at the University of Santa Cruz, California under the advice of Dr. Arnav Jhala.

  Part (b): I am concurrently an intern for the Estate of Buckminster Fuller.

  Part (c): In my career path, in conjunction with my advisor, I am planning on applying to the Computational Media PhD program

- **Optionally Investible Time.**

  My calendar is maintained online at this location:

  http://joshpang.com/index.php?p=calendar

  While any event is a commitment, I make efforts to be flexible except when attending a University class. Emergencies and crises take precedence as they arise.

- **Health.** I have no major medical diagnoses preventing my participation in World Game. I do, however, am currently patterned to be unreachable for serious work from

6:00pm-10:00am weekdays, and unreachable on weekends generally. This is often impinged upon by my own mismanagement of my time and energy, creating negative feedback cascades. This is self-corrected by hook or by crook.

- **World Game Points**. I think it would be cool to consider how to map objective feedback from culture — is it bank account stats, or twitter follower stats, or academic citations, or a combination? I eagerly pursue the day when our stats maintenance is effortless and transparent, like in MMO or Fantasy Tabletop RPG.

***Superbetter* Secret Identity:** I do have a secret identity. As is traditional, my Sanskrit guru, Dr. Ram Karan Sharma, has, as my parents before me, named me यशस्वी transliterated as Yashasvi. While there is no major Television Show for me to include as she recommends, nor is there a major Sanskrit literary figure with which to work, I get a similar thrill of joy from Steven Skiena's *Who's Bigger?* Given the translation of my secret identity is rooted in the science of reputation.

***Superbetter* Quests:** While I have used the app, and read through the quests, the most significant *Superbetter* quest I am on is through a separate publication, *Spark Joy* by Marie Kondo. I'm really into it.

Chapter 3

Problem-solving Guide

The purpose of World Game is to make the world work.

Question: What is preventing the world from working?

Answer: There is a class of problems that are central to the health of the planet and the health of our human civilization. The marriage, I'll say unhappy marriage, between humanity and Earth is one definition of the world. Problems occurring light years away which are irrelevant to our immediate dangers of global security are to be considered by and large *after* World Game is won.

At this point in World Game, we will have sorted the personal equation via the Avatar. The next step is to use the Avatar to affect change in the world. Change is formalized through the written word. Therefore, the main game loop is to craft in writing solutions

to be implemented. In some sense, this is your State of the Union, as is a U.S. Presidential tradition. “Here are the problems, here are my solutions. All let’s left is to implement what’s written.”

World Game is not so much serious as sincere, using the distinctions Alan Watts was known to make. The micro-problems in the Avatar are quite real and must be dealt with. The macro-problems are as well. Problems do not mix well with comedy, or lighter than air fiction. However, fiction is integral to our lives, sort of ‘metaphors we live by’ to nod at Lakhoff.

Because our world is so vast, we do not have consensus on much of what is fictional versus what is nonfictional in the world. Perhaps all great religions are considered nonfiction by some, and fiction by others. Often what we thought was nonfiction is later revised. That seems to imply a spectrum of fiction, with accuracy to reality aligned with nonfiction, and inaccuracy to reality aligned with fiction. And yet, is that entirely true?

World Game works when played with *authenticity*.

Do you pray for world peace?

Certainly Pope Francis' work is very much aligned with World Game.

What about indigenous shamanism?

As modern science continually uncovers, there is often deep truth paid in blood and sweat at human expense in any subsisting culture.

What about magic?

The design philosophy in our contemporary moment is to give claims the benefit of the doubt. A solution works until proven guilty. Part of the mechanics of World Game is the world will progressively give feedback to our solutions as they evolve. Indeed, though Sri Aurobindo may claim to have helped defeat Hitler in World War II through his psychic-telepathic powers, the World remembers Churchill. Perhaps this will be revised, perhaps it won't. Until we are sure, Sri Aurobindo deserves a footnote in history to say the least.

If the solution presented is “my good karma in tending the zen garden is fractally affecting all the universe toward a more positive vibration and this is the bandwidth I have to contribute to the world no more no less “ — that’s certainly a welcome solution. Maybe other Zen folks will pick up on this. All of this is relevant to World Game. Are these fiction? Is a Zen garden going to help stop Climate Change? Or is it *exclusively* renewable energy? This is up to the individual, and also the world’s going along with it or not. Game on.

The following documentation continues with what has been said previously.

CMPM 290J **World Game** **Spring 2016**

Problem Guide

As an entrance for this class in World Game, you may choose a global problem or a comprehensive set of global problems. You may work alone or choose to partner with another student in the class.

Timetable The timetable for the problem guide is as follows.

- Find a team (if you decide to form a team), select a tentative problem or set of problems, and notify me via email no later than Tuesday May 10, 2016.
- Discuss with me your proposal after class in person or during my office hours by phone (M-F 10-6), finalize the selection of the topic, and agree on the material that you will constitute your World Game move by Wednesday May 11, 2016.
- Submit your report (a paragraph to a page) via GoogleDrive by the last day of the critique period, which is Thursday May 12, 2016. Your report should be separate from your emailed critique.
- Your chances of success will be increased if you read your report aloud to the class on the day of the critique of World Game on Friday May 13th, 2016
- You are invited to consider submitting your report, or an expanded version of your report, to the Buckminster Fuller Challenge: https://bfi.org/challenge/about/criteria

Appendix of Possible Topics

We suggest *against* the use of cards to organize the topics.

These are *serious* problems, and arbitrarily shuffling them is disrespectful to the people who shoulder whatever the issue is.

- As mentioned in class, in his 1981 *Critical Path* and in a subsequent 1992 *COSMOGRAPHY: A POSTHUMOUS SCENARIO FOR THE FUTURE OF HUMANITY*, R. Buckminster Fuller presented his World Game invented by him in the 1960s (as an alternative to a war game), that is to say, he gave a complete characterization of the collections of world problems and solutions that could be simulated with energy-cost accounting by an arbitrary set of teams in a round-robin game.

  The goal of this project would be to study and understand Fuller's classification, which is known as World Game. As a byproduct, you will also learn about Fuller's characterization of an adequate set of global problems and solutions (that is, necessary and sufficient conditions for a given high standard of living to be realized). What impact will it have toward the 100% goal?

  As part of the same problem you will have to design a metric for telling whether a given set of problems and solutions form an adequate set of a winning condition (referencing the 100% of humanity from Fuller's characterization). You will also have to analyze the logistical complexity of this problem as best as you can.

  Sources: Tracing the literature in this area is part of the project (wikipedia is fine). A starting point is Fuller's World Game Chapter from *Critical Path*. A more recent and more gentle introduction to this topic is the paper found here: "Introduction to the

New Edition of Operating Manual for Spaceship Earth" by Jaime Snyder, Co-Executor of the Estate of R. Buckminster Fuller, 2008.

- A topic related to the previous project is the study of *the sustainability of your individual life* concerning the complexity of problems arising in playing the World Game. The prototypical *sustainable life* thinkpiece is Snyder's *trimtabbing* theorem in his paper "Introduction to Ideas and Integrities: A Spontaneous Autobiographical Disclosure", California, September 2009. This result provided a complete classification of the complexity of the sustainability problem arising from a finite set of individual moves by determining, for each set of individual moves, whether the sustainability problem is being addressed just-too-late or just-in-time before World Game is officially won or lost. Several different *sustainability theorems* have been established since Fuller's time. Sustainability theorems regarding our daily lives tend to be rare and worth studying.
- Learn about Earth Policy (from the Earth Policy Institute); read the brief descriptions on *Plan B 4.0*, *World on the Edge,* and *Full Planet, Empty Plates* and show they are World Game problems; write a brief paragraph on each book containing the definitions and any connections regarding the World Game and *Plan B 4.0*, *World on the Edge,* and *Full Planet, Empty Plates*.

  General Source: http://www.earth-policy.org/, Rutgers University
- Study some of the data that establish that U.N. resolutions and the World Bank procedures have overly-slow behavior in the worst case. In particular, study the ONE campaign on U.N. resolutions and the sustainability principle. Early basic references include:

1. https://www.one.org/us/issues/ — fight to end extreme poverty.
2. http://www.unmillenniumproject.org/goals/ — the official global organization.
3. http://www.worldbank.org/en/projects-operations/country-strategies — world bank.

- Study some of the data that investigates hard specific instances of sustainability. This is an area with an interesting mix of experiment and analytical results. A starting point would be to read some of the early and highly influential papers, which include:
    1. https://en.wikipedia.org/wiki/Sustainability — choose a topic.
    2. http://www.rmi.org/ — the sustainability of energy.
    3. http://bfi.org/challenge/winners — the sustainability of various topics.
- Implement a variant of the World Bank procedure and run thought experiments on hard specific instances of sustainability problems to validate or invalidate the experimental results of the ONE campaign. Could unconditional guaranteed income work? An implementation of the procedure leaves room for using a variety of additional mechanics in choosing the "next" failing state to support and for implementing the "debt jubilee rule".

  The goal will be to solve sustainability problems in the critical region with a good number of failing states (at least 5 to 10 failing states).
- On the general topic of sustainability in personal lives, there is a comprehensive recent "Handbook of Sustainability", edited by Annie Leonard in 2007. It contains 13 videos, each of which addresses a different aspect of sustainability. Several different

projects could be based on some of the chapters of this handbook — http://storyofstuff.org/

- Study some of the connections between World Game and banking systems. A relatively recent topic that has received considerable attention is the study of repairs of inconsistent banking such as the movie *The Big Short*. There are connections with banking constraints, computational finance, and disjunctive World Game strategies. An overview of this area can be found in the monograph by R. Buckminster Fuller *Grunch of Giants: Gross Universe Cash Heist*, St. Martin's Press, 1984.
- Study the basics of war games, which is a formalism for specifying statements involving military strategy. Typical topics include: reasons for running war games; connections between war games and the World Game; applications of war game reasoning about distributing resources and to computer-aided distribution of resources.

  A more ambitious project along these lines would also include a study of the basics temporal sequencing logistics and its relevance to computer-aided distribution of resources.
- Study the connections between cultures and the World Game, and how computers might reduce this complexity. A main reference in this area is Brian Fagan's *Clash of Cultures*, which asserts that a property of cultures is their mutual exclusion of other cultures if and only if it is definable by a *dehumanizing* and an *alienating* of the other culture in contact. Note that these is a technology-independent and resource-independent characterization of conflict (i.e. there is no mention of modern computational, social simulations, etc.). See the monographs:

1. B. Fagan, “Clash of Cultures”, AltaMira Press, 1997.
2. C. Hedges, “War Is A Force That Gives Us Meaning,” Anchor, 2003.

- Globalization is a broad paradigm of anthropological problems that includes, as special cases, sustainability and cultural problems. There are tight connections between globalization, development, and culture that have yielded a deeper understanding of the anthropological aspects of global sustainability. The goal of this project would be to understand some of these connections and their applications to the discovery of just-in-time solvable cases of World Game. A project on this topic could be based on one or more studies of David Graeber’s compendium of work.
- Choose a topic that matches your own interest (e.g. World Game and mechanics of making it fun, World Game and democratic participation, World Game for security and authentication, AI research assistants in World Game, such as IBM Watson of Jeopardy! or Alphabet’s/Google’s AlphaGo being used for assisting global decision making - the list is endless).

  To appreciate the breadth of the topic of World Game in Playable Media and entertain additional choices, you may want to take a look at the proceedings of the World Design Science Decade https://bfi.org/design-science/primer/world-design-science-decade or in the proceedings of Jane McGonigal’s work https://janemcgonigal.com/.

CMPM 290J **World Game** **Spring 2016**

Your Problem Solution

-- Due after you create a Personal Avatar

-- You do have to submit your Problem Solution to me if you want to play.

- Consider skimming Sections 1, 2, 3, and 4 of *Reality is Broken* book.
- Do any exercises from *Reality is Broken* book if you wish.

Step 1. Show that you are in a unique position to carry out, produce, or otherwise initiate the solution.

Given this is a graduate class, you may wish to leverage your thesis work as your solution.

Step 2. Describe your solution.

1. Indicate the energy necessary to fully realize your idea.
2. Indicate a timeline in which your idea will come to fruition, and any deadlines.

Step 3. Position your solution in reference to other world problems.

1. Describe how the solution, communicated in Step 2, related to improving the conditions of our world.
2. If possible, any quantifiable reference points would be useful.

Step 4. Honestly assess the challenges that might beset your implementation. Provide a possible "try catch" for any challenge.

Note 1: Please typeset your homework using word processing and upload a PDF to GoogleDrive before the deadline.

Note 2: The purpose of the Problem Solution is the thrust of your move in World Game. Any careful read of Fuller's original vision of the game posits a simulation which would be translated to the real world in the event of a winning team. For us, the simulation must take the shape of a written document without the necessary computer tools supporting richer simulations. My personal read of *Critical Path* lends the book itself as a type of entry into World Game, especially his Critical Path chapters and plan for Brazil. However, I have a tendency to think recursively, so I need to confirm my reading with other scholars.

Evaluation via GoogleDrive

I have designed my example submission to display my actual expectation of the amount of work to be done. We are all busy people, and yet we all want to make a difference. So, I expect others like myself to leverage their preexisting work into a new and conscious focus for making the world work. Moreover, balancing the fun and joy of the game, the flow, is something I am tinkering with as a designer and a player.

You will be evaluated based on both the letter and the spirit of your entry. There is no failing grade or punishments for being silly. The winning solution will "pay" for the others by its ultimate saving of time.

Pang Problem Solution

My entry in World Game tabletop RPG seminar taking place Friday 5.6.16 – Friday 5.13.16, Santa Cruz, California is entitled *Golang - Planetary Programming Language*. The artifact of my entry can be found here:

https://drive.google.com/open?id=0B0-XD1zvUBHZZlRrdWt5MC1MV00

Step 1. Given best use of time for all, I will present the abstract of my publication for Step 1.

> Computers are the future. Our path as a species is unclear — will it be leisurely walk or a series of disruptive changes? One thing is for sure, given the scale of seven billion separate people, making computers simple and friendly will be tantamount toward peace on Earth.
>
> The plethora of programming languages is a blessing to the curious mind, but a curse to the average joe. As we collectively embrace computer science literacy, the need for a standardized curriculum will increase in urgency until we are in a daily-affairs technological emergency. Better to be anticipatory and nip this one in the bud — like now.

1. The necessary energy needed to implement my idea is tremendous. It would require the cooperation of a worldwide education system which does not

exist. Nor is there in existence a planetary body with which to create such an education system. Therefore, as is the thrust of my entry, I plan to leverage Alphabet, Inc. itself as the wave I will surf to implement the idea. My hope is through the academic system, it would reach their offices and they would reach out to me.

2. I expect within the next decade to know whether or not this is a feasible strategy. I see no foreseeable deadlines in reference to when the concept of a planetary programming language would become obsolete.

Step 2. Assuming you've looked into my character profile, I am in a unique position to carry out this because I am at an age and career path to undertake such a large responsibility, and due to my computer science studies and so forth and so on. I did, in fact, receive a passing grade from a graduate programming languages course in large part from the strength of this idea.

Step 3. As I say in the abstract, computers are the future. The constant forward motion computers have provided has been overwhelming net positive thus far in the sense of *livingry* as opposed to *killingry*. I suggest an abundance of our problems, such as the distribution of resources and overpopulation, can be "towed" by the bigger ship of technology, literally in this case Alphabet Inc.

1. I am displeased that I am relying on supranational corporations and obscenely wealthy individuals in order to realize my plan. However, I make the case in the details of my entry that eventually computer algorithms will redistribute wealth and power, and that our current situation will look in hindsight as doing the right things for the wrong reasons where computers

are concerned. Watson learning Jeopardy! instead of global problem solving is a case in point.

2. Alphabet's strength in the world is my main quantifiable reference point. You can see numbers here: https://abc.xyz/investor/news/earnings/2016/Q1_alphabet_earnings/. Furthermore, the speed of change is another quantifiable reference. See comment:

   "*Between the dawn of humanity and 2003, roughly five exabytes of information was created. An exabyte is roughly a million gigabytes. We generate that amount in every two days now. So you understand why it's so painful to get up in the morning? Its because in one day – at that rate – we have calculated, generated half of the entire human consumption of information that occurred in the entire history.*"

   -Eric Schmidt, Executive Chairman of Alphabet, Inc.

Step 4. First and foremost is the lack of unity toward either choosing or implementing a singular language. I've tried to address this at large in the essay, but it surely is the stuff of trouble. As far as a try catch scenario, I'd try the "wait and see" protocol if I catch a lack of unity problem. Frankly, my submission is incumbent on a lot of moving parts and good luck.

Chapter 4

Implementation

Obviously when hosting World Game, the dates from my examples will need to be changed. If the group is singularly focused on immersing themselves in the game, a week is perfectly adequate, and a nice timeframe given the week's place in our work world. As an architecture, these handouts work well. We do not suggest wanton changes. However, like in many *Dungeons and Dragons* games, one group differs from another, and these diversities can make a big difference in a higher order of quality. In any event, the documents are designed to be ready to go right out of the box.

Fuller proposed World Game replace the entire university system. What did he mean by this? The short version is that the university system could be leveraged like our global college sports competitions to create a sport out of solving the world's problems.

Brazilian universities may become well known for producing solutions which produce compliance and win votes easily. Universities in Silicon Valley may become well known for producing technological solutions. People wishing to join these teams will take great care to apply themselves based on all the information available.

The proto-typical game shipped in the box was played in a graduate class at UC, Santa Cruz; a graduate class is an intended audience. Every single student had a different reaction to the game, and this rainbow richness acted as a strong soil for a garden of ideas to grow; beautiful fruits bloomed from this garden. Many people felt very strongly about the whole thing. A lot of really good feedback was given. We're talking about something we've all wanted for a very long time, and which almost everyone has thought about and done something about for many generations.

I think it is a sign, a good omen, that World Game is being played

in this day and age, 2016. This may be the pre-cognition, the foreshadowing, of attaining lasting success for 100% of humanity. At the close of World Game is a new phase for our species. After World Game comes Galaxy Game? Where do we concern ourselves with problems lightyears away? We'll have to work on the name when we get there.

For the moment, the source code is open source in the sense that anyone may read the World Game internal documents. There's no dirt under the rug here. However, managing the intellectual property rights is something we take seriously at this juncture in time. It's simply too easy to break the integrity of the architecture, and we are working on creating "Construction Sets" and other modding avenues. Certainly this concern with IP will continue for some time, and likely into any software phases. When we arrive in a society where everyone is perfectly educated and enlightened and competent, we may not need locks on our doors anymore. Until then, they serve a purpose of preventing accidental

destruction. The fence surrounding the garden protects the flowers from an errant soccer ball!

All this in mind, to implement World Game, contact jpang4@ucsc in order to receive access to the editable Google Drive versus static PDFs. This is a very thin veil of firewall, but it will do for now. Having to increase our level of infrastructural security will be a sign of success.

Once contacted, Mr. Pang will work with you to ensure your World Game session goes well. He is available for *pro bono* and professional consulting on these and other matters. All of this is in direct and conscious support of making our world work ASAP.

In bocca al lupo!

Chapter 5

Discussion

The truth in the opening lines of Mr. Dicken's *A Tale of Two Cities* seems to have intensified over time. Certainly since 1859 when the volume was published all people would prefer it was simply the best of times, and not the worst of times. While indeed, as your eyes read the refracting light from these pages processing the words in the language parts of your brain, there are truly inhuman tragedies occurring just out of your earshot. Presumably, if they were in earshot, you would be addressing them instead of reading this. World Game was originally conceived of as an anti-War Game. Another way of thinking about World Game is World Game is won when war is obsolete. Not just macro "Stars and Stripes" wars. Little micro-wars as well. Zero-sum is simply not the answer more or less ever.

While it is not fair to ask players to address themselves, “all their soul, all their heart, and all their mind” to addressing global well being — in fact, such a thing might be detrimental to health due to overwhelming stress — still, an ever refining appreciation of the *now moment* and what juxtapositions are at play to produce this *now moment* make for meta-cognitive decision making impossible without proper perspective. The sky isn’t falling, yet things are out of control. We need to move from planetary tourists to planetary stewards, as Spaceship Earth spirals obliviously.

Finally, it seems like enjoying World Game really makes for better solutions. We might well be on our way to the first happy revolution.

Bon Voyage!

References and

Further Reading

[1] Fuller, R. 2015. *Critical Path.*

Santa Cruz: The Estate of R. Buckminster Fuller.

https://itunes.apple.com/us/book/critical-path/id1040335889?mt=13

[2] Fuller, R. 2015. *Operating Manual for Spaceship Earth*.

Santa Cruz: The Estate of R. Buckminster Fuller.

https://itunes.apple.com/us/book/operating-manual-for-spaceship/id1005931733?mt=11

[3] McGonigal, Jane. 2015. *SuperBetter: A Revolutionary Approach to Getting Stronger, Happier, Braver, and More Resilient*. Penguin Press,

[4] McGonigal, Jane. 2011. R*eality is Broken: Why Games Make Us Better and How They Can Change the World*. The Penguin Group.

Bibliography

Alban, Sarah. “Independent Report Highlights Esri as Leader in Global GIS Market.” ESRI. 2015. http://www.esri.com/esri-news/releases/15-1qtr/independent-report-highlights-esri-as-leader-in-global-gis-market

Alexander, Caroline. *The Endurance: Shackleton's Legendary Antarctic Expedition*. Knopf Doubleday. 1998.

Apte, Vaman Shivaram. *The Practical Sanskrit-English Dictionary*. Prasad Prakshan. 1959. http://dsalsrv02.uchicago.edu/cgi-bin/philologic/getobject.pl?c.0:1:4947.apte

Barron James. “Its Stars Eclipsed, Hayden Is Cleared for Demolition.” New York *Times*. 1995. http://www.nytimes.com/1995/11/22/nyregion/its-stars-eclipsed-hayden-is-cleared-for-demolition.html

Ben-Eli, Michael. “Michaelbio_about.mp4” Sustainability Labs. 2017. http://www.sustainabilitylabs.org/michael/home/

Bogost, Ian. *Persuasive Games* (p. 3). MIT Press. 2010.

Brin, Sergey and Larry Page. “Our story.” Google. 1998. https://www.google.com/intl/en/about/our-story/

Brin, Sergey and Lawrence Page. “The Anatomy of a Large-Scale Hypertextual Web Search Engine.” Seventh International World-Wide Web Conference. 1998. http://infolab.stanford.edu/pub/papers/google.pdf

Bump, Philip. “How Silicon Valley Saved Obamacare, and Obama, and the Democratic Party.” The Atlantic. 2014. https://www.theatlantic.com/politics/archive/2014/02/how-silicon-valley-saved-obamacare-and-obama-and-democratic-party/358593/

Burnett, Richard. “MONTRÉAL CELEBRATES THE 50TH ANNIVERSARY OF

EXPO 67." Tourisme Montréal. 2017.
https://www.mtl.org/en/experience/50th-anniversary-expo-67

Chial, H. "DNA sequencing technologies key to the Human Genome Project." Nature Education. 2008.
https://www.nature.com/scitable/topicpage/dna-sequencing-technologies-key-to-the-human-828

Churchill, Winston S. 11 November 1947. "Quotes." The International Churchill Society. 2017.
https://www.winstonchurchill.org/resources/quotes/the-worst-form-of-government

Computer History Museum. Mountain View, California. "Apple II." Personal Computers: The Apple II. 2017.
http://www.computerhistory.org/revolution/personal-computers/17/300/1047

Computer History Museum. Mountain View, California. "The first Bombe is completed." Timeline of Computer History. 2017.
http://www.computerhistory.org/timeline/computers/#169ebbe2ad45559efbc6eb357207bb27

Copeland, Jack and Diane Proudfoot. "Alan Turing: Father of the Modern Computer." The Rutherford Journal, Vol. 4. 2012.
http://www.rutherfordjournal.org/article040101.html

Counts, Laura. "The Man Behind Pokémon Go: John Hanke, MBA 96." BerkeleyHaas. 2016.
http://newsroom.haas.berkeley.edu/man-behind-pokemon-go-john-hanke-mba-96/

Cruz-Neira et al. "The CAVE: audio visual experience automatic virtual environment." Communications of the ACM. Vol. 35 No. 6. (p. 64-72). 1992.
http://dl.acm.org/citation.cfm?id=129888.129892

Desoto, K. Andrew. "Under the Hood of Mechanical Turk." Association for Psychological Science. 2016.
http://www.psychologicalscience.org/observer/under-the-hood-of-mechanical-turk#.WS7uPjOZORs

Dougherty, Conor. “Astro Teller, Google’s ‘Captain of Moonshots,’ on Making Profits at Google X.” New York Times. https://bits.blogs.nytimes.com/2015/02/16/googles-captain-of-moonshots-on-making-profits-at-google-x/

Estate of R. Buckminster Fuller. Personal communication to author. 2017. http://www.buckminsterfuller.net/

Fortnow, Lance. “The Status of the P Versus NP Problem.” Communications of the ACM, Vol. 52 No. 9, Pages 78-86. 2009. https://cacm.acm.org/magazines/2009/9/38904-the-status-of-the-p-versus-np-problem/fulltext

Franklin, Stan. Personal communication to author. 2013. http://stanfranklin.com/

Fuller, R. Buckminster. "A Comprehensive Anticipatory Design Science (p. 357)." Journal - Royal Architectural Institute of Canada, Vol. 34. 1957.

Fuller, R. Buckminster. “Basic Biography.” Estate of R. Buckminster Fuller. https://books.google.com/books/about?id=mqLgDQAAQBAJ

Fuller, R. Buckminster. Robert Snyder, editor. *Buckminster Fuller: An Autobiographical Monologue/Scenario* (p. 39). St. Martin’s Press. 1980.

Fuller, R. Buckminster. “BUCKMINSTER FULLER Presentations To Congress THE WORLD GAME” (p. 9). HEARINGS BEFORE THE SUBCOMMITTEE ON INTERGOVERNMENTAL RELATIONS OF THE COMMITTEE ON GOVERNMENT OPERATIONS UNITED STATES SENATE NINETY-FIRST CONGRESS FIRST SESSION on S. Res. 78 TO ESTABLISH A SELECT SENATE COMMITTEE ON TECHNOLOGY AND THE HUMAN ENVIRONMENT. 1969.

Fuller, R. Buckminster. “Cartography.” Patent #US2393676A. U.S. Patent Office. 1936. https://patents.google.com/patent/US2393676A/en?inventor=Fuller+Buckminster&page=1

Fuller, R. Buckminster. *Critical Path* eBook edition. Estate of R. Buckminster Fuller. 2015.

Fuller, R. Buckminster. *Nine Chains to the Moon* (p. 256). Anchor Books 1973, reprint ed. 2000.
Fuller, R. Buckminster. *Operating Manual for Spaceship Earth* eBook edition. Estate of R. Buckminster Fuller. 2015.

Fuller, R. Buckminster. *Synergetics: Explorations in the Geometry of Thinking*. Online Edition. Estate of R. Buckminster Fuller. 2017. http://www.synergetics.info/

Fuller, R. Buckminster. Robert Snyder, film maker. *The World of Buckminster Fuller*. Masters and Masterworks Productions, Inc. 1974.

Fuller, R. Buckminster. *Utopia or Oblivion* eBook edition. Estate of R. Buckminster Fuller. To be published in 2017.

Fuller, R. Buckminster. "World Game Series: Document One." World Resources Inventory, Southern Illinois University. 1971.

Gabel, Medard. "Global Solutions Lab." 2017. http://designsciencelab.com/

Gabel, Medard. *Energy, Earth, and Everyone*. Doubleday, rev. ed. 1980.

Gabel, Medard. *Ho-Ping: Food for Everyone*. Doubleday. 1979.

Gibbs, Samuel. "Google buys UK artificial intelligence startup Deepmind for £400m." The Guardian. 2014.
https://www.theguardian.com/technology/2014/jan/27/google-acquires-uk-artificial-intelligence-startup-deepmind

Goldman, William. *Adventures in the Screen Trade*. Grand Central Publishing. 2012.

Halevy, Alon et al., "The Unreasonable Effectiveness of Data (p. 8)." IEEE Intelligent Systems, Vol. 24 Issue 2. 2009.

Harari, Yuval. *Sapiens*. Harper. 2015.

Hassabis, Demis and David Silver. “AlphaGo’s next move.” Deep Mind Blog. 2017. https://deepmind.com/blog/alphagos-next-move/

Hawken, Paul. *Drawdown*. Penguin Books. 2017.

Helft, Miguel. “The Godfather of Digital Maps.” Forbes. 2016. https://www.forbes.com/sites/miguelhelft/2016/02/10/the-godfather-of-digital-maps/

Hertzfeld, Andy and Susan Kare. Folklore.org. “The Original Macintosh.” 2013. https://www.folklore.org/html/about.html

Heule, Marijn J. H., and Oliver Kullmann. “The Science of Brute Force.” Communications of the ACM, Vol. 60 No. 8. 2017. https://cacm.acm.org/magazines/2017/8/219606-the-science-of-brute-force/fulltext

Hillenbrand, Laura. Unbroken: A World War II Story of Survival, Resilience, and Redemption. Random House. 2014.

Hodges, Andrew. “The Military Use of Alan Turing.” 2003. http://www.turing.org.uk/publications/mathswar1.html

Hodges, Andrew. *Alan Turing: The Enigma: The Book That Inspired the Film “The Imitation Game”*. Princeton University Press. 2014.

Huguet, Kristin et al. “Apple Reports Fourth Quarter Results.” Apple. 2016. https://www.apple.com/newsroom/2016/10/apple-reports-fourth-quarter-results/

Ian Goodfellow, Yoshua Bengio, and Aaron Courville.” Smilkov, Daniel and Shan Carter. TensorFlow Playground. “Um, What Is a Neural Network?” 2016. http://playground.tensorflow.org/

Iansiti, Marco and Karim Lakhani. “The Truth About Blockchain.” Harvard Business Review. 2017. https://hbr.org/2017/01/the-truth-about-blockchain

Isbister, Katherine. “Episode 48: Gaming and Emotion - Katherine Isbister.” Literate Gamer. 2017. https://media.zencast.fm/literate-gamer/episodes/48

Jacobs, David. “An Expo Named Buckminster Fuller.” New York *Times* (p. 33). April 23, 1967.

Jahromi, Neima. “The Uncanny Resurrection of Dungeons & Dragons.” The New Yorker. 2017. https://www.newyorker.com/culture/cultural-comment/the-uncanny-resurrection-of-dungeons-and-dragons

Kadvany, John. “Indistinguishable from Magic: Computation is Cognitive Technology.” Minds & Machines 20:119–143. 2010. http://johnkadvany.com/GettingStarted/Kadvany_Design/Assets/Downloads/IndistuinghableFromMagicKadvanyMindsMachinesFeb2010.pdf

Kadvany, John. “Pāṇini’s Grammar and Modern Computation,” Journal of History and Philosophy of Logic. 2016.

Kolaitis, Phokion et al. “Aggregation of Votes with Multiple Positions on Each Issue (p. 209–225).” 16th International Conference, RAMiCS. 2017.

Kolaitis, Phokion et al. “Efficient Querying of Inconsistent Databases with Binary Integer Programming.” Proceedings of the VLDB Endowment, Vol. 6, No. 6. 2013. http://www.vldb.org/pvldb/vol6/p397-tan.pdf

Kolaitis, Phokion. Personal communication to author. 2017. https://users.soe.ucsc.edu/~kolaitis/

Krieger, David. Nuclear Files. “Mutually Assured Destruction”. Accessed 2017. http://www.nuclearfiles.org/menu/key-issues/nuclear-weapons/history/cold-war/strategy/strategy-mutual-assured-destruction.htm

Lamport, Leslie. “Paxos Made Simple.” ACM SIGACT News (p. 51-58). 2001. https://www.microsoft.com/en-us/research/publication/paxos-made-simple/

Launchbury, John. “A DARPA Perspective on Artificial Intelligence.” DARPAtv - YouTube. 2017. https://youtu.be/-O01G3tSYpU

Lennon, John and Paul McCartney. “Revolution.” Revolution. Apple Records. 1968.

Lewis, Michael. “Is the stock market rigged?” 60 minutes. 2014. http://www.cbsnews.com/news/michael-lewis-explains-his-book-flash-boys/

Markoff, John. “Moore’s Law Running Out of Room, Tech Looks for a Successor.” New York *Times*. 2016.

https://www.nytimes.com/2016/05/05/technology/moores-law-running-out-of-room-tech-looks-for-a-successor.html.

Masunaga, Samantha. “SpaceX plans to launch first satellite prototype for its Internet constellation this year.” Los Angeles Times. 2017. http://www.latimes.com/business/la-fi-spacex-satellites-20170504-story.html

Mateas, Michael and Noah Wardrip-Fruin. “Defining Operational Logics.” Proceedings of DiGRA. 2009

Mateas, Michael. Personal communication to author. 2017. https://users.soe.ucsc.edu/~michaelm/

Mateas, Michael et al. “Advanced Game Technologies.” Scacchi, W. (Ed.), (2012). The Future of Research in Computer Games and Virtual Worlds: Workshop Report, Technical Report UCI-ISR-12-8, Institute for Software Research, University of California, Irvine, Irvine, CA. July 2012. http://isr.uci.edu/tech_reports/UCI-ISR-12-8.pdf

John McHale Archives. Seen in:
Wigley, Mark. *Buckminster Fuller Inc.: Architecture in the Age of Radio.* Lars Müller Publishers. 2016.

McGonigal, Jane. “Gaming can make a better world.” TED. 2010. https://www.ted.com/talks/jane_mcgonigal_gaming_can_make_a_better_world/transcript?language=en

McGonigal, Jane. *Reality is Broken: Why Games Make Us Better and How They Can Change the World.* The Penguin Group. 2011.

McGonigal, Jane. *SuperBetter: A Revolutionary Approach to Getting Stronger, Happier, Braver, and More Resilient* Penguin Press. 2015.

Miller, Paul. "Google reveals the mysterious custom hardware that powers AlphaGo." The Verge. 2016. https://www.theverge.com/circuitbreaker/2016/5/19/11716818/google-alphago-hardware-asic-chip-tensor-processor-unit-machine-learning

Musk, Elon. "Elon Musk Speaks About Tesla and SpaceX at Vanity Fair's New Establishment Summit." Vanity Fair - YouTube. 2014. https://youtu.be/fPsHN1KyRQ8
-risk-management-system-huge-achievement

Non-attributable. "BlackRock: The monolith and the markets." The Economist. 2013. https://www.economist.com/news/briefing/21591164-countries-15-trillion-assets-should-

Non-attributable. "Esports set for £1bn revenue and 600 million audiences by 2020." BBC. 2017. http://www.bbc.com/sport/39119995

Non-attributable. "Facebook." Facebook. 2004. https://www.facebook.com/pg/facebook/about

Non-attributable. "Industry Facts." The Entertainment Software Association. 2017. http://www.theesa.com/about-esa/industry-facts/

Non-attributable. "Jesus." Wikipedia. 2017. https://en.wikipedia.org/wiki/Jesus

Non-attributable. "S Korean dies after games session." BBC News. 2005. http://news.bbc.co.uk/1/hi/technology/4137782.stm

Non-attributable. Stanford Report, July 28, 1999. http://news.stanford.edu/news/1999/july28/fuller-728.html

Non-attributable. "Weather forecasting." Science Daily. 2017. https://www.sciencedaily.com/terms/weather_forecasting.htm

Non-attributable. “Wikimedia Foundation.” Wikipedia. 2017. https://en.wikipedia.org/wiki/Wikimedia_Foundation

Non-attributable. “Wikipedia:Academic use.” Wikipedia. 2017. https://en.wikipedia.org/wiki/Wikipedia:Academic_use

Non-attributable. “Wikipedia:Protection policy.” Wikipedia. 2017. https://en.wikipedia.org/wiki/Wikipedia:Protection_policy#semi

Non-attributable. “o.s.EARTH” worldgame.org 2017. http://www.worldgame.org/

Page, Larry and Eric Schmidt. “Larry Page & Q&A with Eric Schmidt at Zeitgeist Americas 2011 (29:04 - 29:20).” ZeitgesitMinds - YouTube. 2011. Transcript available from link: https://youtu.be/srI6QYfi-HY

Page, Larry. “Foreword.” *How Google Works* eBook edition. Grand Central Publishing. 2014.

Page, Larry. “The Beginning of Google.” Charlie Rose. 2001. https://charlierose.com/videos/6277

Page, Larry. TED conference. Interview with Charlie Rose, “Where’s Google Going Next.” Transcript available from link https://youtu.be/mArrNRWQEso

Page, Lawrence et al. “The PageRank Citation Ranking: Bringing Order to the Web.” Stanford Infolab. 1998.

Pang, Josh. “Golang - Planetary Programming Language.” 2016. https://tinyurl.com/joshlang

Pang, Josh. “Pseudo Code.” 2015. https://github.com/joshua0pang/Pseudo_Code/blob/master/Pseudo_Code.java

Pang, Josh. “World Game Tabletop RPG.” 2016. https://tinyurl.com/world-game-rpg

Petzold, Arnold. The Annotated Turing: A Guided Tour Through Alan Turing’s Historic Paper on Computability and the Turing Machine. John Wiley & Sons, Inc.

2008.

Pichai, Sundar. “Alphabet 2016 Q3 Earnings Call.” Alphabet Investor Relations - YouTube. 2016. https://youtu.be/xPvUegxXk8A

Potvin, Rachel and Josh Levenberg. “Why Google Stores Billions of Lines of Code in a Single Repository.” Communications of the ACM, Vol. 59, No. 7, Pages 78-87. 2016. https://cacm.acm.org/magazines/2016/7/204032-why-google-stores-billions-of-lines-of-code-in-a-single-repository/fulltext

Riley, Tess. “Just 100 companies responsible for 71% of global emissions, study says.” The Guardian. 2017. https://www.theguardian.com/sustainable-business/2017/jul/10/100-fossil-fuel-companies-investors-responsible-71-global-emissions-cdp-study-climate-change

Ross, Michael. “Do research ethics need updating for the digital age?” American Psychological Association. Monitor on Psychology. Vol 45, No. 9. 2014. http://www.apa.org/monitor/2014/10/research-ethics.aspx

Sack, Warren. “Democracy in computational conditions.” Réseau français des instituts d'études avancées. 2016. http://fellows.rfiea.fr/dossier/democratie-et-numerique/article/democracy-computational-conditions

Sack, Warren. *The Software Arts*. 4 May 2017 manuscript version.

Sato, Kaz et al. “ An in-depth look at Google’s first Tensor Processing Unit (TPU).” GOOGLE CLOUD BIG DATA AND MACHINE LEARNING BLOG. 2017. https://cloud.google.com/blog/big-data/2017/05/an-in-depth-look-at-googles-first-tensor-processing-unit-tpu

Silver, David et al. “Mastering the game of Go with deep neural networks and tree search.” *Nature*, Vol 529. 2016. https://storage.googleapis.com/deepmind-media/alphago/AlphaGoNaturePaper.pdf

Silver, Nate. *The Signal and the Noise*. Penguin. 2012.

Skiena, Steven and Charles Ward. *Who's Bigger?: Where Historical Figures Really Rank*. Cambridge University Press. 2013.

Skiena, Steven. Quant Shop. Stony Brook University. 2016. http://www3.cs.stonybrook.edu/~skiena/quant-shop/

Skiena, Steven. *The Algorithm Design Manual*. Springer. 2008.

Skiena, Steven. *The Data Science Design Manual*. Springer. 2017.

Snyder, Jaime. "Introduction." *Ideas and Integrities*. Lars Müller Publishers. 2009.

Stewart, John. Charlie Rose."THE DAILY SHOW" (52:07 - 53:37). 2016. Transcript available from link: https://charlierose.com/videos/29499

superannuation. "How much does it cost to make a big video game." Kotaku. 2014. http://kotaku.com/how-much-does-it-cost-to-make-a-big-video-game-1501413649

Taylor, Jill Bolte. "My Stroke of Insight." TED. 2008. https://www.ted.com/talks/jill_bolte_taylor_s_powerful_stroke_of_insight

The Computer History Museum's Exhibition, "Make Software." http://www.computerhistory.org/makesoftware/

Tomayko, James. "Computers in Spaceflight: The NASA Experience." 1987. https://history.nasa.gov/computers/contents.html

Turing, Alan. Jake Copeland, editor. "Letter to Winston Churchill (1941)." *The Essential Turing*. Oxford University Press. 2004.

Turing, Alan. "On computable numbers, with an application to the Entscheidungsproblem". Proceedings of the London Mathematical Society. Ser. 2, Vol. 42, 1937. http://www.turingarchive.org/browse.php/b/12

Turner, Fred. *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism*. University of Chicago Press. 2008.

UNESCO: United Nations Educational, Scientific, and Cultural Organization. 2017. https://en.unesco.org/themes/literacy

Varian, Hal. "Search - Google AdWords - Hal Varian explains." Toronto SEO Company - YouTube. https://www.youtube.com/playlist?list=PL28D81F8088CD3D88

Wales, Jimmy. "Jimmy Wales: How a ragtag band created Wikipedia." TED - YouTube. 2007. https://youtu.be/WQR0gx0QBZ4

Wardrip-Fruin, Noah. "Playable Media and Textual Instruments." *Dichtung Digital*. 2005. http://www.dichtungdigital.de/2005/1/WardripFruin/index.htm.

Wardrip-Fruin, Noah and Roberto Simanowski. "Interview with Noah Wardrip-Fruin." *Digital Literature*. 2006. http://www.artificial.dk/articles/wardripfruin.htm

Wardrip-Fruin, Noah and Michael Mateas. "Envisioning the Future of Computational Media." Center for Games and Playable Media. 2014.

Wardrip-Fruin, Noah. Personal communication to author. 2017. https://games.soe.ucsc.edu/people/noah-wardrip-fruin

Whitehead, Alfred North. *An Introduction to Mathematics* (p. 61). The University Press. 1911.

Whitehead, Alfred North. *Science and the Modern World* (p. 4). Free Press. 1997.

Whitehead, Alfred North. *The Aims of Education*. "The Rhythmic Claims of Freedom and Discipline." Free Press. 1967.

Zimmerman, John et al. "An Analysis and Critique of Research through Design: towards a formalization of a research approach." Proceedings of the 8th ACM Conference on Designing Interactive Systems. 2010.

Zuckerberg, Mark. "Facebook Founder Mark Zuckerberg Commencement Address |

Harvard Commencement 2017." Harvard University - YouTube. 2017. https://youtu.be/BmYv8XGl-YU

Zobel, Justin. *Writing for Computer Science*. Springer. 2004.