Simulation:
Deceit or Conceit

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This is a working paper to begin to distil a framework for understanding the various complexities surrounding technology-based simulation. How it can be understood, what it is, and where and how it should be applied.

Pop Culture
In recent decades simulation has captured the public's imagination via popular TV shows like *Star Trek*, best selling novels like Neil Stephenson's *Snow Crash* and blockbuster movies such as *The Matrix. Star Trek's* "Holodeck" is a four dimensional virtual world, in which participants are fully immersed and with which they interact physically. Their five senses respond to this virtual world so 'perfectly' that the experience is indistinguishable from 'real events' (i.e. events outside the Holodeck). Stephenson's "Metaverse" is a virtual world that bypasses the body and taps directly into the mind. The mind can act, feel and move as if the five senses were really stimulated, when actually the body remains completely uninvolved. *The Matrix* arguably pushes this simulated universe one step further, suggesting that life might be an elaborate hoax: a Metaverse in which you unknowingly participate to distract your body from its real purpose- to be an energy source for machines. Both the Holodeck and the Metaverse are virtual environments whose strength and appeal depend on their ability to simulate and enhance real life. The Holodeck is built on the assumption that 'good' simulation is one that follows the rules of nature- mimicking and copying real life; whereas the Metaverse is based on the seemingly opposite belief –a seductive virtual world is one where the rules can be changed, for example to let participants fly. This correspondence (or lack thereof) between the virtual/simulated world and the 'real' world seems to be at the crux of most discussions on the merits and uses of simulation.

Beyond the Holodeck
While the Holodeck and Metaverse are examples of simulation, the actual industrial field is much broader than is suggested in these sci-fi examples. The simulation applications that most resemble these fictions are those produced by virtual reality laboratories around the world- people working towards some sort of Holodeck. This environment, or 'cave' as it is typically called, is "an eight-foot chamber, surrounded on all sides (sometimes including floor and ceiling) by video screens, [in which the user steps in] wearing 3-D glasses and gripping a joystick, [and] navigates through a

virtual world."[1] However, even in these 'caves', the Holodeck vision is not complete, as 3 of the 5 sense are poorly reproduced: "in the cave there's nothing to smell, not much to hear and certainly nothing to taste or touch."[2] In spite of these limitations, "people often react to virtual experiences as they were real-world experiences."[3] This allows for positive uses in specific situations, like helping cure phobias such as fear of spiders, heights, small spaces, or flying which affect about 10% of the population and for which simulated treatments have been very effective.[4] However, the efficacy of these treatments, or other uses of the Holodeck type environment (one in which the simulated world is 'sufficiently like' the real world) hinges on the cave's ability to faithfully reproduce the real world. The challenge is to understand the level at which it becomes 'as good as reality', given the purpose at hand (more on this later).

While the sci-fi vision of Holodecks and virtual worlds are the most recognizable forms of simulation they are actually not the most prolific. Far more numerous are industrial and educational applications, such as simulation in the educational, medical, design, manufacturing and gaming fields. The following section briefly describes the ways in which simulation is impacting each of these different areas.

<u>Education</u>

As simulated environments have the "ability to explore cause-and-effect relationships without having to wait a long time to see the results and the ability to convey the effects in vivid and credible ways", [5] they can be a powerful tool for educational purposes. Kurt Schmuker from Apple Computers has assembled a taxonomy of simulation software for educational purposes. In it, he provides the following example.

> "GenScope provides the student with an interactive environment in which the relationships between chromosomes, genes, and observable traits can be both explored and tinkered with. The student is offered several different views of the same information: from pop-up menu chromosomes on idealized "popsicle stick" genes—a great view for the beginning student— to the view of genetic information that is really used in science: family trees of populations with observable traits for each individual labelled."[6]

Not all educational simulations are software programs. For example, the Baby Think It Over (BTIO) simulator is a 'doll' given to teenager students to help them get a sense of the effort involved in caring for an infant. The ultimate goal is to reduce the number of teenager pregnancies. I personally spent a few nights with BTIO and can confirm its effectiveness. The doll looks quite real and weighs as much as an infant. It

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[1] David Cameron, Keeping It Real, *Technology Review*, (March): 2002.

[2] Paroma Basu, The Virtual Voyager, *Technology Review*, (September): 2001.

[3] B.J. Fogg, *Persuasive Technology* (San Francisco, CA: Morgan Kaufmann, 2003), p. 61.

[4] Ibid, p. 74.

[5] Ibid, p. 63.

[6] Kurt Schmucker (1999), *A Taxonomy of Simulation Software* at www.apple.com/education/LTReview/spring99/simulation/.

registers sudden shocks (hitting or dropping) as abuses and will only stop crying when the caretaker 'feeds' it. This information then is fed back to the school counsellor who can then tailor his focus to the teenager's treatment.

Unlike Holodeck type virtual reality, absolute realism is not essential for simulation to be effective in educational purposes. Quite the contrary, a simplified, idealized version of the world can be a much more effective first step for learning. As Schmucker describes, "By gently moving from the idealized view to the real view, the student can gradually grow from a simple understanding of basic concepts to the application of those concepts in the messy and complex real world".[7]

Medical

A handful of research labs are now investigating simulation to bypass early testing and understand more clearly the interactions that a new drug may have on cells, organs or the entire body. This type of simulation was only recently made possible by the successful sequencing of the human genome. Its goal is to reach a point where "researchers will use such computer simulations to identify new drug targets and to design and screen new drugs that will lead to entirely new treatments—if not cures."[8]

The medical realm also uses simulation in educating doctors: to recreate the 'feel' of something. In this form, "students can practice the routine task of inserting a catheter into a patient's hand, or more difficult procedures like a colonoscopy or even a lung biopsy. These simulators don't just provide vivid computerized visual renderings of human innards. They also re-create something equally critical: how all the injecting, cutting, inserting and palpating actually feel to the doctor performing them."[9] While this technology is already highly useful for teaching purposes, it has the possibility in the future to allow 'remote' medical operations through the Internet. In both the drug testing and doctor educational applications, the correspondence between the simulated environment and the real environment is crucial- much more so than in the previous examples cited in this paper. We are already getting a sense of the wide variety of 'acceptable simulations', the 'realism' of which depends on the purpose.

Design and Manufacturing

The invention of the airbag, the improved safety of every car made in the past ten years, and the increased comfort when driving at high speeds are just a few of the products and innovations that were made possible by the automobile industry's wide use of simulation. In this context, the simulation process is a powerful tool for analysing, designing and operating complex systems. For example, simulation of airbag deployments has helped engineers design better bags and place them in optimal configuration for crash safety. Simulation of noise environments in various vehicles at various speeds has allowed for modifications in the car's design to reduce ambient noise. In some cases these tests would be prohibitively expensive if run on 'real' prototypes. In others, they would simply be impossible. Simulation is not only saving billions of dollars in unnecessary prototypes and mistakes, but it is also shaving of a significant amount of development time. While the benefits to date have mainly be

[7] Kurt Schmuker, Ibid.

[8] Gary Taubes, The Virtual Cell, *Technology Review*, (April): 2002.

[9] Ivan Amato, Helping Doctors Feel Better, *Technology Review*, (April): 2001.

enjoyed by the more complex problems and large industries such as transportation and medical, it is beginning to filter down into smaller design and manufacturing uses as well.

Games

The gaming industry is probably the greatest consumer of simulation: from role-playing to flight simulators. The most popular simulation games are the *Sims* series; for example *SimCity* in which players are asked to build entire urban landscapes- chosing the transportation infrastructure, the tax system, land development rules, city landscaping etc… By varying these parameters, the player can explore the 'consequences' of various decisions, and combinations- potentially learning something about the underlying causes to urban sprawl, violence or pollution. Of course, this simulated environment is built on the game creator's assumptions regarding agreeable v. threatening urban configurations, so whether or not one can infer real world conclusions from experience with the game is an important question.

Certain games are explicitly built to provide a realistic environment, in particular as regards the laws of nature: examples include more accurate gravity, collision and fluid dynamics-such as rippling waves, pouring rain, sinewy smoke and flickering fires. Yet many question the necessity of such features (and investments), arguing "a successful game is that the characters are believable—which is not the same as being realistic."[10] As evidenced in the wide variety of gaming simulations- from near perfect recreations of the actual experience (flight simulators) to purposefully exaggerated renditions of mass social phenomena (Sims), the correspondence between the real and the simulated worlds is a 'variable' factor, different purposes apparently requiring different levels of simulation.

Simulation: a legacy of deceit

The examples listed above give a sense of the variety of usages of simulation in our present world and the number of casual definitions for the word. I found the following definition in the Webster dictionary:

> **sim·u·la·tion**
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> **1**: the act or process of SIMULATING
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> **2**: a sham object **:** COUNTERFEIT
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> **3a**: the imitative representation of the functioning of one system or process by means of the functioning of another <a computer *simulation* of an industrial process>
> **b**: examination of a problem often not subject to direct experimentation by means of a simulating device

The original meaning (France 14th century) had heavy negative connotations- a predisposition that survives today is people's instinctive distrust for simulated results. For many people, no matter how allegedly good the simulation might be, the 'real' simply cannot be substituted. Notice the similar definitions for the words *counterfeit* and *simulate:*

[10] Katherine Cavanaugh, Kaboom! Video Games Get Physical, *Technology Review*, (September/October): 1999

> **coun·ter·feit :** made in imitation of something else with intent to deceive.
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> **sim·u·late:** to give or assume the appearance or effect of often with the intent to deceive.

Similarly, **synonyms** for *simulation* suggest distrust: assume, act, affect, bluff, counterfeit, fake, feign, pretend, put on or sham…

Sci-fi writer Jerry Pournelle underlines this continuing concern about simulation in a response to SimCity:

> "The simulation is pretty convincing - and that's the problem, because ... it's a simulation of the designer's theories, not of reality ... [M]y point is not to condemn these programs. Instead, I want to warn against their misuse. For all too many, computers retain an air of mystery, and there's a strong temptation to believe what the little machines tell us. "But that's what the computer says" is a pretty strong argument in some circles. The fact is, though, the computer doesn't say anything at all. It merely tells you what the programmers told it to tell you. Simulation programs and games can be valuable tools to better understanding, but we'd better be aware of their limits".[11]

Pournelle makes an important point: users of computers and simulation programs are often oblivious to the underlying mechanism- unaware that the conclusions are somewhat preordained by a programmer (a mere human, subject to error like all of us), and likely to ascribe too much faith to these results. One person’s distrust seems to be another person’s over-confidence. Apparently, many users of simulation (mostly simulation programs) are not ‘aware of their limits’, likely to infer false beliefs about the real world from computer manipulations.

Simulation: the risk of conceit

Yet Pournelle is not entirely dismissing all uses of simulation. Quite the contrary, he emphasizes the realms in which SimCity is a valuable tool: for better understanding (which goes back to my earlier point about simulation and education, and the virtues of building a stylised world for the sake of learning). In addition, one could extrapolate from his analysis of SimCity’s limitations to state that any simulation tool is only as good as its applications: only relevant within well-defined limits, set by the programmer. In raising questions about the limitations of simulation, Pournelle seems to be addressing the crux of the issue; one which surprisingly enough is not mentioned in most definitions of the term. Even Shmucker who strived to find an acceptable definition for *simulation* (having been disappointed with all existing definitions) fails to address this point:

> “A simulation is a software package (sometimes bundled with special hardware input devices) that re-creates or simulates, albeit in a simplified manner, a complex phenomena, environment, or experience, providing the user with the opportunity for some new level of understanding. It is interactive and usually grounded in some objective reality. A simulation is based on some

[11] Ted Friedman, *Semiotics of SimCity* at www.firstmonday.dk/issues/issue4_4/friedman/

> underlying computational model of the phenomena, environment, or experience that it is simulating."[12]

Though he uses the terms "grounded in objective reality" and "computational model", he does not emphasize the fact that all models are only applicable within bounds, and that part of the scientist's art is to know where and when the model no longer applies. Granted the model is a simplified representation of the world, but it holds very few claims to truth, reality or objectivity. Rather it is a short hand that scientists use to describe and impact the world around them. Models are not god given or eternal-quite the contrary, they change and are replaced with time. To put it bluntly, the simulation is only as good as the model.

As the simulation program is built on a single (or a combination of) model, the user has to wonder at the reasons that led the programmer to chose this particular model. This introduces a certain degree of bias in the program. As Fogg warns: "Nothing guarantees that they are accurate. The rules built into the system may not be based on the best knowledge of cause-and-effect relationships but rather on the bias of the designer."[13] Similarly, Schmucker notes that, "inevitable differences and simplifications between reality and the simulation of that reality are not properly understood by the student."[14] Even if the user agrees with the designer/programmer's choice of model, she still needs to be aware of the limits within which the model yields acceptable results. One way of establishing these barriers of acceptability is to run benchmark studies: dual experiments that compare simulated results to 'real results', to validate both the program's capacities and its limitations. Such tests are systematically run for simulation programs in product development and medical training. Car design, for example, greatly benefits from simulation of crash and safety parameters-a trust that was developed from decades of joint tests on real and virtual prototypes. Yet here again, all configurations are not foolproof, and the user has to be aware of the limits within which the program yields satisfactory results.

Generally, simulated results are only acceptable within limits, and these limits have to be set by the user. In some cases, correspondence with reality might not be an issue; in others it might be the crucial issue. This depends on the user's goal. As I showed above, if the goal is education or entertainment, the user might prefer an exaggerated version of reality (Dragon DNA in genScape). However, if the goal is vehicle occupant safety, the user needs to obtain results that are not significantly different from those he would get, if he ran the tests on material prototypes. Generally simulation **should be as good as 'real' for the purpose at hand.** This is the element that was missing from Schmuker and others' definitions of simulation: the 'purpose at hand' must be defined, as it is an essential component of the quality of the simulation. Note that the word **"good"** refers to a qualitative, rather than a quantitative parameter. The idea is not to measure the correspondence between the real and virtual world, but rather to establish that the differences between these worlds are insignificant to the final goal.

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[12] Kurt Schmuker, Op. Cit.

[13] B.J. Fogg, Op. Cit., p. 67.

[14] Kurt Schmucker, Op. Cit.

Conclusion and Thesis Ideas

Given the relativistic definition for simulation (as good as real for the purpose at hand) the burden for evaluating a particular application falls on the user. As simulation becomes more prevalent in our world, this will inevitably lead to the education and miseducation of users. I will be exploring this dynamic within the sub community of product designers.

As part of my thesis work next year I intend to explore the uses of simulation for the product design world in questioning, how would the product design process change with the use of virtual simulation? Part of the value of simulation for design is reducing both time and cost in creating real world simulations (i.e. prototyping), while also giving the designer greater feedback earlier in the process. Further questions that need to be addressed include – can the designer make do without a physical prototype in their process or where does it break down? In particular, I am interested in exploring the designer's relationship to his virtual prototype as it involves the issues of reliability and credibility discussed in this paper. Provided that simulation becomes an increasing part of the engineering and design process, presumably entailing a shorter development cycle, what use will be made of this additional time; better products, more products, less employees and with what impact on the consumer society?