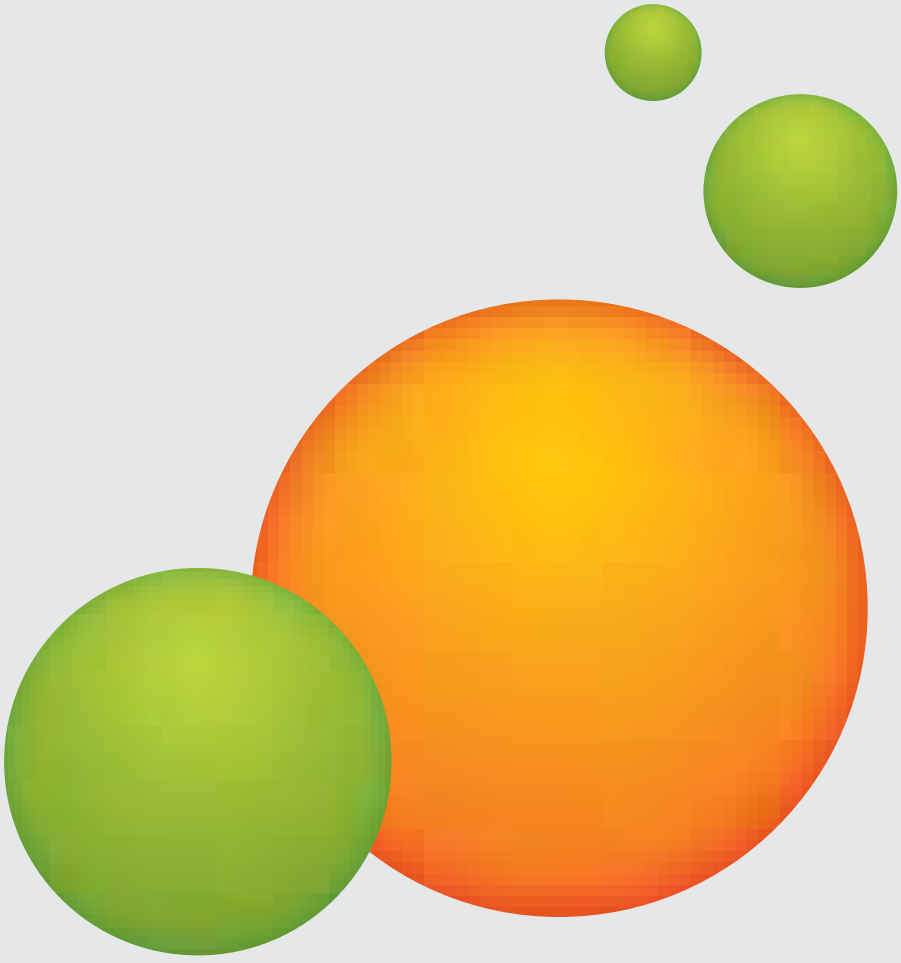
SIGNTIFIC

Signtific Project: Year 1 Report Update

July 2009



124 University Avenue, 2nd Floor | Palo Alto, CA 94301 | 650.854.6322 **www.iftf.org**

INSTITUTE FOR THE FUTURE

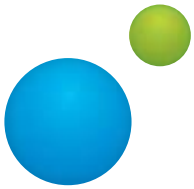
about the …

SIGNTIFIC PROGRAM

The purpose of Signtific (formerly known as X2) is to identify future disruptions, opportunities, and competitive landscapes related to the content and dynamics of global science and technology innovation; to develop a new platform for understanding global innovation trends; and to present this information to policy- and decision-makers, as well as the general public, in a useful form.

INSTITUTE FOR THE FUTURE

The Institute for the Future (IFTF) is an independent, nonprofit strategic research group with more than 40 years of forecasting experience. The core of our work is identifying emerging trends and discontinuities that will transform global society and the global marketplace. We provide our members with insights into business strategy, design process, innovation, and social dilemmas. Our research generates the foresight needed to create insights that lead to action. Our research spans a broad territory of deeply transformative trends, from health and health care to technology, the workplace, and human identity. The Institute for the Future is located in Palo Alto, California.



THE SIGNTIFIC PROJECT TEAM:

Marina Gorbis

Cesar Castro

Mathias Crawford

Jane McGonigal

Alex Pang

Kathi Vian

CONTENTS

NOTE | All images and data represented in this report, unless otherwise noted, can be found at IFTF's signtific.org or lab.signtific.org.

EXECUTIVE SUMMARY

WHAT IS SIGNTIFIC?

The Signtific Project is designed to engage the global scientific community in anticipating the most important innovations and disruptions in science and technology—and understanding their implications for the future of science and of society at large. It stands at the leading edge of several trends that will reshape the practice of science over the next few decades:

- It uses an open-source approach to identify and aggregate signals of potential scientific innovations and disruptions.
- It leverages new social media to engage both professional and citizen scientists at new scales.
- It uses gaming principles to explore alternative incentive structures for collaboration and knowledge sharing among scientists.
- It targets specific geographic and ethnographic niches that are likely to become leaders in emerging disciplines.

In these ways, Signtific is both a platform for understanding the changing face of science and an experiment in creating this change. This report summarizes the accomplishments of the project in the past year, with a special focus on Signtific Lab: a platform that builds on the principles of gaming to engage scientists and the lay public in thought experiments about leading-edge developments.

THE SIGNTIFIC PLATFORM: A TRIAD FOR DISCOVERY

Signtific consists of three distinct but interrelated platforms:

1 | The **Signtific website**: an online collaborative repository for signals and forecasts about key developments in science and technology.

2 | A **system for conducting workshops** in geographic and ethnographic niches, to create regional roadmaps using the signals and forecasts from the Signtific online site to seed the discussion and integrate the results back into the repository.

3 | The **Signtific Lab**: a platform for rapid iteration of extreme-scale thought experiments, using gaming principles to drive the evolution of community thought and to glean insights into potential disruptive impacts of scientific innovations.

The Signtific development team has worked to integrate these distinct platforms to create a seamless web of discovery—to acquire and evolve insights about the future of science and technology. In particular, Signtific Lab represents a powerful new tool for rapid ideation and for effectively and efficiently identifying "long-tail" or "outlier" content that may have wide-ranging impacts for policy.

GAMING: FROM SUPERSTRUCT TO SIGNTIFIC LAB

In the fall of 2008, the Institute for the Future (IFTF) conducted the first massively multiplayer forecasting game (MMFG), Superstruct, to test the concept of using games for forecasting. While that experiment demonstrated the power of MMFGs to engage a broad public (more than 7000 players from more than 90 countries) in forecasting the future, it also provided key lessons for the development of a dedicated gaming platform designed to meet the needs of Signtific. The design goals for Signtific Lab were thus to:

- Provide a lightweight online environment rather than a complex immersive environment to minimize development time as well as the need for special skills and knowledge among users.
- Build a platform that can be used, reused, and repurposed for multiple, short gamelets rather than a single, extended gameplay (2-3 days vs. 6 weeks).
- Give players a rapid introduction to rigorous scientific and technological facts that are nonetheless broad enough to allow a wide range of users to participate intelligently.
- Provide rapid feedback to the game community to encourage a swift evolution of ideas.
- Leverage other social media platforms, such as Twitter, to support community-building and drive participation.

Figure i
An introductory video describes a future scenario to set the stage for the thought experiment.

Using these principles, the Signtific team designed and built the Signtific Lab platform around three key elements:

1 | A short introductory video scenario that provides the future context for gamelets that are called “thought experiments”

2 | A set of player “cards,” each of which is a Twitter-length micro-forecast

3 | A scoring system, with a dashboard and special awards, to incentivize participants and filter for the best forecasts

Using this platform, the team drew from existing signals to conduct a preliminary trial thought experiment, called “Free Space” which was run with the public three times, in three different settings. Figures i–iii illustrate the three key elements of the platform.

Figure ii
Users play “cards” that contain micro-forecasts. The initial cards may be Positive Imagination or Dark Imagination forecasts. Players can build on any card by adding Momentum, Antagonism, Investigation, or Adaptation cards.

Figure iii
Individual scorecards are part of a dashboard that help users track their performance and encourages them to contribute more content in categories.

FIRST RESULTS: THE FREE SPACE TRILOGY

The Free Space thought experiment posited a future in which cubesats (micro-satellites that individual scientists can use for running space experiments) were cheap and commercially available to individuals. Free Space was run in Wellington, New Zealand; Hannover, Germany: and San Jose, California. These trials were a success by every measure, generating a vast amount of high-quality content regarding the future of space and satellite technologies. See Table i below and Figure iv on page 6.

For each thought experiment, Ariel Waldman, founder of Space Hack and an expert in the field of emerging DIY space technology, helped the team collate and evaluate the player cards to synthesize forecasts. The results include the following emerging potential shifts that this scenario engenders and that are important for the policy community to understand:

- The start of **earth watching**: space exploration takes us back home.
- The start of **eco-currency**: eco-information from cubesats is used to back the value of national currencies based on eco-resources.
- The start of **space medicine**: small zero-gravity labs advance medical knowledge.
- The start of **solar prosperity**: solar energy collected by personal cubesats become a fixed source of income for even the poorest individuals.
- The start of **space sourcing**: networks of cubesats create a new economy akin to the rise of the Internet in the 1990s.
- The start of **cloud financing**: cubesats support POS in the cloud, with 90% of all WorldDollars originating in the cloud.
- The start of **lightweight geoengineering:** cubesats serve as delivery mechanisms for effecting regional weather change.

Table i
Statistics for the Free Space Trilogy

Trial	Webstock 2009 Wellington, New Zealand February 18–19	CeBIT 2009 Hannover, Germany March 3–4	ETech 2009 San Jose, CA March 9–10
Number of users	315	100	200
Cards played	3466	875	1700

- The start of a **space privacy industry**: continuous surveillance by cubesats drive countermeasures to provide "privacy for sale."
- The start of **space crimes**: cubesats provide a platform for conducting and hiding criminal activity
- The start of a **space renaissance**: cubesats are harbingers of a new culture afforded by the democratization of space.

The details of these results, along with samples of the actual player cards that produced them, are presented in more detail in *Chapter 1* of this report.

SUPERSTRUCTED REALITIES: A SECOND TRIAL SCENARIO

In addition to the Free Space Trilogy, the project team conducted an additional trial of Signtific Lab, using an alternate scenario on the theme of Superstructed Realities—a future in which virtual and physical realities are seamlessly blended.

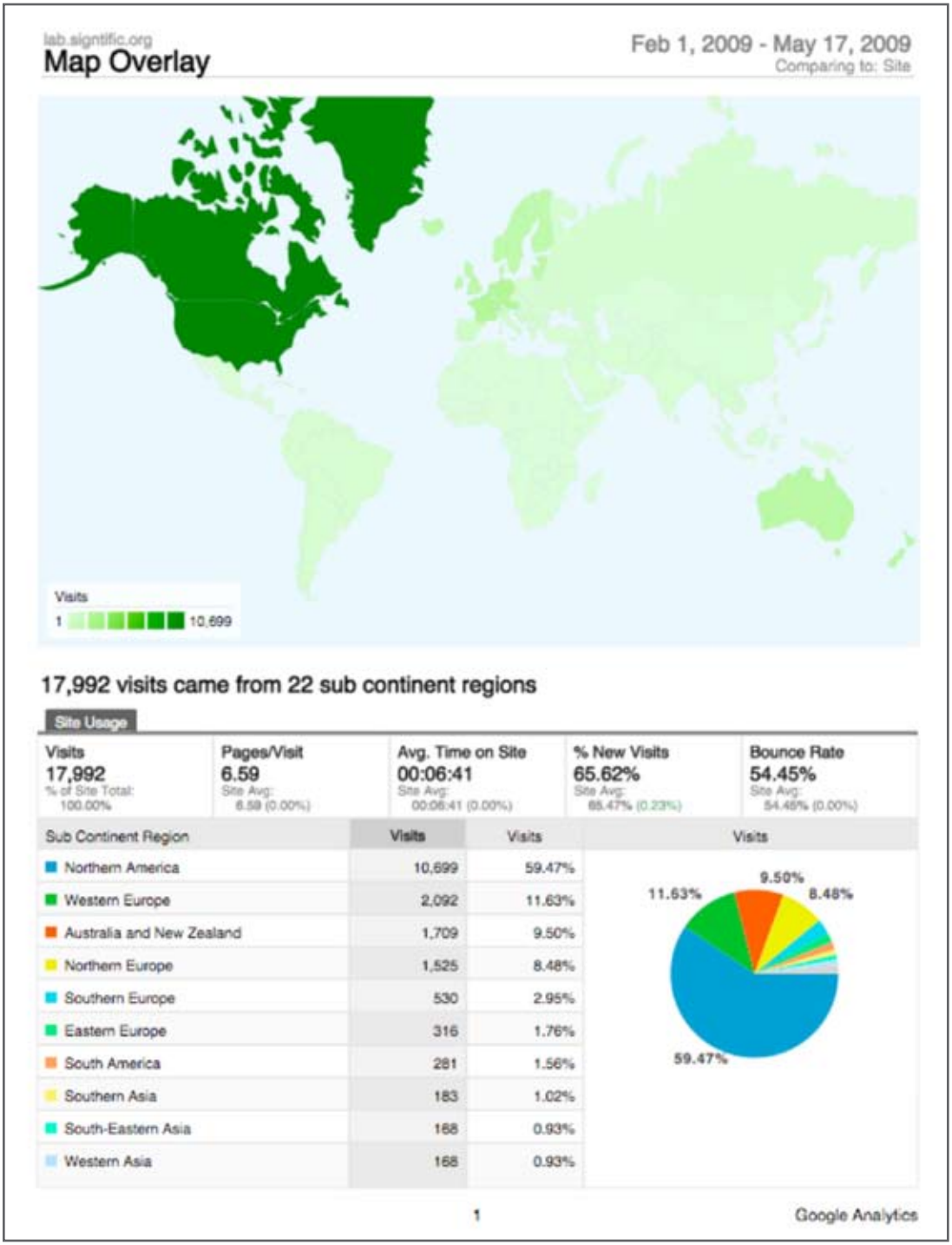
This thought experiment was run as part of IFTF's annual Ten-Year Forecast conference. In less than 24 hours, it produced more than 3500 micro-forecasts, with clusters of U.S. users in Atlanta, GA, Hyattsville MD, Moline, IL, San Bruno, CA, New York, NY, Austin, TX, St. Louis, MO, Boston, MA, and Ithaca, NY. Outside the United States, the top clusters of users were from Helsinki, Finland; Skopje, Macedonia; Winsford, UK; Toronto, Canada; Santiago, Chile; and Milan, Italy.

Some of the top-rated micro-forecasts from this trial included:

- **Decision-making disadvantaged:** Your decision-making ability is affected by which help guides you buy. Those who can only afford cheap help guides make bad decisions.
- **Decision-making gap:** Are there growing pockets of decision-making disability, like asthma, diabetes?
- **New m2m vocabulary:** We realize how utterly, drastically different each mind really is. Translating between raw data is almost possible; new m2m vocabulary is born.
- **New m2m youth culture:** Mind privacy isn't a big concern for youth. Parents worry about how open teens are with m2m tech (like social networks a decade ago). But also: American teens form a union to protect their rights after 1000s of parents surreptitiously install vid monitors behind their eyes.
- **New skills to superstruct reality:** People learn how to produce 3D video, viewable in precise locations, outdoors in the real world.

For more details on the lessons from all the Signtific Lab trials, see *Chapter 1*.

Figure 4
While North America dominated the contributions in the three Free Space trials, players from emerging hot spots of science and technology in South America, Eastern Europe, Southern Asia, Western Asia, and South-Eastern Asia also contributed.



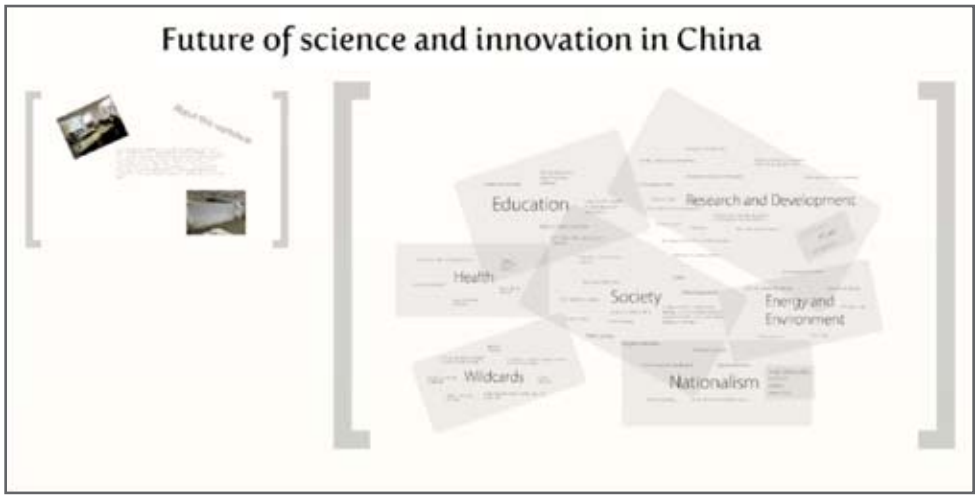
WORKSHOP UPDATE: THE CHINESE SCIENTIFIC DIASPORA

As mentioned, geographically or ethnically focused workshops are an integral part of the Signtific Project. They help anticipate the emergence of regional expertise and ensure a cross-cultural perspective to the body of signals and forecasts in the Signtific platform.

On April 29, 2009, IFTF conducted a Signtific workshop with Chinese and ethnic Chinese scientists, doctors, and entrepreneurs in the San Francisco Bay Area. The workshop participants built a roadmap of major issues and trends affecting the future of science and technology in China, focused on five big issues:

- **Rural/urban education disparities:** The educational disparities between rural and urban China are likely to lead to loss of scientific talent as well as an increase in social tensions.
- **Health-driven innovation:** With an aging middle population, a growing middle class, rising health awareness, and a growing set of science-based medical services, China will invest in life science, and in particular, in lower-cost medical technologies, pharmaceuticals, and service delivery.
- **New intellectual property strategies:** As Chinese technology companies move up the value chain, the Chinese tolerance for violations of intellectual property rights will decline, and new strategies for securing intellectual property will emerge.
- **Mobility-friendly science careers:** The foreign-trained and globally networked Chinese scientists who are currently being recruited back to China will eventually challenge the scientific establishment there to create more flexible career and institutional structures to accommodate mobile talent.

Figure v
The Prezi mapping tools have been integrated into the Signtific process to provide visual roadmaps based on local workshops.



- **Large-scale energy and water infrastructures:** In the face of national science and technology (S&T) priorities on energy and clean water, Chinese scientists and engineers will likely spend more effort on large-scale massive infrastructure projects than on small-scale conservation or neighborhood alternative energy.

For more details on the Chinese Scientists Workshop, see *Chapter 2*.

SIGNTIFIC.ORG: SIGNALS FROM THE LAST SIX MONTHS

Signtific.org is the core content site for the Signtific Project. Since it was relaunched with a new visual design, a customized feature set, and a focus on community engagement, the site has had almost 15,000 visitors; nearly 40% of these were from outside North America, with 7.4% from Asia.

More important, the number of registered users on the site increased dramatically (from approximately 735 to 1140 users), as did the number of signals (from 697 to 1209). Here is a summary of some sample signals from this most recent set (with the contributing country in parentheses):

- **Robots take over scientific research** (United Kingdom):
  http://signtific.org/en/signals/robots-take-over-scientific-research

  Scientists have created a Robot Scientist, which the researchers believe is the first machine to have independently discovered new scientific knowledge.

- **Ambient intelligence strategy in service, toward territories extensions for companies in a coopetition economy** (France):
  http://signtific.org/en/signals/ambient-intelligence-strategy-service-toward-territories-extensions-companies-coopetition-ec

  The end of silo industries in cooperation economy offers a new playground for companies that cooperate in a dynamic competition, where shared ambient intelligence strategies could extend the territories of all collaborators.

- **City wide information systems** (United States):
  http://signtific.org/en/signals/city-wide-information-systems

  Community supported and installed information keep citizens citywide informed about the myriad issues that require decision-making on their part.

- **Out with the old (skin), in with the new (skin)** (France):
  http://signtific.org/en/signals/out-old-skin-new-skin

  A substance created from stem cells helps regenerate skin, with implications for both human and robotic applications.

- **Hey, teachers, leave our kids alone!** (France):
  http://signtific.org/en/signals/hey-teachers-leave-our-kids-alone

  Once a playground for academics and military types of all kinds, website Lifehacker reminds its readers that it is still possible to educate oneself mainly from the Internet.

- **Major downturns spur innovation** (United States):
  http://signtific.org/en/signals/major-downturns-spur-innovation

  Economist Alexander Field found that the 1930s (the Great Depression) was paradoxically the decade of greatest technological advancement of the 20th century.

- **Researchers report of a brain and spinal tumor following human fetal stem cell therapy** (United States):
  http://signtific.org/en/signals/researchers-report-brain-and-spinal-tumor-following-human-fetal-stem-cell-therapy

  Concerns have been raised over this experimental therapeutic approach after a case published in PLoS describes a rare side effect of human fetal stem cell therapy.

- **Open-source drug discovery** (United States):
  http://signtific.org/en/signals/open-source-principles-offer-opportunities-advance-health-research-aggregating-personal-heal

  Today, anyone with enough science knowledge and computational power has the ability to contribute to research advances, outside any institution.

- **South Korea to build top-speed information highway** (United States):
  http://signtific.org/en/signals/south-korea-build-top-speed-information-highway

  South Korea plans to upgrade their already fast broadband internet access by 2013 to be 10 times faster than today.

- **Biomedical applications on the iPhone platform** (Hungary):
  http://signtific.org/en/node/52944

  Approximately 100 medical applications are now available for the Apple iPhone.

- **Understanding the Twitterverse** (United States):
  http://signtific.org/en/node/52943

  HP researchers found that most Twitter users have a small number of friends compared to their followers/followees; this suggests that there are at least two tiers of social networks that need to be understood to gain a full appreciation of the Twittersphere.

- **Video phone efficiency in defibrillator sage by untrained laymen** (Hungary):
  http://signtific.org/en/node/52940

  A group of researchers from the Republic of Korea conducted an observational study to demonstrate that “real-time communication with visual images [via mobile phone with video capabilities] can provide critical information and appropriate instructions to both laypersons and dispatchers.”

- **Researchers lay out vision for lighting revolution** (United States):
  http://signtific.org/en/node/52937

  Innovations in photonics and solid-state lighting will lead to trillions of dollars n cost savings, along with a massive reduction in the amount of energy required to light homes and businesses around the globe.

- **Cheap, user configurable eyeglasses could improve vision for billions of the world's poor** (United States):
  http://signtific.org/en/node/52936

  An Oxford physicist has developed eyeglasses that can be "tuned" by the wearer to correct his or her vision, eliminating the need for a trained optician in countries where specialists are rare.

- **China's Longxin microprocessor** (China):
  http://signtific.org/en/node/52917

  Chinese Academy of Sciences will debut a 65 nm Longxin 1.2 GHz microprocessor at the end of the 2008 and an 8-core version in 2009.

- **Gaming provides another approach to open-science research** (United States):
  http://signtific.org/en/signals/gaming-provides-another-approach-open-science-research

  Researchers at the University of Washington and Howard Hughes Medical Institute have designed a game called Foldit, which "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."

- **Stem cells used to create organ for transplant** (United States):
  http://signtific.org/en/node/52915

  A Colombian woman has become the world's first recipient of windpipe tissue constructed from a combination of donated tissue and her own cells.

For more details on these signals, see *Appendix 3*.

NEXT STEPS: AGGREGATION, ENGAGEMENT, VISUALIZATION

In the first 18 months of the Signtific Project, the project team has made important progress toward developing new methodologies to uncover signals, forecasts, and outlier developments in the future of science and technology. The project is just getting off the ground. With basic infrastructure now in place, the project team can turn its attention to refining the processes for aggregating scientific discovery, engaging a broad-based global community in harvesting the most important insights from that discovery, and developing tools to make this information more accessible.

Already in the time since the Signtific Project began, the use of social media for scientific discovery and technological innovation has grown rapidly. For example, Galaxy Zoo has invited the public to help classify galaxies from Hubble photographs, achieving 50 million classifications during the first year. The National Phenology Network is reaching out via Internet social networking platforms to invite citizen scientists to provide data, in order to get a more complete view of what's happening to the planet as the climate warms. FoldIt uses computer gaming to engage citizen scientists in contributing to important scientific research. In Southeast Asia, Integrated Approaches for Participatory Development (IAPAD) is a focal point for sharing information and technical progress on community-based mapping, with a particular focus on 3D modeling.

The Signtific Project has the potential to "superstruct" these kinds of communities—that is, to bridge them and build upon them, aggregating disparate scientific projects to cross-fertilize scientific thinking and create a bottom-up system of scientific monitoring and even second-order discovery.

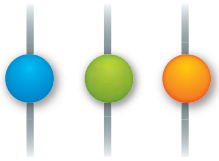
The focus of continued development of the three integrated Signtific platforms will be to engage these kinds of communities to leverage their networks and build a superstructure through which professional and citizen scientists alike can track and even shape the global scientific agenda.

Specifically, the Project hopes to accomplish the following:

- **Extreme-scale roadmaps:** Engage a broad range of open-source scientific networks in virtual workshops that leverage the Signtific team's experience with face-to-face workshops on a much larger scale.
- **Deep thought experiments:** Design Signtific Lab thought experiments to probe the specific expertise of content-focused open-science networks and use their discoveries as a jumping off point for anticipating future developments in science and technology.
- **A hubless platform:** Demonstrate the use of existing social media tools—from Twitter and Facebook to new video platforms—to rapidly mobilize communities of trackers around specific domains and geographies of discovery and innovation.
- **Visual forecasts:** Develop lightweight visualization tools and create competitive challenges for individuals and groups to create innovative visual forecasts of future science and technology.

- **Analytic tools:** Refine the analytic tools in the Signtific platforms to facilitate our ability to cluster signals, forecasts, and micro-forecasts by geography, by user expertise, and by generation to better understand the patterns of scientific discovery and technological development around the world.

As new tools and scientific communities are emerging, we feel it is critical to continue the Signtific Project as a platform for experimenting with radically new tools and processes for technology forecasting. For details of this development plan, please see *Chapter 4*.



INTRODUCTION

Over the next decade, the practice of science will evolve in ways that will both support and disrupt society. Open-source practices will change the incentive structures—and therefore the institutions—that serve as the gatekeepers of scientific knowledge. Science will become an increasingly global enterprise, with regional niches of expertise in both the Global North and Global South. Citizen scientists will find new channels to contribute to professional science, and professionals will learn to take advantage of these lay contributions. Finally, governments will depend increasingly on the flows of scientific and technical information in both administrative and policy functions, with vastly greater reliance on quantitative data as well as models and simulations of complex processes.

This report summarizes the efforts to date of the Signtific Project (formerly The X2 Project) to engage the global scientific community in anticipating the most important innovations and disruptions in science and technology—and to understand their implications for the future of science and of society at large. Recognizing the changes in scientific practice noted above, the project:

- Uses an open-source approach to identify and aggregate potential signals of disruptive scientific innovations
- Leverages new social media to engage both professional and citizen scientists at new scales
- Integrates gaming principles to explore alternative incentive structures for collaboration and knowledge sharing among scientists
- Targets specific geographic, ethnographic, and demographic niches likely to produce leaders in emerging disciplines

The project consists of three distinct but interrelated platforms. The first is the Signtific website—an online collaborative repository for *signals and forecasts* about key developments in science and technology. The second is a system for conducting workshops in geographic and ethnographic niches—creating *regional roadmaps* that use the signals and forecasts from the Signtific online site to seed the discussion and then integrating the results back into the repository. The third is Signtific Lab—a platform for rapid iteration of *extreme-scale thought experiments*, using gaming principles to drive a broad-based, bottom-up process of collaborative forecasting.

The Signtific development team has worked to integrate these distinct platforms to create a seamless web for acquiring, refining, and developing insights about the future of science and technology. In developing the Signtific Lab game platform, for example, we believe that we have created a powerful tool for rapid ideation and for effectively identifying so-called "long-tail" or "outlier" content that may have wide-ranging impacts for policy. This new methodology has been validated in four public thought experiments conducted in spring 2009, producing a total of more than 6000 micro-forecasts in less than 10 days total runtime. Not only were we able to achieve very high participation rates (with active contributions by more than half of the registered users), but the quality of the micro-forecasts was impressive.

This report updates our earlier report entitled *X2 Project: Year 1 Report* (SR-1203). In that report, we provided details of the evolution of the original X2 signals platform to the Signtific.org platform, as well as the development of our workshop process for regional science experts. (This process relies on an interactive online platform, known as Prezi, to create conceptual roadmaps of the future developments in science and technology.) In this report, we focus primarily on the development and testing of the Signtific Lab platform (*Chapter 1*), with brief updates on workshop (*Chapter 2*) and signaling (*Chapter 3*) activity in the final six months of the original project contract.

In the course of the contract period, the Signtific Project has made important progress toward developing new methodologies to engage the scientific community and the larger public in forecasting science and technology. But the project is just getting off the ground. With the basic infrastructure now in place, the project team can turn its attention to refining the processes for aggregating scientific discovery, engaging a broad-based global community in harvesting the most important insights from that discovery, and developing tools to make this information more accessible.

More important, Signtific has the potential to "superstruct" the rapidly evolving open-source scientific networks that are already changing the face of science. Superstruct is a word we use to describe processes that extend the potential of existing structures and bridge across them to build something that amplifies the contributions of everyone. We are at a critical juncture in the evolution of all our social institutions, and experiments like Signtific represent the nascent forms that will shape the world of tomorrow. The Signtific Project is thus far from complete. *Chapter 4* of this report describes the important next steps as we see them.

CHAPTER 1

THE SIGNTIFIC LAB PLATFORM FOR THOUGHT EXPERIMENTS

Over the past six months, the Signtific project has launched Signtific Lab, the project's game platform, and has run three trials of our initial thought experiment— "Free Space"—in three different locations: New Zealand (Auckland), Germany (Hanover), and San Jose, CA. In addition, we've run a single trial of a "Superstructed Reality" thought experiment.

In these tests, the Lab has been a success by every measure, generating a vast amount of high-quality content regarding the future of space and satellite technologies. Furthermore, the positive outcome of these games is not limited to our site metrics alone. Our strategy of engagement with new science and technology communities (beyond those already found at Signtific.org) has led to increased exposure of our work to a much broader global network of individuals.

SIGNTIFIC LAB METHODOLOGY: SHORT, SIMPLE, RAPID ITERATION

After participating in the design and execution of the IFTF Superstruct alternate reality game, the Signtific team recognized that the immersive environment created in the Superstruct scenario was too complex for a seamless integration with the Signtific.org signals platform. In designing Signtific Lab, the development team sought to create a system that facilitated rapid ideation around signals that exist in the Signtific signals/forecasts database. In this conception of the platform, the Signtific Lab runs a very lightweight, flexible version of Superstruct that lends itself nicely to many iterations of the same game, and games that are much shorter in length (2–3 days vs. 6 weeks). At the heart of the game experience are three key elements:

1 | A short introductory video scenario that provides the future context for gamelets that are called “thought experiments.” (Figure 1–1)

2 | A set of player “cards,” each of which is a Twitter-length micro-forecast (Figure 1–2)

3 | A scoring system, with a dashboard and special awards, to incentivize participants and filter for the best forecasts (Figure 1–3)

In this environment, a game is called a “thought experiment,” and each thought experiment proceeds in three important phases: design/development, execution/moderation, and analysis/reporting.

Designing and Developing a Thought Experiment: Building on the Signals from Signtific.org

The process for developing a thought experiment begins with analysis of the content generated on the signals platform and from workshops. Drawing on this content, the Signtific team crafts a plausible scenario of a specific future reality. The Signtific Lab, therefore, is a place to test and revise scenarios that are grounded in current-day signals and forecasts. As we mention on the site, “the Signtific Lab is a public laboratory for developing and sharing non-obvious ideas about the future of science and technology.” By design, the lab’s introductory text (see Appendix 1) is intended to create a set of fairly rigorous scientific facts that will guide the types of contributions added to the site. At the same time, the facts are broad enough to allow users to engage with the scenario without actually having to have scenario-specific knowledge.

Running and Moderating the Thought Experiment: Partnering for Scale and Focus

Once a scenario has been crafted, and after an introductory video has been created in order to prime users for the scenario, the Lab team is ready to run the scenario as a thought experiment. In partnership with organizations running conferences or other large gatherings of potential lab participants, the Lab team activates the lab’s website and allows users to contribute to the scenario for between 24 and 72 hours.

Thought experiments around a particular scenario are run multiple times in order to maximize the diversity of types and quality of user contributions. Aside from generating more ideas around a specific topic, there are many additional benefits to this approach. In running a

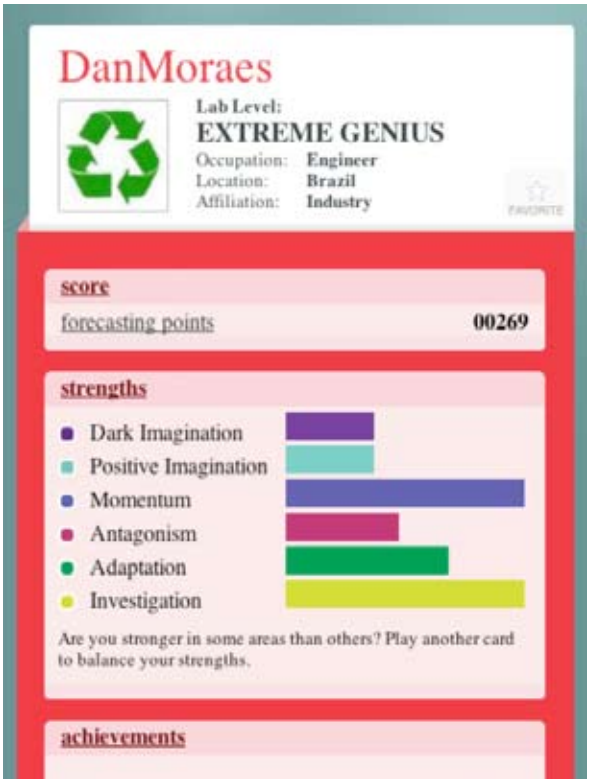
Figure 1–1
An introductory video describes a future scenario to set the stage for the thought experiment.

scenario more than once, the Signtific Lab team is able to refine the starting conditions for the game in order to provoke certain types of reactions and elicit certain kinds of ideas from players. In the Free Space trilogy, for example, the initial trial produced a large number of responses—or "cards" in the game's nomenclature—related to privacy and tracking of individuals via networked cubesats. Using this data set as the "normal" response set, the second trial refined the guiding text on the thought experiment's home page, and the accompanying fact's about the scenario (*see below*), in order to prompt users to play cards that were more "outlying."

A final crucial element of the thought experiments was the role played by the Signtific Lab's expert community guide. In order to ensure that content generated on the site remained within the bounds of plausible science fact, the lab invited Ariel Waldman, founder of Space Hack and an expert in the field of emerging DIY space technology, to serve as a community guide. In addition to lending credibility to the starting conditions for the thought experiment, Waldman was able to help the Signtific Lab team make more informed decisions while moderating the progress of the game; she helped determine what ideas were actual outliers and what ideas more closely resembled science fantasy. The team also created a separate blog (http://blog.signtific.org/lab/) that is used to update players on the progress of the game, highlight interesting ideas, and announce the award winners of the particular game (*see below*). It has proven to be a very effective communication tool.

Figure 1–2
Users play "cards" that contain micro-forecasts. The initial cards may be Positive Imagination or Dark Imagination forecasts. Players can build on any card by adding Momentum, Antagonism, Investigation, or Adaptation cards.

Figure 1–3
Individual scorecards are part of a dashboard that helps users track their performance and encourages them to contribute more content in categories.



Analyzing and Reporting Results of the Thought Experiment: Incentivizing with Dashboards and Rewards

The final step for this platform to succeed is to provide effective in-game analysis and post-game rewards. For in-game tools, we must strike a balance between making the existing ideas too easy to find and the inability to look at prior ideas. If it is too easy to find specific ideas or players, the game can devolve into a popularity contest; if it is too hard, players won't find cards to build their own ideas on. Thus, the in-game tools we've developed so far allow the players to observe each card as it is posted in a ticker-tape fashion on a live dashboard and also to search for ideas by keyword analysis (tag cloud). In addition, we provide a list of the top players on a Leader Board, and we recently added a new list of the top ideas, called Great Ideas, again to provide a means for the participants to quickly engage in the game.
See Figures 1.4–1.7.

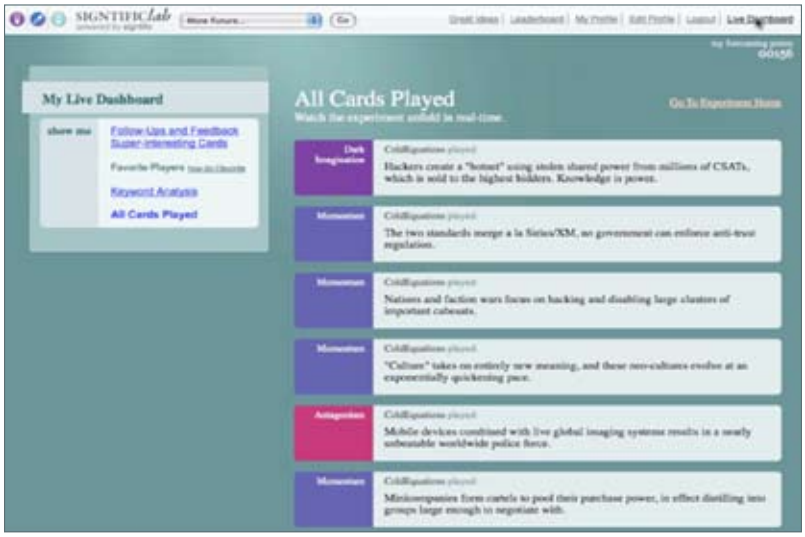


Figure 1.4
Screenshot of Signtific Lab Live Dashboard.

Figure 1.5
Screenshot of Signtific Lab Keyword Analysis.

In order to incentivize contributions to the experiment—as well as to help distinguish which players were the most engaged with the scenario and which ideas were the most interesting or thought-provoking for the experiment participants—our game design team instituted a number of scoring and achievement criteria for players to earn throughout the trials. (The full text of the scoring system is found in *Appendix 1*).

The lab's scoring system rewards users not only for specific ideas, which can be rated as a "lab favorite" by other users and "super-interesting" by lab guides. It also rewards players for how their ideas are developed by other players, with points earned as follow-up cards are played on their micro-forecasts. The benefits of this method of scoring are clear: users are recognized for their ability to push others to think and play cards, and the game ensures that

Figure 1–6
Screenshot of Signtific Leader Board.

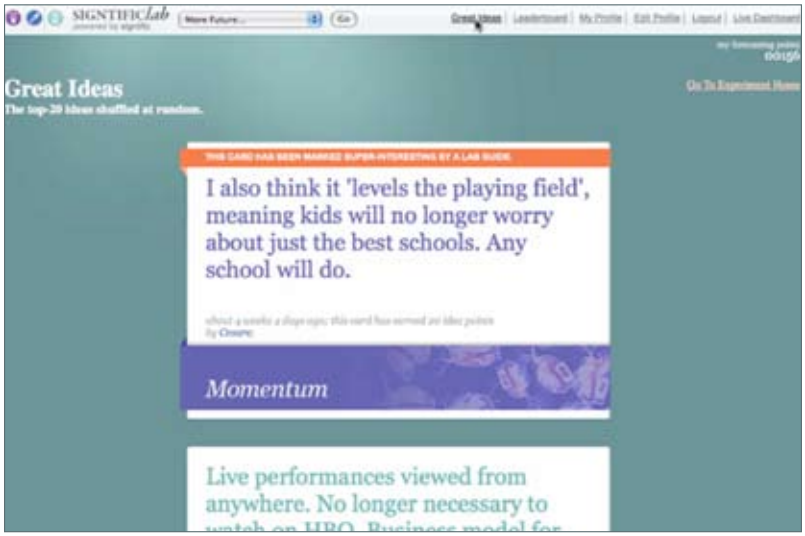


Figure 1–7
Screenshot of Signtific Great Ideas page.

the role of provoking and facilitating conversations is as important as the role of coming up with individually strong ideas. Table 1–1 shows the scoring system for earning points; Tables 1–2 and 1–3 show levels of achievement that are automatically scored. Table 1–4 lists the special awards conferred by the Lab guides.

THE FREE SPACE TRILOGY: THREE VERSIONS OF A THOUGHT EXPERIMENT

The first thought experiment that the team undertook was called "Free Space," which hypothesizes that space technology will soon be cheap and accessible to ordinary people, unleashing a stampede of bottom-up innovation. The idea for this thought experiment was triggered by a signal on cubesats—micro-satellites that individual scientists can use for running space experiments. A recent National Science Foundation (NSF) decision to fund cubesats suggests that we may be at a point where cubesats might radically alter the economics of space science and we can begin to anticipate DIY uses by amateur scientists. Signtific Lab challenged players to forecast the future of this technology by describing what they would do if they had access to a cubesat.

Table 1–1
How Players Earn Points

Player Action	Points Earned
Add any micro-forecast	2
Someone builds on player's micro-forecast	1
The chain reaction for a player micro-forecast reaches 10 forecasts	10 bonus points
A micro-forecast is selected as a "lab favorite" micro-forecast	0 bonus points

Table 1–2
Personal Achievement Levels

Player Level	Forecasting Points Required
Novice	0
Keen	5
Clever	10
Brilliant	20
Beyond brilliant	50
Luminous	100
Genius	175
Beyond genius	300

The First "Free Space" Trial: Webstock 2009, Wellington, New Zealand

The first of three "Free Space" trials was run at the Webstock conference in Wellington, New Zealand on February 13–19, 2009. The Webstock website described the event as follows:

> Webstock is a range of web-related events with the aim of improving how web-sites are built through inspiration, education, insightful analysis and practical application. It features industry leaders and kick-ass speakers talking on topics such as accessibility, web standards, usability and other best practices.

Table 1–3
"Winning" Achievements

High score	Most points earned in an experiment
Provocateur	Started the longest chain-reaction in an experiment
The Works	Contributed all five types of micro-forecasts in a single experiment
Trilogy	Completed three different experiments

Table 1–4
Honorary Achievements Awarded by Lab Guides

Ted Talk Award	Micro-forecast most worthy of an 18-minute elaboration
MacArthur Genius Award	Micro-forecast most worthy of five-year funding
Hawking Award	Micro-forecast wth the clearest sense of the very big picture
Feynman Award	Micro-forecast with the clearest sense of the very small picture
Ventner Award	Micro-forecast that makes the biggest paradigm shift
Heisenberg Award	The player who had the biggest impact on the conversation

This 2-day trial attracted 315 users, who produced 315 micro-forecasts. The lab guides selected the following cards for “special interest” awards:

itchy biscuit for a **Momentum Card**:

A hybrid of geo-caching and personal key cryptography emerges as a means of identity and location security

Comments from Lab Guides: Super-interesting! Especially interested in how this would be hacked and how often people would think to clear their personal caches. Helps us look further at defining our 3-D social web.

kiwi for a **Momentum Card**:

Crowd sourcing connects the open source laser shields together in a mutated mesh which surprisingly bounces free wifi around the world.

Comments from Lab Guides: This would make a tremendous impact if it happened! Demonstrates the power of the cubesat space collective with unprecedented and unpredictable results.

Pigs-in-space for a **Positive Imagination Card**:

When an area has too much pollution guidance systems send lockout signals disallowing vehicles in those areas until pollution levels reduce.

Comments from Lab Guides: This is an interesting balance of a government using technology to gain control over personal property and efficient automation of helping environmental issues.

Jeremy Arnold for a **Positive Imagination Card**:

Sat developers find a way to harvest energy from the wake of the magnetosphere, supplementing photovoltaic solar collection.

Comments from Lab Guides: This could be what bridges all fields of science and technology and pushes them to discover a new source of alternative energy. We think this would be an effort all countries could get behind.

thebruce for a **Positive Imagination Card**:

Artificial Intelligence is birthed, utilizing the entire cubesat network. Too powerful to manage, this literal “Skynet” becomes self aware.

Comments from Lab Guides: Fantastic! A forecast for how singularity might take form!

andyhkn for a **Positive Imagination Card**:

With a bio interface, we could have augmented memory and processing tools that could follow us anywhere.

Comments from Lab Guides: This exposes the conversation between man and machine, and man and the universe, and how the interconnectedness will interplay with real-time ground and space-based observations. Sounds like the mind will merely be a transporter for knowledge, sent to a more efficient and secure storage unit.

The honorary award winners were:

FEYNMAN AWARDS for micro-forecasts with the clearest sense of the very small picture went to:

- Buster McLeod for a **Dark Imagination Card**:
  Cubesat + Mac Mini (webcam and iPhoto's face recognition) = we find 1 million people that look vaguely like Osama bin Laden.
- jim-in-austin for a **Dark Imagination Card**:
  If, as suggested in the video, one can no longer be lost, does it follow that one can also no longer decline to be found?
- Adam Shand for a **Positive Imagination Card**:
  America moves its electoral college into space. You now elect the satellite for your beliefs and it's AI then votes on your behalf.

TED TALK AWARDS for micro-forecasts most worthy of an 18-minute elaboration went to:

- rtgarden for a **Momentum Card**:
  Youth develop altruistic movement to use wii cubesats to help bring elders into social sphere. Elderly nuerogenesis sought through gaming.
- jorgeguberte for a Dark **Imagination Card**:
  Psychotronic Surges, the 'evolution' of Psychotic Surges. Your mind becomes 'robotic', and it's hard to control it.

MACARTHUR GENIUS AWARDS for micro-forecasts most worthy of five-year funding went to:

- Deslivres for a **Positive Imagination Card**:
  People equipped with special implants can be used as "skinrides" by users from all over the world willing to live another person's life.
- physicsdavid for a **Positive Imagination Card**:
  Environmental isolation of each cubesat allows network of sats to become a large-scale quantum computer, using quantum crypto communication.

VENTNER AWARDS for micro-forecasts that make the biggest paradigm shift went to:

- Pigs-in-space for a **Positive Imagination Card**:
  Other people's failures are streamed to your cubesat which uses real-time pattern matching to identify if you will make the same mistake
- suzanne for a **Momentum Card**:
  Lifelogging replaced by "lifeleading," lives lived entirely by the wisdom of the crowd. Started as a stunt, becomes widespread.

Reflecting on the cards played in this trial, lab guide Ariel Waldman, produced the following forecast:

User-Generated Cubesats Improve/Deteriorate Mental Health

A theme around the idea of everyone having access to their own personal cubesat emerged today. From business to technology, the idea of having the final frontier at our fingertips helped fuel the players' forecasts to anticipate the advancement of other industries and issues. More interestingly, on the topic of health, there was a clear dichotomy between positive and dark imagination forecasts.

A common concern was how the pervasiveness of cubesats would affect our mental health, as seen in the following cards (or ideas) from Trial #1:

> **"Humans seeing the stars up close get a severe insignificance reality-check and cases of clinical depression/suicide escalate."**
>
> **"People loose their curiosity because information is so readily available."**

Some people today suggest that an emotional "mutation" has already emerged with the digital native culture from seeing yourself and others through a screen. As we communicate and consume more data everyday on the Internet, are we losing connections to the offline world as a result? If in the future cubesats become as common, will we risk losing touch with the Earth altogether?

Others think it will have a positive affect on our mental health:

> **"Being able to look down on ourselves simultaneously as individuals & as part of a whole makes us all nicer people."**
>
> **"Social consciences are pricked by seeing the consequences of actions; can also see direct impact of interventions (e.g. aid)."**

From thinking about how cubesats will affect the planet and Low Earth Orbit, to thinking about how they will affect us as human beings, the forecasts so far have been very insightful as to what consequences we need to think about as a culture as we continue to progress forward in space exploration.

The Second "Free Space" Trial: CeBIT Trendforum 2009, Hannover, Germany

A second trial of the "Free Space" thought experiment was conducted at the CeBIT trade fair in Hannover, Germany, on March 3–4, 2009. The CeBIT website described the trade fair on its website:

> CeBIT is the world's largest trade fair showcasing digital IT and telecommunications solutions for home and work environments. The key target groups are users from industry, the wholesale/retail sector, skilled trades, banks, the services sector, government agencies, science and all users passionate about technology.

In response to the types of cards played and questions produced during Trial 1, the Signtific Lab team developed additional technical specifications for the second trial. (*See Appendix 1*.) The team also focused the players on their real-life, present-day knowledge by asking them to imagine the following:

- The specific job you have today in a world of free space
- The company you work for in a world of free space
- The building you live in today in a world of free space
- What you were doing yesterday at 7:30 PM … in a world of free space

This trial engaged approximately 100 players and produced 875 cards. Here the lab guides focused on identifying the following *outlier* micro-forecasts:

- A necklace of cubesats are tethered and strung above the equator to provide navigation and absolute positioning to all other sats
- Hostile telecommunications corporations buy all of the iSat launching slots to prevent competition.
- Major textbook companies will be early adopters, launching fields of cubesats to rent with curriculum packets.
- Sat backdoors and tracing tools give anti-terror efforts unprecedented access to terrorist strategy, operations, and activity.
- Disruption of the magnetosphere and ionic pooling from solar wind results in a constant aurora. It never gets darker than dusk on Earth.
- Moon-landing vehicles are paid mega-bucks to launch iSats from the moon to orbit around the lunar surface.
- SETI enhance is SETI@home program to let people use Cubesats as clustered radio telescope. It becomes the largest space analyser ever made.

- Much is made of the difference in psychology between the “Earthpointers” and the “Stargazers” (referring to personal sat POV)
- Clusters of satellites create sat-wikis aggregating not only your information at home, but anyone’s satellite you deem relevant.
- Heavy computing is sent to solar powered cubesats which regulate their own temperature for processing reducing power consumption on earth
- Cubesats are used to regulate the planet’s weather system, cooling the equator, heating poles. Everywhere becomes temperate, all year-round.
- Grabbing Sat-TV (HDTV) signals in the USA and leading it via grid-Sats to Europe, where you don’t have direct line of sight access.
- With tethering and advances in PV tech, solar energy collection becomes more efficient with the ability to create huge reflecting arrays
- A peer2peer voice-over-iSAT network distributes 140 second messages and does for phonecalls what text messages did for emails
- The prevalence of data systems incorporating new feeds every 90 minutes leads to a new “time metric” dividing each day into 18 “cubes”
- A “One Cubesat Per Child” program is started. Theoretical price of cubesat drops to ten dollars.
- Massive “Human Data Repositories” are created to store lifecasts and act as archives and memorials to humans and the human race.
- Many IT jobs begin offering “cubesat dozens,” a 12 minute break every 90 minutes to allow staff to check their cubesat feeds
- With tethering and advances in PV tech, solar energy collection becomes more efficient with the ability to create huge reflecting arrays
- A sentience arises from the unification of human neurology that projects itself into contingent universes and explores unimagined domains.
- A constellation of mini-cryogenic genetic archives, waiting out the collapse, & opting out of the ecosystem until further notice.

The Third "Free Space" Trial: ETech 2009, San Jose, California

The third trial of the "Free Space" thought experiment was conducted at O'Reilly's ETech conference, March 9-10 in San Jose, California on March 9–10, 2009. The ETech web site described the conference as follows:

> ETech, the O'Reilly Emerging Technology Conference, is O'Reilly Media's flagship "O'Reilly Radar" event. ETech gathers together the world's most interesting people to bring to light the important and disruptive innovations that we see on the horizon, rather than the ones that have already arrived. ETech hones in on what's going to be making a difference not this year, or maybe even next year, but around the corner as the market digests the next wave of hacker-led surprises.

After running the first two trials for this scenario, the team wanted to push the participant community to come up with truly "outlying" ideas. A series of scenario modifications were designed to prompt players to avoid playing "mainstream" cards. In addition, players were given an "Outlier Challenge." (*See Appendix 1*.)

The result of this trial was 1700 micro-forecasts from 200 players. It's worth noting that, in this trial, the positive imagination cards outweighted the dark imagination cards by a 2:1 ratio, and the type of card played most often was a momentum card, with a total of 870 of these cards. Finally, there were 450 antagonism cards played, 350 investigation cards played, and 200 adaptation cards played, indicating a substantially high amount of "second level" content. Here is a sampling of some of the most compelling outlier cards:

- Reusable cubesats provide cheap and easy zero-G protein synthesis for personalised genetic medicines.
- Geosensing of viral outbreaks months before they begin to spread.
- Point to point laser communication relay network. Communication that cannot be intercepted, anywhere on earth.
- Increased coverage via aperture synthesis w/ multiple collective cubesats allow us to find a new place to live via optical interferometry.
- Ultrasound-modulated audio imaging allows precision follow-me music services -- ipod w/out the earbuds; shared tunes w/o the ghetto blaster.
- I define data sets to be acquired by cubesat(s), peer links w/ other cubesats. Data xmitted to Earth in RT; servers crunch & feed 2 me.
- Cubesat Neural Networks are developed. Larger Satellite "organisms" are developed with specific functions assigned to each tethered piece.
- 3D display technology, paired with free-fall wind tunnels and cubesat feeds, create the ultimate outerspace simulation.

- Public transit fails to massive hitch-hiking network. You state your destination, a bid, and how safe your driver's rep is & wait for match.
- Any group can build their own constellation of LEO commsats (like Iridium) for less than $10K -- private secure mobile networks for all.
- The existence of expensive add-ons allows wealthy users to donate large amounts of bandwidth back to the community.
- Massive increase in value in image ID and searchability drives accessibility of desired images commensurate with text today.
- Add ons like infra-red, sonograms & X-ray technology are used by ocean watchers to chart species movements, tidal patterns, algae growth etc
- Locations of people can be quickly determined by triangulating your data stream from repeater towers. More data = more precision.
- Farmers contribute their data to a global network for a fee, helping scientists to understand environment. Farmers now farming data->profit.
- Cubesats sharing a single orbit can reach out and connect to each other to form a dyson ring.
- Yes! Could use remote sensing to create a "heatmap" of forests to show how much CO2 is captured and which areas are "highest value"
- foodshed mapping generates consistent ideas of how to create cradle 2 cradle cities with agricultural independence. Cities rise again anew
- children create a system of microcredit that uses pastoral animals and livestock as currency. text messages create donation system and care
- Trompe-l'oeil landscapes & architecture include new materials to fuzz IR/visible/radio output - civilian stealth tech.
- Cubesats will cause major occupational shifts - enforcement officers turning space pilots, reporters- knowledge managers, homeless- mentors
- Space elevators would permit easy implementation of a space-based tether, which would generate electricity without fossil fuels.
- An intelligent, responsive network of cubesats finds the right incentive structure for individuals - they customize 'gaming for progress'
- These algorithms might migrate back to computers on earth, enabling the science of incentivisation to develop further outside of gaming
- Accurate 3d world model synthesized from 2d images + elevation data, becomes baseworld for a new MMOG, MirrorWorld.
- Skyhooks used to anchor shield against solar radiation and deter greenhouse effect whilst terraforming undertaken.
- Alternative, universal internet currency evolves, outside any government's central bank control.

- cubesats self-form phased array RF or optical systems to monitor environment, micro-target wireless signals, laser ablation power to probes
- Csats access to the diseasome & genome allows for instant prototyping, matching & deployment of the closest available doctor, donor & center
- cubeSat net + global sensor net + tree replacement models -> tree futures market enabling us to deforest at rate < Earth's replacement rate
- OLPC and cubesat will allow kids to collectively vote for future laws, bills, & policies. Voting results will be factored into real policy
- People apply for citizenship within the cubesat network, claiming where their data lives is their actual residence.

From this trial, our lab guide Ariel Waldman created three forecasts, as follows:

1 | Distributed Cubesat-ing

Similar to distributed computing projects like SETI@home, forecasts are brainstorming ways in which cubesats could work together for the greater (and more capable) good.

Players sporkthrower and ubik forecasted this trend:

> **specialised cubesat units self assemble into larger collaborating units, forming an ecosystem or colony with greater functionality.**
>
> **A new ecosystem arises around cubesats: tools for collaborative data collection & analysis; new sensors & effectors; cubesat management...**

Pronoia played a momentum card off of this trend:

> **Super advanced cubesat mgmt promotes a new space culture to emerge where massive co-creation and instant collaboration are the rule.**

While ka.johannson and rtgarden pushed the forecasts one step further by imagining what specific applications could be utilized with the power of distributed and collaborative cubesat-ing:

> **Co-dependent satellites with each focusing on their speciality. Dedicated sats for earth comms, asteroid detection, proximity etc.**
>
> **SATSETI deploy large netforce to monitor acidic plumes in natural water bodies. International science imaging effort begins.**

Unlike the SETI@home project that uses more power to search for the unknown, these forecasts are using the increased power to help augment already established data consumption on a more accurate and reliable level.

These two positive imaginations also share the concern for protecting and understanding the Earth more, which reflects a growing issue on the minds of many today. Just last month, the space community suffered a loss with the failure of **NASA's Orbiting Carbon Observatory satellite**, which was set to "make precise, time-dependent global measurements of atmospheric carbon dioxide (CO2)." After **eight years of development** to launch the OCO, we can only hope that the continuous efforts to collaborate and use the power of many can help speed up the process of rebuilding such significant technologies and scientific data.

2 | Space exploration takes us back home

In my last forecast, I touched on how collaborative cubesats can use their combined power to achieve greater goods, citing a better understanding of our Earth as an example.

In this forecast, I want to dive into forecasts that explore this topic further. History points to how an overwhelming amount of new knowledge can benefit our society's future:

> **Cubesats create massive citizen engagement in scientific inquiry, inspire truly global thinking & foment a renaissance in cultural progress.**

I found the concept of space exploration leading us back to understanding ourselves to be intriguing. This thought process isn't solely about critical thinking—participatory exploration is all about **actively** getting involved. Players brainstormed ways in which the cubesats could not only further our knowledge, but take action to protect our home planet:

> **Each cubesat is equipped with a deployable mylar mirror which can decrease solar flux, and slow global warming**
>
> **Cubesats unfold into large reflective membranes, aggregate into reflector arrays to steer solar energy, enable programmable climate systems.**
>
> **Holds equipment that can be used for cloud-seeding: great for high drought areas- not so great for neighboring villages who will be deprived**

Of course, other forecasts think that it might not all be sunshine and rainbows:

> **The profusion of satellites is such that it occludes the sun, causing a new ice age**

The balance between large arrays of cubesats reflecting sunlight to protect us versus blocking out the sun to destroy us is interesting. A few months ago **on the Discovery Channel, Roger Angel explored actually building a prototype of this concept**. The **results of the prototype** were reported as a letdown. While critics say geoengineering is a waste of time in the fight to protect our planet, I would argue that limiting any imaginations to save life risks the possibility of not creating the one (or many) "ridiculous" execution that does work.

3 | Large, small, and complex

In his short, brilliant book *Our Cosmic Century*, astronomer and Royal Society president Sir Martin Rees argues that in the 21st century, science will concern itself with three things: the very large, the very small, and the very complex. Rees' summary has always impressed me for its elegance; and so I'm impressed to see that players in the latest round of the Free Space game have discovered these three applications themselves.

At the level of the very small, there are two cards by sbisson and iHuckDisc, on using cubesats to develop customized medicines in microgravity:

> **Reusable cubesats provide cheap and easy zero-G protein synthesis for personalised genetic medicines.**
>
> **Weak molecular forces can come more into play in microgravity, allowing more specific protein orientation and fitting.**

In the realm of the very large, ap0phenia and corntoole explore the possibilities created by having swarms of cubesats, sometimes thousands of miles apart, work together:

> **Network forms super telescope used to collect data on dark matter, microscopic black holes. Revolutionise current day theories of physics.**

> **cubeSAT net form cheap laser interferometers to detect gravitational waves and confirm Einstein's prediction.**

Finally, in the realm of the very complex, corntoole suggests:

> **cubeSat net + global sensor net + tree replacement models -> tree futures market enabling us to deforest at rate < Earth's replacement rate.**

Analyzing the cards for themes, the team identified 10 top themes from this trial:

1 | The start of Earth watching

ETech players were very interested in using cubesats to better understand our global ecology.

> **"csats deorbited in vacant areas of oceans as impulse input to passive sonar imaging. Oceanographers get great maps, submarines lose stealth."**

> **"cubesat net + global sensor net + tree replacement models -> tree futures market enabling us to deforest at rate < Earth's replacement rate."**

> **"precise harvest data is centrally processed by inter-gov food distribution centre. Food is globalyl distributed based on nutritional needs."**

2 | The start of eco currency

We also saw the start of ecologically backed currencies, that is, the idea of backing our national currencies with the value of our national ecologies.

> **"Could use remote sensing to create a 'heatmap' of forests to show how much CO2 is captured and which areas a 'highest value.'"**

> **"provides real-time data for exchange rates on new ecologically backed currencies (aka Costa Rica's)."**

3 | The start of solar prosperity

Players forecasted a future in which personal wealth was linked to a universal currency. Solar energy drawn collected by personal cubesats would become a fixed source of income for even the poorest individuals.

> **"everyone is given a solar paneled cubesat, which collects energy for their universal savings account from their universal energy account."**

> **"All people now have a basic recurring energy income of $1/day, in the ultimate tax-haven. This doubles the income of the world's poorest."**

4 | The start of space medicine

ETech players re-envisioned Cubesats as small, zero-g laboratories in which experiments could be run in ways not possible under earth conditions.

> **"Reusable cubesats provide cheap and easy zero-G protein synthesis for personalised genetic medicines."**

> **"weak molecular forces can come more into play in microgravity, allowing more specific protein orientation and fitting."**

5 | The start of space sourcing

Building on the successes of crowdsourcing of problems, space was imagined to be the next frontier for collaboration and employment. The affordances of networks of cubesats would be used to create a new economy akin to the rise of the Internet in the 1990s.

> **"Cubesats will cause major occupational shifts - enforcement officers turning space pilots, reporters - knowledge managers, homeless - mentors."**
>
> **"Planetary sourcing moves from research labs to private ventures, space sourcing turns mainstream, unemployment vanishes, 7 day weekend nears."**

6 | The start of cloud financing

Building on the idea of a new satellite-based economic system, new types of transactions and business models were seen to be developing to become intricately linked to Earth-bound activities.

> **"The world in 2019 is dependent on POS in the cloud. iSat is being mandated- World Economic Commission for transactions >10WD - World Dollars."**
>
> **"The World bank reports that 90% of all WorldDollars originated in the cloud and is expecting that number to by 98% by 2021."**

7| The start of a privacy industry

The development of continuous and ubiquitous surveillance was seen to be an inevitability by ETech participants. More interesting, however, was the idea that a significant portion of industry in the future would be geared toward protecting individuals' privacy.

> **"Privacy hacktivists develop countermeasures including smog generators, reflective mylar dust, laser Csat blinders, and planting more trees."**

8 | The start of lightweight geo-engineering

ETech participants anticipated a great deal of overlap between cubesats in space and terrestrial occurrences; cubesats were seen as potential delivery mechanisms for effecting change in, for example, drought-stricken regions and the melting ice caps.

> **"Can we create Glaciers by transferring space coolant to glacial regions."**
>
> **"I can dispense silver iodide anywhere in the world at a command from my phone, seeding clouds at a whim. I am burned as a witch."**
>
> **"Holds equipment that can be used for cloud-seeding: great for high drought areas - not so great for neigboring villages that will be deprived."**
>
> **"rainwitch.com is a new service that mediates citizen cloud-seeding, smoothing out the inevitable overshoot/ringing of an open loop system."**

9 | The start of space crime

Participants also foresaw the development of a new frontier in fighting terrorism and other domestic security threats, and anticipated some novel ways that cubesats might be used by the criminal elements of society.

> **"distributed global delivery of biological weapons. It is not what we put in space, but where what we put in space can be distributed."**
>
> **"CSATS become a method for criminals to dispose of evidence since it's outside the jurisdiction of any country."**
>
> **"terrorist creates CSAT mounted IED + mini thrusters. USe imagery to locate vital structure 4 low cost, high damage destruction from above."**

> **"If CSats have chemical thrusters, probably more opportunity for mischief during launch when a raft of CSats are aggregated?"**

10 | The start of a space renaissance

Finally, and perhaps most significantly, cubesats were seen as harbingers of a new age of human engagement not just with space, but with the new cultural, social, and scientific possibilities afforded by the democratization of space.

> **"Cubesats create massive citizen engagement in scientific inquiry, inspire truly global thinking & foment a renaissance in cultural progress."**

As in previous trials, the lab guides gave out honorary awards.

TED TALK AWARDS for micro-forecasts that are most worthy of an 18-minute elaboration went to:

PattyRyan for a **Positive Imagination card**:

> Massive increase in value in image ID and searchability drives accessibility of desired images commensurate with text today

ninaksimon for a **Momentum card**:

> Yes! Could use remote sensing to create a "heatmap" of forests to show how much CO2 is captured and which areas are "highest value"

ninaksimon for a **Momentum card**:

> Yes! Could use remote sensing to create a "heatmap" of forests to show how much CO2 is captured and which areas are "highest value"

kxlsyd for a **Positive Imagination card**:

> Everyone is given a solar paneled cubesat, which collects energy for their universal savings account from their universal energy account.

june for a **Momentum card**:

> Add ons like infra-red, sonograms & X-ray technology are used by ocean watchers to chart species movements, tidal patterns, algae growth etc

---

A **HAWKING WARD** for micro-forecasts with the clearest sense fo the bery big picture went to:

ka.johansson received a **HAWKING AWARD** for their **Positive Imagination card**:

> Cubesats sharing a single orbit can reach out and connect to each other to form a dyson ring.

VENTNER AWARDS for micro-forecasts that make the biggest paradigm shift went to:

sporkthrower for a **Positive Imagination** and a **Momentum card**:

> Biologically embedded sensors can use a sat to instantly alert 911/EMS of a medical emergency
>
> mass production of lenses and mirrors with very little spherical aberration allows for advances in optics applications

Pronoia for a **Positive Imagination card**:

> Cubesats will cause major occupational shifts - enforcement officers turning space pilots, reporters- knowledge managers, homeless- mentors

A **FEYNMAN AWARD** for micro-forecasts with the clearest sense of the very small picture went to:

wdonohue for two **Momentum cards**:

> Sublet sensor and processor resources to researchers - flocks of common interest sats can rent out as gestalt labs for short-term projects.
>
> Trompe-l'oeil landscapes & architecture include new materials to fuzz IR/visible/radio output–civilian stealth tech.

Superstructed Reality: A Fourth Trial

The Signtific Lab team conducted one additional thought experiment as part of IFTF's annual Ten-Year Forecast Conference in April 2009. This was a public experiment that ran for 24 hours, and leveraged the networks of attendees, who were mainly strategic leaders of large corporate and government organizations. The focus of the experiment was the future of "Superstructed Realities"—"where life is a customized blend of the physical and digital worlds you want to live in"—leveraging geolocation, simulation, augmented reality, lifecasting, biometrics, and more.

As with the "Free Space" thought experiments, the team developed an introductory video that set the conditions for the experiment as follows:

> In 2019, we live in a Superstructed Reality.
>
> Sensors and user-generated data streams feed us real-time information about our bodies, our environments, our resources, and our communities. Meanwhile, virtual spaces let us rehearse and plan our lives, practicing interactions and testing ideas. Continuous feedback loops between "real" and "virtual" worlds make it possible to learn more—for better and for worse—about who we are, what we're doing, and what we might be capable of.
>
> The Better World Awards celebrate the best uses of blended reality technologies. In 2019, three contenders face off for the Grand Prix trophy, honoring the product, service, or network that best blends the real and the virtual to serve the common good. The nominees are:

Supermodel: Make better decisions in life and at work by creating simulations based on your unique personal circumstances. Powered by cloud supercomputing, Supermodel comes with more than 1,000 customizable templates for business, education, and other major life choices.

Ecophoria: See your local natural environment without buildings, people, and other modern artifacts. This augmented reality service strips away the visual noise of everyday life. Discover real hidden streams, plants and wildlife, and find out how close to nature you really are.

The PowerWorld mod for *World of Starcraft*: The less power you use in real life, the more powerful your WoS avatar becomes. Your strengths and superpowers in the game are inversely related to your personal electrical power consumption at home, and shared power consumption in public spaces. Power down in your real life to power up in the virtual world!

PROMPT: In 2020, what would your organization submit as its entry for the Better World grand prix trophy?

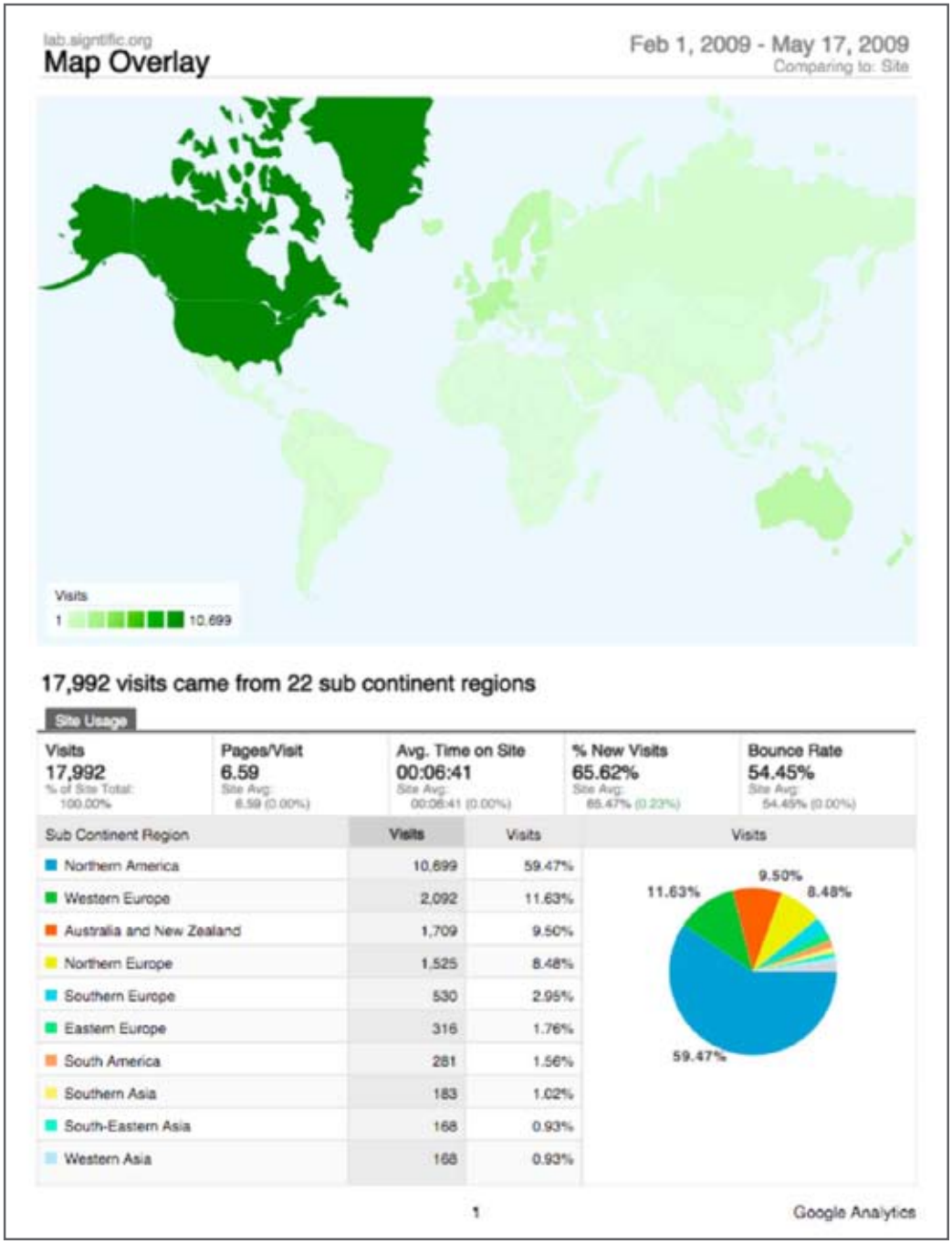
This thought experiment produced more than 3500 micro-forecasts, with top clusters of forecasts coming from the United States, Finland, Macedonia, United Kingdom, Canada, Chile, Italy, and France. A few of the top micro-forecasts are representative of the themes that emerged in this trial:

- Your decision-making ability is affected by which help guides you buy. Those who can only afford cheap help guides make bad decisions.
- The start of a decision-making gap? Are there growing pockets of decision-making disability, like asthma, diabetes?
- We realize how utterly, drastically different each mind really is. Translating between raw data [is] almost impossible; new m2m vocabulary [is] born.
- Mind privacy isn't a big concern for youth. Parents worry about how open teens are with m2m tech (like social networks a decade ago),
- American teens form a union to protect their rights after 1000s of parents surreptitiously install vid monitors behind their eyes.
- People will learn how to produce 3D video, viewable in precise location, outdoors in the real world.

SIGNTIFIC LAB SUMMARY STATISTICS: A MAP OF SITE VISITS FOR THE FREE SPACE TRILOGY

In the period from February 1, 2009 to March 31, 2009, the Signtific Lab thought experiments (which lasted only a few days each) drew more site visits (17,992) than the Signtific signals site (14,824) from November 1, 2008 to March 31 2009. These statistics point to the efficacy of the Signtific Lab model in attracting participation. In addition, more Lab visitors came from locations outside North America (40.6% compared to 37.4%). The site use statistics for the Lab are summarized in Figure 1–8.

Figure 1–8
Site usage statistics collected automatically for the Signtific Lab website, November 1, 2008–March 31, 2009.



NEXT STEPS FOR SIGNTIFIC LAB: ENGAGING AND INTEGRATING

Signtific Lab has demonstrated an effective model for engaging a global public in forecasting possible scientific, technological, and social innovations and disruptions that could proceed from today's cutting-edge science and technology. It is a robust, easily customized platform for conducting thought experiments across many different domains and in many different geographic and cultural settings.

An obvious next step for Signtific Lab is thus to begin to use it with specific niche audiences that are likely to have specific scientific expertise or distinctive cultural perspectives. In particular, the growing number of open-source science networks in fields as diverse as astronomy and ecology, health sciences and agriculture create opportunities for Signtific Lab to go deep into these niches and also to "superstruct" across them—to bridge and build upon them to aggregate their perspectives and create a more nuanced vision of the future.

In addition, there remain some design and technological issues, including:

- Streamlining the process for setting up new thought experiments.
- Capturing the content of a thought experiment automatically and integrating it into the Signtific.org platform (in particular, sets of chain reactions that represent areas of high interest).
- Developing analytics that can automatically sort forecasts and track chain reactions by geography and age of participant.

These next steps set the direction for the project overall. *See Chapter 4*.

CHAPTER 2

THE SIGNTIFIC WORKSHOPS: THE CHINESE SCIENTISTS WORKSHOP

Face-to-face workshops have been a key part of the Signtific platform since its inception. The workshops allow the project team to engage geographic, demographic, and ethnographic niches in the Signtific processes and drive participation to the online site.

The *Year 1 Report* summarizes the workshops that were conducted through October 2008. Since then, the team has convened one additional workshop with Chinese and ethnic Chinese scientists, doctors, and entrepreneurs working in the San Francisco Bay Area.

THE PARTICIPANTS: U.S. AND CHINA-BORN EXPERTS

These experts included medical doctors at University of California, San Francisco, Chinese-American venture capitalists dividing their time between the United States and China, and Chinese-born entrepreneurs building global companies.

Chunhua Ding | President, Association of Chinese Students & Scholars

Dongxiao Feng | Assistant Professor, UCSF

Ho John Lee | Entrepreneur and Consultant

Dr. Steve Lin | Executive Director, Silicon Valley Science & Technology Association

Po Chi Wu | VC and Professor, Beijing University

Baoxue Yang | Assistant Professor, UCSF

Larry Zhang | Senior Enginee, Cisco Systems

Michael Zhao | CEO, Array Networks

THE ROADMAP: FIVE ISSUES ON THE HORIZON

The participants spent the day building a roadmap of major issues and trends affecting the future of science and technology (S&T) in China, identifying five main issues:

1 | Rural/urban education disparities and the future talent pool for S&T

A generation or two ago, a substantial number of engineering students—including a substantial number who became senior Party members and technocrats—came from the countryside; however, because of declining funding for schools and greater competition for university education, rural kids are now losing out big-time to the growing urban middle class kids. Workshop experts worried that there'll be a "lost generation" of scientific and technical talent left in the countryside. When combined with an aging population, this will turn an already-bad shortage of technical talent into a severe problem. By closing off educational and economic opportunities, it will also raise the likelihood of social tensions, riots, and other problems.

2 | Health-driven innovation

Workshop participants saw significant opportunities for bio-IT and service innovation driven by health. The demand for medical care is going to skyrocket in the next couple decades, thanks to an aging population, growing middle class, rising health awareness, and growing use of science-based medical services (and the scientific investigation of the foundations of traditional medicine). All this, combined with the rollout of a national health ID system and growing foreign investment, will drive increased domestic research for life science, and in particular, the growth of lower-cost medical technologies, pharmaceuticals, and service delivery.

3 | New intellectual property strategies

The era of Chinese companies benefitting from loose intellectual property rules and enforcement are drawing to a close. As they move up the value chain, Chinese technology companies are starting to complain more about losing protection for their own intellectual property (IP) (though often to other Chinese companies rather than foreign competitors). There's also a greater awareness that within the legal community, Chinese patent writing and portfolio management skills are far behind Japan, Europe, or the United States. This creates problems for companies that have or want an international presence, and in particular for companies that want to build up portfolios of "triadic" patents—i.e., patents simultaneously registered in Japan, the European Union and United States. It's not clear that native Chinese law firms are going to develop the necessary skills.

4 | Mobility-friendly science careers

Foreign-trained and globally-networked Chinese scientists are being recruited back to China with the promise of rapid opportunities for professional advancement. (Some are foreign-born or Chinese foreign-trained scientists, for whom China constitutes a "new frontier" or opportunity; others have Ph.D.s or M.D.s from Chinese universities, and have difficulty building careers outside of China.) Currently they're under terrific pressure to raise the global status of Chinese science, but as a group, they will eventually challenge the scientific establishment to create more flexible career and institutional structures to accommodate mobile talent. Some of the pressure will come from accomplished Sea Turtles who, having done well in China and on the global stage, are recruited by other countries and can use their leverage to extract changes in Chinese science policy; some will come from scientists who have spouses and children who were born (or still live) in other countries.

5 | Large-scale energy and water infrastructures

Developing energy and clean water sources will be national priorities for the S&T community in China (as in every country we've conducted workshops in). However, given that water and energy shortages can affect tens of millions of people at once, our experts thought that Chinese scientists and engineers would spend more effort on large-scale, massive infrastructure projects than on small-scale conservation or neighborhood alternative energy.

Figure 2–1 shows a view of the Prezi roadmap that resulted from the workshop. The entire map can be viewed at **http://prezi.com/68036/view/**.

Figure 2–1
The Future of Science in China Roadmap

CHAPTER 3

THE SIGNTIFIC.ORG SIGNALS DATABASE

In Fall 2008, Signtific.org was relaunched with a new visual design, a customized feature set, and a focus on community engagement. (The details can be found in the *Year 1 Report*. Since then, the number of registered users on the site has increased drmatically, as has the number of signals on the platform. At the same time, during the redesign we learned a great deal about what makes a "strong" signal, and about why individuals contribute signals to Signtific, and we look forward to further refining the site in order to better reflect this knowledge.

SUMMARY STATISTICS: NOVEMBER 2008-APRIL 2009

Current contributions to the Signtific website are made to one of the following two categories:

Signals: A signal is a short entry that describes a significant change, indicates emerging issues, or hints at future disruptions in science and technology. A signal comprises: a descriptive concise title, a list of tags (keywords), a summary of the change, a summary of the larger impact the change will have, and some sources that the signal draws on.

Forecasts: A forecast combines a set of signals to identify a key trend, disruption, opportunity, or shift in the competitive landscape.

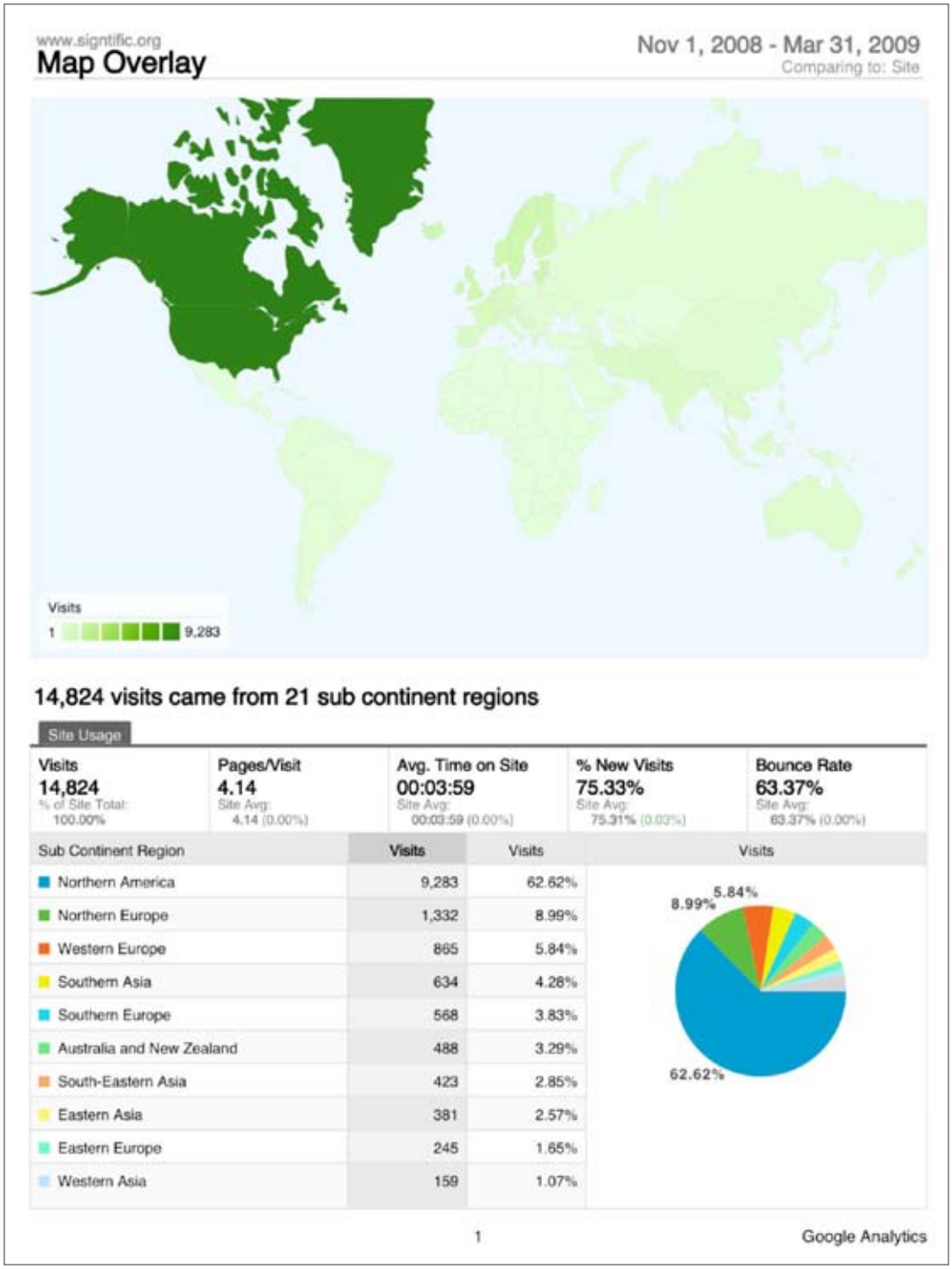
Table 3–1 compares the total number of signals and forecasts created by users in the Signtific database at the time of the *Year 1 Report* (October 2008), and at the end of the contract period for Signtific (April 2009).

Table 3–1
Total number of signals October 2008 and April 2009

Date	Signals	Forecasts
October 9, 2008	697	262
April 30, 2009	1209	285

At the time of the *Year 1 Report*, Signtific.org had approximately 735 registered users. As of April 30, 2009, the site had approximately 1140 users. Figure 3–1 shows more detailed statistics regarding the site users. These numbers are derived from site traffic statistics.

Figure 3–1
Summary Statistics for Signtific.org. November 1, 2008 to March 31, 2009



LEVELS OF ENGAGEMENT: TWO FRAMEWORKS

For the work of the Signtific project—which seeks to engage the global community in anticipating the most important disruptions and innovations in science and technology—it is necessary to understand the dynamics of engagement and, in particular, to create opportunities for the community to engage at all levels.

These levels are often described as a ladder of contribution, as shown in Figure 3–2 (from Forrester).

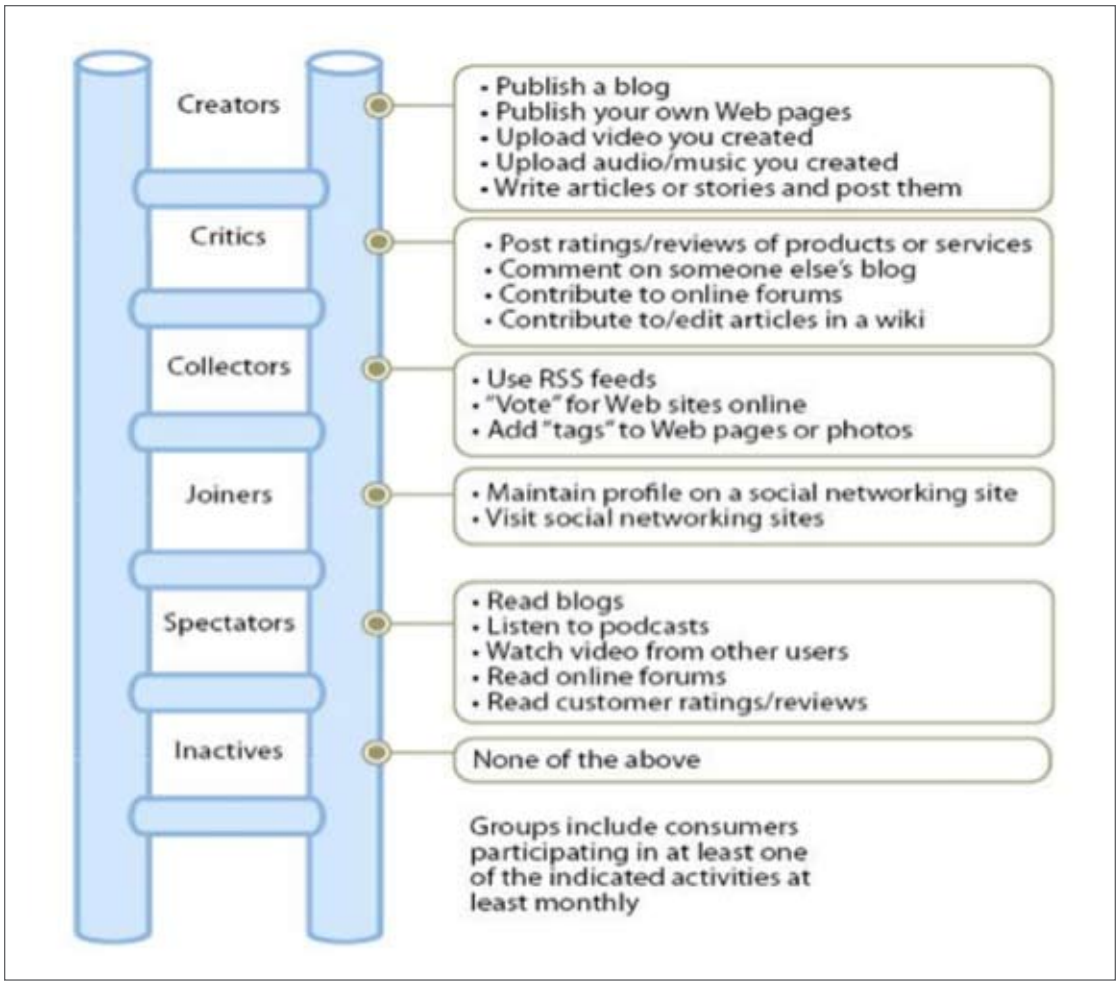


Figure 3–2
Forrester's Ladder of Contribution

Sometimes engagement levels are also depicted as a pyramid of engagement, as shown in Figure 3–3 (from the Altimeter Group).

Both these frameworks describe the various levels in which we can work to achieve participation. Too often in social networks, organizations focus on the very top (or highest) level of contribution. And because these kinds of contributors represent a small % of the overall community, many social networks are deemed failures because the majority of participants did not edit a Wiki, publish a blog, or write an article. But there are also valuable contributions as you move down the ladder (or pyramid).

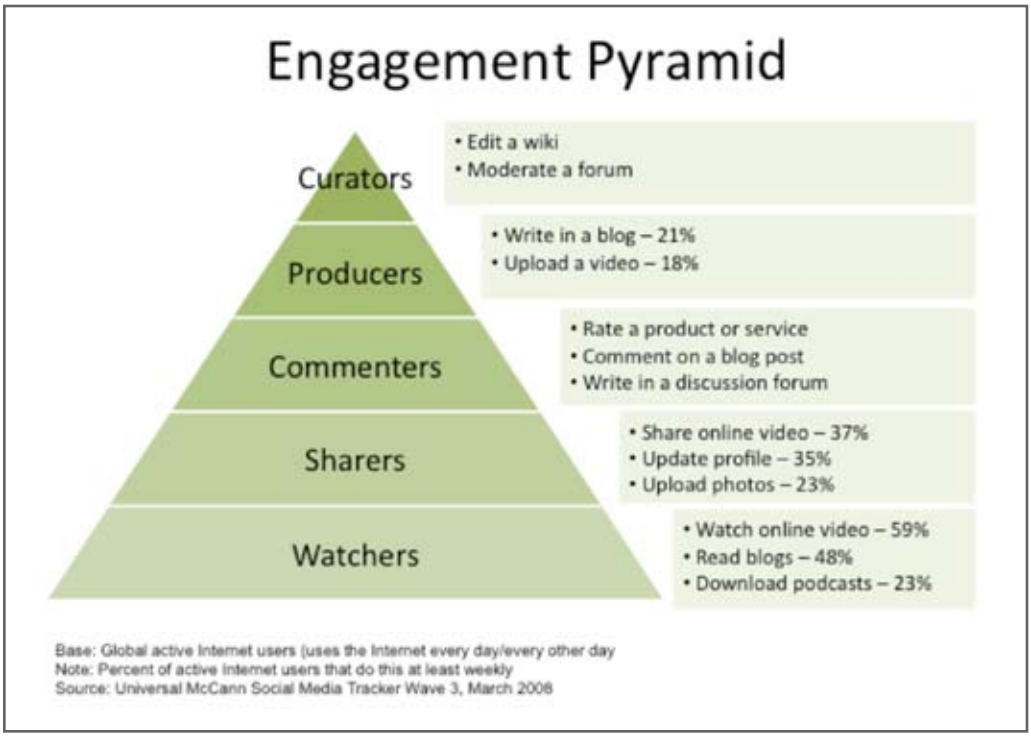


Figure 3–3
The Altimeter Group's Pyramid of Engagement

The Signtific Pyramid: From Reading to Signaling

In the development of both Signtific.org and the Signtific Lab, we have worked to create the opportunity for a broad community of users to participate at all levels. In doing so, we have explicitly defined our own pyramid of engagement for Signtific.org, shown in Figure 3–4.

Signtific.org is the project's persistent sensing platform that is available for anyone to contribute on a continuous basis. On Signtific.org we start with providing the community interesting content to read. Once they see something of interest, they can do several basic functions: rate, add tags, and share (externally). If they are more keenly interested in the content they can comment and add to their personal notebooks. Beyond commenting, they can create their own groups and add interesting signals and forecasts to the group, which also serves as a discussion forum. And finally, if they come across interesting content elsewhere they wish to share on Signtific, they can create signals and forecasts.

Thus the contribution of 653 signals and forecasts in a period that saw 14,824 visits to the site means that about 3 out of every 70 visits results in a signal—a quite high level of engagement for the top of the pyramid.

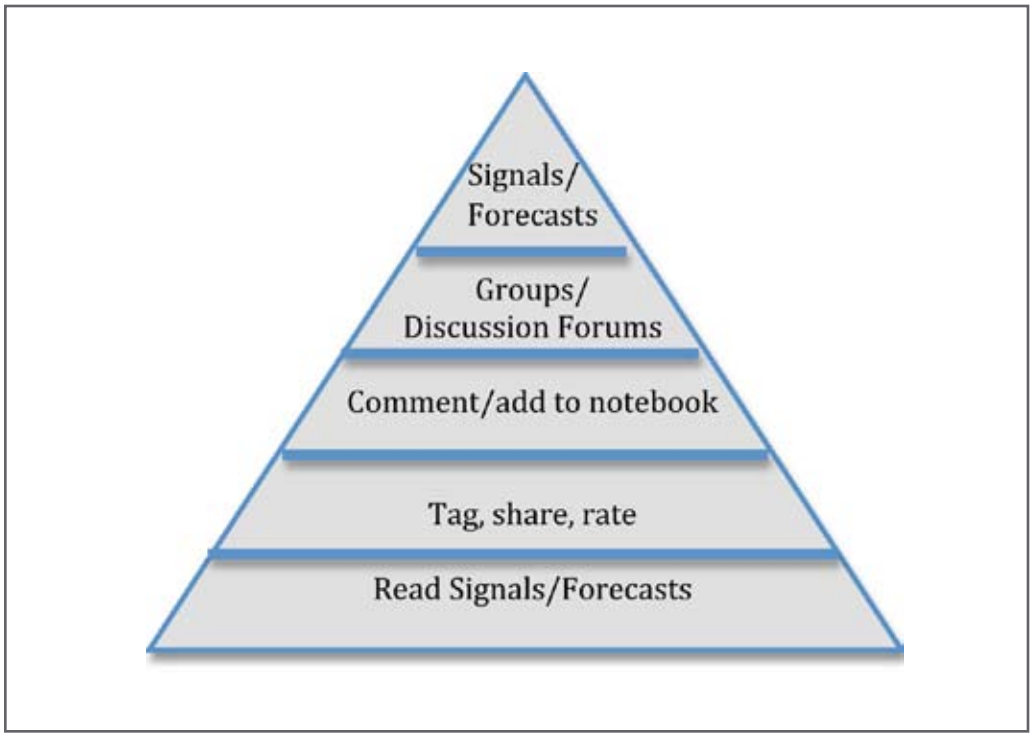


Figure 3–4
The Signtific.org
Pyramid of Engagement

FROM SIGNTIFIC.ORG TO THE SIGNTIFIC LAB: EVENT-BASED ENGAGEMENT

The Signtific Lab is more event-based, consisting of thought experiments (or rapid ideation sessions) that are short in duration (24–72 hours). Because of this short duration, we have compressed the pyramid of participation and created a basic unit of contribution (a micro-forecast 140 characters in length or less). In addition, we have designed the lab to allow participants to build on one another's contributions in a very intuitive manner, mark the most interesting ideas, and ask follow-up questions. In the lab, we also provide other incentives and rewards for participation, including: a leader-board, awards to the most interesting cards, and other forms of recognition for the top contributors. (*See Chapter 1*).

During the course of the first three public thought experiments that were carried out in February and March of 2009, we saw participation rates in excess of 50% (percent of actual participants vs. registered users) and average contribution rates of 7-9 ideas per participant.

A key element that tends to drive contribution is the participation of community managers, known as lab guides in Signtific Lab. This role is critical to educate, inform, nudge, and otherwise drive contribution from the community. It is an active role that is vital to the success of any social network.

SIGNALS OF INTEREST: NEW CONTRIBUTIONS OVER THE PAST SIX MONTHS

The following are summaries of signals of interest from the past six months. For the full text of the signals, please see Appendix 3.

- **Robots take over scientific research** (United Kingdom):
  http://signtific.org/en/signals/robots-take-over-scientific-research

  Scientists have created a Robot Scientist, which the researchers believe is the first machine to have independently discovered new scientific knowledge.

- **Ambient intelligence strategy in service, toward territories extensions for companies in a coopetition economy** (France):
  http://signtific.org/en/signals/ambient-intelligence-strategy-service-toward-territories-extensions-companies-coopetition-ec

  The end of silo industries in cooperation economy offers a new playground for companies that cooperate in a dynamic competition, where shared ambient intelligence strategies could extend the territories of all collaborators.

- **City wide information systems** (United States):
  http://signtific.org/en/signals/city-wide-information-systems

  Community supported and installed information keep citizens citywide informed about the myriad issues that require decision-making on their part.

- **Out with the old (skin), in with the new (skin)** (France):
  http://signtific.org/en/signals/out-old-skin-new-skin

  A substance created from stem cells helps regenerate skin, with implications for both human and robotic applications.

- **Hey, teachers, leave our kids alone!** (France):
  http://signtific.org/en/signals/hey-teachers-leave-our-kids-alone

  Once a playground for academics and military types of all kinds, website Lifehacker reminds its readers that it s still possible to educate oneself mainly from the Internet.

- **Major downturns spur innovation** (United States):
  http://signtific.org/en/signals/major-downturns-spur-innovation

  Economist Alexander Field found that the 1930s (the Great Depression) was paradoxically the decade of greatest technological advancement of the 20th century.

- **Researchers report of a brain and spinal tumor following human fetal stem cell therapy** (United States):
  http://signtific.org/en/signals/researchers-report-brain-and-spinal-tumor-following-human-fetal-stem-cell-therapy

  Concerns have been raised over this experimental therapeutic approach after a case published in PLoS describes a rare side effect of human fetal stem cell therapy.

- **Open-source drug discovery** (United States):
  http://signtific.org/en/signals/open-source-principles-offer-opportunities-advance-health-research-aggregating-personal-heal

  Today, anyone with enough science knowledge and computational power has the ability to contribute to research advances, outside any institution.

- **South Korea to build top-speed information highway** (United States):
  http://signtific.org/en/signals/south-korea-build-top-speed-information-highway

  South Korea plans to upgrade their already fast broadband internet access by 2013 to be 10 times faster than today.

- **Biomedical applications on the iPhone platform** (Hungary):
  http://signtific.org/en/node/52944

  Approximately 100 medical applications are now available for the Apple iPhone.

- **Understanding the Twitterverse** (United States):
  http://signtific.org/en/node/52943

  HP researchers found that most Twitter users have a small number of friends compared to their followers/followees; this suggests that there are at least two tiers of social networks that need to be understood to gain a full appreciation of the Twittersphere.

- **Video phone efficiency in defibrillator sage by untrained laymen** (Hungary):
  http://signtific.org/en/node/52940

  A group of researchers from the Republic of Korea conducted an observational study to demonstrate that “real-time communication with visual images [via mobile phone with video capabilities] can provide critical information and appropriate instructions to both laypersons and dispatchers.”

- **Researchers lay out vision for lighting revolution** (United States):
  http://signtific.org/en/node/52937

  Innovations in photonics and solid-state lighting will lead to trillions of dollars in cost savings, along with a massive reduction in the amount of energy required to light homes and businesses around the globe.

- **Cheap, user configurable eyeglasses could improve vision for billions of the world's poor** (United States):
  http://signtific.org/en/node/52936

  An Oxford physicist has developed eyeglasses that can be "tuned" by the wearer to correct his or her vision, eliminating the need for a trained optician in countries where specialists are rare.

- **China's Longxin microprocessor** (China):
  http://signtific.org/en/node/52917

  Chinese Academy of Sciences will debut a 65 nm Longxin 1.2 GHz microprocessor at the end of the 2008 and an 8-core version in 2009.

- **Gaming provides another approach to open-science research** (United States):
  http://signtific.org/en/signals/gaming-provides-another-approach-open-science-research

  Researchers at the University of Washington and Howard Hughes Medical Institute have designed a game called Foldit, which "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."

- **Stem cells used to create organ for transplant** (United States):
  http://signtific.org/en/node/52915

  A Colombian woman has become the world's first recipient of windpipe tissue constructed from a combination of donated tissue and her own cells.

CHAPTER 4

RECOMMENDED NEXT STEPS

Over the last 18 months of working on this project, the Signtific Project team has made important progress toward developing new methodologies to uncover signals, forecasts, and outliers that anticipate future shifts in science and technology. Furthermore, the project team has developed:

- New forecasts and perspectives based on the content produced from international workshops.
- A new signaling/forecasting platform developed specifically for this project.
- A new collaborative insight platform also developed specifically for this project.

In this same time frame, a host of new open-source and collaborative scientific networks have begun to leverage social networks and social media to engage professional and citizen scientists in specific areas of scientific inquiry. For example:

- Galaxy Zoo has invited the public to help classify galaxies from Hubble photographs, achieving 50 million classifications in the first year.
- The National Phenology Network is reaching out via Internet social networking platforms to invite citizen scientists to provide environmental data in order to get a more complete view of what is happening to the planet as the climate warms.
- FoldIt is having considerable success using computer gaming to engage citizen scientists in contributing to important protein folding research.
- In South-East Asia, Integrated Approaches for Participatory Development (IAPAD) is a focal point for sharing information and technical progress on community-based maping, with a particular focus on 3D modeling.

These are just a few examples that point to the spread of social network strategies in science and technology development. They also underscore the fact that the methodologies and platforms we are building in the Signtific Project are absolutely critical to engaging a wide variety of participants from around the world in the process of monitoring and forecasting scientific and technological change.

IFTF is well versed in the importance of social networking, Web 2.0 collaboration, game design/theory, workshops/facilitation, and the new methods to engage online communities in active participation. All of this experience, coupled with the extensive research carried out by the Health Horizons, Technology Horizons, and Ten-Year Forecast programs at IFTF, provide the project team a solid foundation on which to develop the important insights that policy-makers will need to reach intelligent decisions about everything from science funding to security, from national health strategies to our digital infrastructure.

The Signtific Project is just getting off the ground in terms of what we are learning about engagement, game design, facilitation, and generating outlier forecasts. The project team strongly believes this work should continue, focusing on the following areas:

- **Extreme-scale roadmaps:** Engaging a broad range of open-source scientific networks in virtual workshops that leverage the Signtific team's experience with face-to-face workshops on a much larger scale.
- **Deep thought experiments:** Designing Signtific Lab experiments to probe the specific expertise of content-focused, open-source networks and using their discoveries as jumping off points for anticipating future developments in niche areas of science and technology.
- **A hubless platform:** Demonstrating the use of existing social media tools—from Twitter and Facebook to new video platforms—to rapidly mobilize communities of trackers around specific domains and geographies of discovery and innovation.
- **Visual forecasts:** Developing lightweight visualization tools and challenging Signtific members and groups to go beyond roadmaps to create innovative visual forecasts of science and technology from the content in Signtific.org and Signtific Lab.
- **Analytic tools:** Refining the analytic tools in the Signtific platforms to facilitate our ability to cluster signals, forecasts, and micro-forecasts by geography, by user expertise, and by generation to better understand the patterns of scientific discovery and technological development around the world.

These important next steps are described in more detail below.

VIRTUAL WORKSHOPS: ROADMAPS AT AN EXTREME SCALE

The team has hosted and facilitated more than a dozen workshops around the world in the first stage of this project. Participants ranged from university students to academics to working professionals in various areas of science and technology. These workshops provided valuable insights into specific regional differences in S&T development and also generated participation in the Signtific.org signals platform. There are several geographic regions yet to be touched by this work: South America, Africa, and the Middle East. It would be important to pursue workshops in these regions.

But beyond an extension of the existing workshop processes, we have the opportunity to take this process to a new scale, to engage hundreds of participants in an interactive roadmap process. These workshops could be organized to take advantage of existing open-source science networks; within these networks, we could organize regional competitions,

encouraging groups to form competing roadmaps and awarding honors to regions based on the quality of the collaborative visions. Similarly, we could create competitions among diverse open-source networks, to test their alternative visions of the future.

Underlying these experiments would be the use of simple tools that we are already familiar with:

- Prezi already provides a multi-user, interactive platform for creating roadmaps of varying complexity and depth.
- Twitter and our existing blog tools provide a platform for engaging a networked public that can grow from the edges to achieve scale.
- IFTF has also defined a basic set of map templates—a kind of taxonomy of maps—that can quickly be adapted to different kinds of roadmapping requirements.

The task is to develop the processes that allow these tools to be used at scales that have not previously been tested in creating science and technology roadmaps.

SIGNTIFIC LAB: DEEP THOUGHT EXPERIMENTS

The Signtific Lab trials described in this report demonstrated the capacity for a lightweight platform to probe a specific theme with a diverse network of experts and the lay public. This experience sets the stage for much more targeted "deep" thought experiments with networks that have already been engaged around specific topics (such as protein folding or climate change, for example). The platform for these experiments is already in place; the task is to:

- Identify and establish joint goals with a wide range of open-source science networks.
- Develop network-specific thought experiments, perhaps drawing on or feeding into the workshop process described above.
- Developing lightweight meta-game structures, leveraging Signtific.org, Twitter, and other cutting-edge social media tools to engage these networks in competitions.

LIGHTWEIGHT INNOVATION: A HUBLESS PLATFORM

While Signtific.org and Signtific Lab both provide platforms that are critical to the success of a distributed signal tracking and forecasting process, it is becoming increasingly obvious that no single platform can be the hub of this activity. Rather, superstructures of the future will most likely be hubless, linking together a variety of platforms like Signtific.org and Signtific Lab with other network platforms in a constantly changing set of processes that rapidly leverage innovations in social media. A key next step for the Signtific Project is thus to define a taxonomy of processes and platforms that can be combined in different configurations to serve as a hubless platform for tracking disruptive innovations and forecasting the future of science and technology. The tasks here include:

- Convening experts in social media to create a taxonomy of media features and affordances that are relevant to the goals of the Signtific Project.
- Set up a process for tracking the emergence of new media applications and "slotting" them in the taxonomy.
- Designing and conducting lightweight trials of various configurations of the processes and tools, using the content of Signtific.org and Signtific Lab as a starting point.
- Begin to define the nature of "citizenship" in the Signtific process, as participants move from being "users" of specific platforms to being Signtific "citizens."

In the rapidly changing landscape of social media, obsolescence is a key challenge to any platform; but a taxonomic approach to processes and tools, with a commitment to lightweight, off-the-shelf implementations can help us understand what emerging hubless platforms might look like—while continuing to achieve the basic objectives of the Signtific Project.

VISUALIZING THE FUTURE: BEYOND PREZI ROADMAPS

Signtific.org and Signtific Labs have the capacity to generate large volumes of content. Community guides (known as lab guides in Signtific Lab trials) have been critical to filtering and interpreting this content—and they will remain so. At the same time, new tools are emerging for synthesizing and visualizing qualitative data. In the spirit of lightweight innovation, the next phase of the Signtific Project should:

- Survey the emerging visualization tools, especially collaborative tools, for their relevance to the Signtific content and objectives
- Develop some basic templates for using these tools with Signtific content
- Engage communities of Signtific citizens in visualization "challenges" to push the edge of these practices

ANALYTIC TOOLS: UNDERSTANDING GLOBAL AND LOCAL PATTERNS

Participants in Signtific.org and Signtific Lab provide basic information about their location, job titles, industries, and, in some cases, their age. All of this information provides the basis for doing some quantitative analysis linking these demographics to specific content themes and patterns. At the same time, a lot of innovation in analysis of social media is leading to new kinds of public knowledge: for example, by analyzing keywords like "flu" and "fever" and even "coming down with" in public Twitter streams, a site called SickCity.org is detecting disease patterns in cities. Combining these strategies with Signtific content promises to reveal interesting geographic, demographic, and even thematic patterns in the way people are thinking about the future of science and technology.

Again here, we are looking for ways to use existing lightweight tools. For example, we hope to:

- Conduct keyword analyses of our own dedicated Twitter streams during runs of Signtific Lab experiments
- Develop backend queries of our existing databases that link content contributions to specific geographic locations, industry sectors, and age ranges
- Develop automated tools, or apply existing tools, for visualizing the patterns that result from these analyses

GOING FORWARD: BASIC PRINCIPLES

The Signtific Project is committed to its core tasks of tracking emerging signals of scientific innovation and disruption and developing compelling forecasts of the future of science and technology to support policy makers.

The socio-technical environment for this kind of work is both challenging and intensely exciting. As an organization dedicated to innovating the methodologies of horizon tracking and forecasting, IFTF is committed to working with the cutting edge tools, applying them in novel ways, and even inventing them when necessary. However, as move ahead with the Signtific Project, we are adopting the following basic principles to guide our work:

- Use existing tools, including our own platforms.
- Focus on lightweight, innovative processes for using these tools.
- Leverage emerging open-source networks.
- Develop code only when necessary to “superstruct” existing tools.

As new tools and communities continue to proliferate around science and technology, we feel it’s critical to continue the Signtific Project as a platform for experimenting with radically new tools and processes for technology forecasting.

APPENDIX 1

SIGNTIFIC LAB EXHIBITS

The following exhibits from the Signtific Lab are included here to show the instructions that users received either on the Signtific Lab site or on the Signtific blog as part of the Free Space thought experiment

EXHIBIT 1: HOW TO PLAY

The following is text from the Signtific Lab website that explains how users participate in lab experiments.

The lab focuses your collective attention on a specific future scenario for a short period of time—anywhere from one hour to one week. During that time, we lead you through a series of quickfire questions to build on and challenge each other's best guesses about what might happen in the future.

1. **Learn the scenario.** Watch the short welcome video, and read the short welcome message. Think about the scenario questions for a minute or two, and you're ready to play!

2. **Play a card.** A card is a micro-forecast about the future.

   Your first card is either Positive Imagination—something good that might happen as a result of the scenario—or Dark Imagination—something not so good that might happen as a result of the scenario.

   If you're optimistic about the scenario, play one or more Positive Imagination cards.

   If you're pessimistic about the scenario, play one or more Dark Imagination cards.

   And if you can picture both Positive and Dark outcomes, then play one or more of each!

3. **Play more cards.** Now you can check out the forecasts created by other lab members! Click through the "card stacks" to read forecasts that catch your eye. You can play a card on top of anyone's forecast.

   "No way!" If you disagree, play an Antagonism card.

   "Yes! And … " If you agree, play a Momentum card.

   "Yes! But…" If you agree, but if you can imagine the forecast playing out differently in your field or part of the world, play an Adaptation card.

   "Hmmm … " If you have a follow-up question, play an Investigation card.

Forecasting Tips

Here are some additional tips for writing interesting forecasts and building on each other's ideas.

- **Make your best guess … but don't worry about being "right."** If you think something is possible, share it! Your forecasts don't have to be probable. They just have to be possible.
- **Play to your strengths.** The Lab is a collaborative community. Everyone is encouraged to draw on their individual expertise. What do you know a lot about? What do you care a lot about? Where do you live? Who do you know? What are you good at? Whoever you are, there are ideas about the future only YOU could have, and there are thoughts only YOU could think. Please share them with us!
- **Make multiple forecasts.** Don't try to come up with the one "best" forecast. Share all your ideas, one card at a time. Then watch and see which of your ideas gains the most traction as the experiment unfolds!
- **Push yourself.** Feel free to play the first ideas you think of. But after that, try to push your ideas to the extreme. Go beyond the obvious. Try to think something you've never thought before!
- **Track your favorite cards.** Every card you play is automatically added to your favorite list. Plus, you can add your other favorite cards to the list, which shows up on your profile page.
- **Track your favorite players.** You can add players to your favorites so their cards are displayed on your dashboard in real-time. Click on a player's name to view their profile page, then click the star to add them to your favorites.
- **Check back in often to see how the experiment is unfolding.** Find out what cards have been played on top of your favorites. Continue the chain reaction …

Scoring and Strengths

Strengths, points, and achievements are an opportunity for you to measure your own progress in developing future foresight and applying it to your everyday work.

The more experiments you participate in, the more you'll increase your individual forecasting strengths and the more forecasting points you'll earn. You can even unlock "achievements," like completing a trilogy of experiments or contributing the most controversial micro-forecast to an experiment.

EXHIBIT 2: SCORING, STRENGTHS, AND ACHIEVEMENTS

The following text from the Signtific Lab site explains to users the various ways that they can excel in the Lab.

As you participate in thought experiments, you'll increase your future forecasting experience, develop your forecasting strengths, and move up the ranks of the Lab.

Strengths

Your strengths increase each time you make a micro-forecast.

Positive Imagination	Your skill in imagining Best-Case Outcomes.
Dark Imagination	Your skill in imagining Worst-Case Outcomes.
Momentum	Your skill in pushing micro-forecasts One Step Further. What happens next in this story?
Antagonism	Your skill in arguing an Alternative Outcome. Disagree? Tell a different story.
Adaptation	Your skill in adapting a micro-forecast for your field or location. Tell a story more relevant to your work or your life.
Investigation	Your skill in asking a follow-up question.

Forecasting Points

You earn points when you make a new micro-forecast. You also earn points when other players build on your forecast. The more your forecasts inspire and provoke others, the more points you'll earn.

Add any micro-forecast	2 points
Someone builds on your micro-forecast	1 point
The chain reaction you started reaches 10 forecasts	10 bonus points
Your micro-forecast is selected a "lab favorite"	10 bonus points

Lab Levels

The more forecasting points you earn, the faster you'll level up.

Level	Forecasting Points Required
Novice	0
Keen	5
Clever	10
Brilliant	20
Beyond brilliant	50
Luminous	100
Genius	175
Beyond genius	300

Achievements

If you really apply your imagination, you'll unlock forecasting achievements. Here are some of the achievements available:

Automatically unlocked

- **HIGH SCORE:** Most points earned in an experiment
- **PROVOCATEUR:** Started the longest chain-reaction in an experiment
- **THE WORKS:** Contributed all five types of micro-forecasts in a single experiment
- **TRILOGY:** Completed three different experiments

Awarded by lab guides

- **TED TALK:** Micro-forecast most worthy of an 18-minute elaboration
- **MACARTHUR GENIUS:** Micro-forecast most worthy of five-year funding
- **HAWKING:** Micro-forecast with the clearest sense of the very big picture
- **FEYNMAN**: Micro-forecast with the clearest sense of the very small picture
- **VENTER:** Micro-forecast that makes the biggest paradigm shift
- **HEISENBERG:** The player that had the biggest impact of the conversation

Note that after the first two "Free Space" trials, the levels were changed as follows:

Level	Forecasting Points Required
Novice	0
Keen	1-4
Inspired	5-19
Brilliant	20-42
Luminous	43-79
Genius	80-179
Extreme genius	180-299
Beyond extreme genius	300-424
Legend	>425

EXIHIBIT 3: THE SCIENTIFIC BASIS FOR THE SCENARIO

The following text appeared on the Signtific Lab website as an introduction to the scientific basis for the Free Space scenario.

A note from Alex Soojung-Kim Pang—Research Director, Institute for the Future:

I became aware of nanosatellite projects a couple years ago, after reading a report on microsatellites and the future of Third World space programs. I've also been following the DIY movement, and the growing use of amateurs in scientific research. I've also been really interested in what happens when a resource that traditionally has been really precious—scarce enough to shape the way you work and do science—becomes essentially free. We've seen how making computational power incredibly cheap has changed the way people do science, and I think you can make a case that cheap sensors and vehicles are having a similar impact on things like public health and oceanography. (You can even see tagged ocean predators as something like very cheap scientific labor.)

The recent NSF decision to put some money into supporting cubesats struck me as a sign that the technology was starting to... well... take off. And cubesats seem to me to be balanced at a point where they can make good use of DIY energies, and because of their low cost, radically alter the economics of space science.

After digging into it a little more, I was impressed by some historical parallels to cubesats. As we all know, in the 1970s, computers were expensive, exclusive, and used by scientists and governments. Within a couple decades, the personal computer democratized access to the technology, and started a revolution in how we work, communicate, and play.

This is not to say that there aren't plenty of technical and legal problems that have to be solved to make cubesats cheap and accessible. While today's cubesats communicate with ground stations via ham radio-level technology, that kind of technology would break down if there were millions of cubesats; engineers are working on protocols for inter-satellite communications, but the technical issues are pretty hard. Before they're launched in great numbers, we need to come up with strategies for dealing with decommissioned or failed cubesats. There's already a lot of space junk (described on Signtific), and if cubesats are to be viable, they really can't make the problem worse. It would also be ideal to have new kinds of launch vehicles that don't pollute (or cost) as much as traditional rockets. And finally, there will doubtless be unforseen legal issues with cubesats.

None of these issues will be solved easily. But people are working on all of them. Space debris experts like Heiner Klinkrad say we can deal with space junk through better design of launchers, the assignment of graveyard orbits for decommissioned satellites (something that some satellite operators are already doing, without official incentives), and changes to satellite design that reduce the number of objects they eject when deploying. Innovation in propulsion systems, rather than being something that would hinder the growth of cubesats, might be accelerated by the greater demand for new propulsion systems that this new category of satellite would create. And some very smart people are working on the next generation of satellite communications.

We recognize that it's optimistic to assume that all these problems can be solved within a decade, but we've decided to be a little audacious. Maybe all the pieces of an ideal space infrastructure won't be in place, but enough will be there to make cheap cubesats feasible. It's entirely possible that their popularity will strain existing communications and launch infrastructures, or create completely new and unforseen problems; but that's what we want to explore in the game. It's not completely implausible to imagine that space in the 2020s could be like computing in the 1970s, and cubesats could be the Apple II—the technology that brings it within everyone's reach, and spurs a whole new generation of design and innovation. It's that dynamic, and opportunities and challenges it could raise, that we want to explore in the game.

EXHIBIT 4: PROMPTS FOR FREE SPACE CARDS

The following text appeared on the Signtific Lab website as text to prompt users to add cards to the Free Space conversation.

Some ideas about what might be done with cubesats:

Individual Cubesats

- Photograph or take sensor readings (for example, readings of the Earth's magnetic field) for an area on the earth every 90 minutes. This can include natural phenomena, or human-generated signals.
- Take sensor readings of the earth's atmosphere, particularly the upper atmosphere and atmosphere/space boundary, or objects in space.
- Monitor their surroundings—for example, to catalog and remove space junk, monitor cosmic rays.
- Conduct experiments aboard the cubesat itself (e.g., looking at genetic mutations caused by exposure to cosmic radiation)—though this is currently one of the most expensive things you can do with a cubesat.
- Send/relay data back to Earth. You can do this directly (via relatively low-bandwidth connections) every 90 minutes, for periods of a minute or two (depending on how powerful your equipment is). By 2019 there could be a premium service that relays data to communications satellites—though this isn't something you can do now.
- Adjust its motion via remote control. Eventually, if you had a system that allowed for continuous communication between ground stations and cubesats, you could "fly" them continually.

Groups of Cubesats

- Act in a coordinated fashion—for example, observe a single area from several vantage points thousands of miles apart.
- Distribute the risks inherent in space launches. The recent loss of the carbon detection satellite during takeoff highlights how a single mechanical problem can destroy years of work. If you can design a swarm of cubesats that have the same capabilities as a big satellite, you can launch them on several rockets, reducing your risk.
- Tether two or more cubesats together. The idea is that you could use tethers to create large antennas, or hold a group of cubesats in precise formation without having to equip each with its own rockets and navigation system.
- More easily repair/improve space research platforms. Swarms of cubesats could be repaired or have individual components replaced much more easily than with today's satellites. Fixing the Hubble Space Telescope, for example, is incredibly complicated because even TOUCHING it messes up its orientation. If you had a swarm of cubesats, however, it should be easier to steer one out of its pack, and replace it with another—without disturbing the rest of the pack. Not only would this make it easier to repair satellites, you could also upgrade them—something that is extremely hard to do now.

Some Notes on Tracking and Broadcasting

- You can only observe/broadcast for a couple minutes because in low-earth orbit you're moving pretty quickly over the earth—the equivalent on the Earth of about 250 miles per hour. Imagine being in a moving car on a highway: you could observe distant mountains with no problem, study big landmarks for a short period, but would have a really hard time birdwatching.

- You can track things that have radio collars or some other active broadcasting device. One Norwegian cubesat, for example, was designed to monitor signals from caribou radio tracking collars. But it wouldn't be practical to keep track of untagged household objects or people. If you had an optical telescope, for example, you'd have to know where to point it; you'd have the short window every 90 minutes in which to find them; and if there are clouds, or if your subject goes indoors, you won't be able to see them.

- Right now, it's possible to send pictures back from a cubesat, but they're not very high-resolution. Today this is done with the equivalent of ham radio equipment. The kinds of things you could transmit, and the speed at which they'd be sent, all depends on cost. Ten years from now, we're likely to have a variety of options—relays to other satellites, direct radio broadcasting to listening posts, laser or microwave communication (higher quality but expensive). But it's incredibly unlikely that you'd ever use a cubesat as a personal streaming video server, unless you want to watch videos for 1-2 minutes at a time, every 90 minutes: there will just be too many other options here on earth, starting with having multi-terabyte iPods.

- This suggests that more generally, it's worth asking, "would it be easier to do this on Earth than in space?"

EXHIBIT 5: NEW SPECS AND INSPIRATION FOR TRIAL #2 PLAYERS

The following was added to the instructions for the second Free Space trial:

We've added some technical limitations since Experiment #1 to take the micro-forecasting to a new level! You'll now find that your personal cubesat:

- Has a volume of 1 L
- Can hold up to 1kg of equipment
- Orbits the Earth every 90 minutes (e.g., is NOT geosynchronous)
- Can use space data transfer protocols and the Interstellar Internet to work together with many other cubesats—in order to provide constant Earth-to-ground connection, or monitoring of a particular place on Earth

What new possibilities can you imagine with these limitations? Who would you and your cubesat(s) collaborate with to change the world?

A few things to keep in mind—this time around we're looking for cards that focus on what player's know best. Imagine:

- The specific job you have today, in a world of free space.
- The company you work for, in a world of free space.
- The building you live in today, in a world of free space.
- What you were doing yesterday at 7:30 PM ... in a world of free space.

These are just a few examples. Use YOUR unique point of view to feed specific and thought-provoking cards to the Lab community!

EXHIBIT 6: NEW OUTLIER CHALLENGE FOR TRIAL 3

For the third Free Space trial, the following Outlier Challenge was added to encourage more radical ideas:

Welcome to ETech: Take the Outlier Challenge!

Here at the Signtific Lab, we love outliers. That's why we want you to take the Outlier Challenge.

In future forecasting terms, outliers are the most surprising ideas. They are what scientists call "non-obvious", and they're the opposite of "wisdom of the crowds" consensus. They take the crowd by surprise. Outliers might not be the most likely ideas, but they would have a huge impact if they actually occurred. They're especially hard to see coming, but when they do come, they disrupt everything—precisely because so few people anticipated them.

The main benefit of a platform like the Signtific Lab is that we can expose each other to many more outliers—and avoid getting blindsided by the future.

To help you uncover new outliers, we've created the Outlier Challenge. Your mission: Avoid "Outlier Fail" and steer towards "Outlier Win."

OUTLIER FAIL—This is a list of apparently obvious ideas about the future of free space. We call them "outlier fail," because they have shown up literally 100 times or more in our forecast feed. You can feel free to create new micro-forecasts about these ideas, but you'd better say something extremely surprising if you want to avoid the outlier fail! Don't just tell us this stuff will happen. We've got that already. Can you say anything surprising or non-obvious about these topics? If not, **Avoid! Avoid! Avoid!**

- Junk in space
- Falling junk from space
- Porn in space
- Terrorists in space
- Stalking from space
- Reality TV from space

OUTLIER WIN—This is a list of the topics we think have the most potential for non-obvious ideas about the future of free space. So use these as springboards to surprise yourself and the other Lab members. The more you explore any of these topics, and the deeper you get down the chain of forecasts, the more potentially outlier you'll get! **Want! Want! Want!**

- DIY space research
- Crowdsourced eco-monitoring
- Disaster spotting & response
- Hacking democracy
- Cubesat entrepreneurs
- Social capital in space
- News from space
- Serious games in space
- Climate change applications
- Food/agriculture innovation
- Chemical/materials research
- Bio/life sciences research
- Oceanographic research
- Tracking and protecting all living things (migration patterns, etc)

Most importantly: stuff we probably never thought of ourselves!

APPENDIX 2

A NEW PERSPECTIVE: THE SMALL SATELLITE REVOLUTION

The Free Space trials led to the following new perspective on small satellites, from Alex Pang.

THE SMALL SATELLITE REVOLUTION

Since the 1950s, when the first satellite was launched, space has been the province of scientists, governments, and corporations. Satellites are exceptionally complex, expensive pieces of hardware, and traditionally have been at the cutting edge of technology (indeed, during the Space Race of the 1960s and 1970s, spending on space was often defended on grounds that space exploration drove innovations in high tech). The end of the Cold War and growth of a luxury commercial space travel industry has altered this dynamic slightly, but by and large, despite high levels of popular interest in space and space travel, space itself still remains expensive and exclusive. This could change in the coming decades, thanks to a new generation of space satellites called *cubesats*.

Cubesats are small satellites, generally a liter in volume and weighing less than a kilogram. The basic standard was developed by scientists at Stanford University and Cal State Polytechnic a decade go. Today, cubesat research groups are operating in Japan, Denmark, Norway, Canada, and across the United States. A number of cubesats have been successfully launched.

At first glance, cubesats are no threat to the primacy of traditional satellites. They're small-scale projects, very modestly funded, often by run students. But their weaknesses may be strengths. Their modest cost—an entire cubesat project from initial design to launch can cost $200-300k—makes them accessible to lots of institutions that have not been in the front ranks of NASA programs. Today, some of the more notable cubesat programs are at institutions like San Jose State, Santa Clara University, University of Kentucky, and Montana State—universities that have been at best subcontractors or junior partners to space science leaders like MIT, Stanford, and Johns Hopkins.

Cubesats are also very attractive to professors and students alike. For graduate students, a cubesat project lasting two or three years is a well-scaled subject for an M.A. thesis or dissertation. For professors, cubesats are useful teaching tools, because they allow students to see all the components of a satellite at once. As NASA Ames scientist Bruce Yost says, "Its small, but it's still a satellite. It has all of the issues with energy, thermal, communications, interference—it even exacerbates them because of their small size." Because you can fit the entire system on a table,

it's easier to understand how all the components work together, and how changes in one part of the design affect everything else—something you can't do with bigger stuff. It also means that you can have mission specialists, payload engineers, and others working together more closely than in a conventional satellite program. Finally, cubesats offer a way to quickly train satellite designers. As Yost put it, "We've got serious workforce issues looming, and there's a big push within the agency to develop and grow the next generation of guys building the next generation of satellites. The students are not in a back lab; they're in every meeting, they have real deliverables."

The development of more efficient photovoltaics, batteries, cheaper computers, and improved optics and communications, will all make cubesats more powerful. If the cost of space launches continues to fall, this could spark a revolution in access to space. In the longer run, as costs continue to fall and access grows, could cubesats democratize access to space just as the personal computer helped democratize access to the Internet? This could have some dramatic impacts.

They could lower the cost of space research. Today's satellites and space probes are expensive because the cost of failure is extremely high: years of development and millions of dollars are on the line with every launch. By dramatically lowering the cost of failure, cubesats could make it possible to experiment with new designs, iterate rapidly, and play with ideas in much the same way scientists tinker in the lab. Space science would be very different, say, astrophysicists could design and launch ten different instruments in a semester, rather than a single instrument every decade. Researchers can be more entrepreneurial, and take more risks, with cubesats than with conventional satellites. As Kris Kimel, president of KentuckySat explains, "If you lose one, you don't like it, but it's not like you've lost five million dollars. That's a key to entrepreneurship. Because it lets you fail, it lets you engage in a level of innovation."

Cubesats could open space to a wider variety of researchers. Space is inherently interesting to only a few kinds of scientists. For many more, though, the opportunity to do experiments in zero gravity, or to use space as an infrastructure, would be highly appealing. As Bruce Yost explained, NASA's latest cubesat launch sent up a pretty standard piece of pharmacological equipment; but because it'll operate in microgravity, it's well worth doing.

Cubesats could open space to NGOs or regional governments. Today, some of the most active supporters of cubesats in the U.S. have been states, rather than the federal government: states like Montana, Idaho, and Kentucky see cubesats as a way for them to develop high-tech space industries, and reap the benefits of space commercialization. Of course, it would also give access to space to smaller commercial players, activist groups, and less benign non-state actors, authoritarian dictatorships, or "feral states."

Finally, cubesats could democratize access to space. If current trends continue, within a decade cubesats could cost a few thousand dollars, making them cheap enough for high school groups or DIY scientists. Within twenty years, they could cost hundreds of dollars, bringing them within range of nearly anyone who wanted to design a satellite.

APPENDIX 3

SIGNALS OF INTEREST
NOVEMBER 2008–MARCH 2009

The following are what we judged to be "signals of interest" from the final six months of the contract period; excerpts are included.

Robots Take Over Scientific Research

http://signtific.org/en/signals/robots-take-over-scientific-research

Maike Rentel, United Kingdom

From the Signal

Scientists have created a Robot Scientist, which the researchers believe is the first machine to have independently discovered new scientific knowledge. The robot, called Adam, is a computer system designed to carry out each stage of the scientific process automatically without the need for further human intervention. Using artificial intelligence, Adam hypothesized that certain genes in baker's yeast code for specific enzymes that catalyze biochemical reactions in yeast. The robot then devised experiments to test these predictions, ran the experiments using laboratory robotics, interpreted the results and repeated the cycle. The researchers used separate manual experiments to confirm that Adam's hypotheses were both novel and correct. Another robotic scientist tested pendulums and springs to figure out the physics laws that govern their movements. Simply by experimenting, the robot deduced the equations governing motion and the physical laws behind them for these simple machines.

Ultimately, teams of human and robot scientists may work together in laboratories. Because biological systems are complex, it is important to record as many details as possible. Science experiments generate a vast amount of information, and taking as much of it as possible into consideration when designing an experiment will lead to more meaningful results. Future robot scientists may be far better at this than human scientists—but we will still need humans to steer the direction of research.

Ambient intelligence strategy in service, toward territories extensions for companies in a coopetition economy

http://signtific.org/en/signals/ambient-intelligence-strategy-service-toward-territories-extensions-companies-coopetition-ec

Christophe Tallec, France

From the Signal:

First related to responsive environments such as domestic discipline, Ambient intelligence means a lot in a service strategy, as an ecosystemic view focused on the stakeholders interactions happening in times and with related spaces and technologies.

Service consumers are more and more often multi-services consumers. So what could be a service using an ambient intelligence strategy? for which service providers could it means a lot being in real time awareness of one's environment, of the other multi-channeled services consumed?

The end of silo industries in cooperation economy offers a new playground for companies that cooperates in a competition dynamic, where shared ambient intelligence strategies could extend the territories of each others. What is nike+ , if not an ambient intelligent shared strategy, connecting the territories of Nike and Apple, two brands in a multi-service consumed experience providing one enriched experience from the consumer point of view ?

We are diving deeper into the information experience we have toward and upon everything between ubiquity and omniscience in the Information Age, have a look at the project from Carnegie Mellon University, Berkeley, Intel: http://www.living-environments.net/projects/citizenscience.

One example of research on new territories provided by ambient awareness in our mobile devices. This physical environment awareness, leading to deeper researches about our citizen experience from being in an environment, to interacting with it.

In ambient intelligence strategies, users of services are meant to be real-time peer-to-peer producers for each others inside their services communities (and beyond). Technologies and science supports the change from consumption to production, shaping new social behaviors as well new social behaviors are calling adapted technologies, for examples mesh networks.

Adopting an ambient intelligence strategy thinking allows to map across the multi channeling services in which the users are evolving, and across their different environments, through time, these new territories and the new uses to come.

City-wide Information Systems

http://signtific.org/en/signals/city-wide-information-systems

Kathy Zarsky, United States

From the Signal:

Community supported and installed information systems to keep citizens citywide informed about the myriad of issues that require decision making on their part. This type of system should link to personal devices, but it also needs to provide universal access so the currently underserved demographics can conduct better decision making. The types of services, activities and misc. information would include transportation, local food production, health related services, weather, energy consumption patterns, etc. As more and more sustainable strategies find their way into our communities, it is imperative that we simultaneously address human behavior and awareness. An individual's current understanding of an issue, their perception of a certain concept and their current values may hinder an otherwise well-conceived sustainability strategy from succeeding if left unaddressed. The new eco-city will deploy sophisticated communication tools to promote full potential of intended programs and services.

"Out with the old (skin), in with the new (skin)"

http://signtific.org/en/signals/out-old-skin-new-skin

Tom Maillioux, France

From the Signal:

From wooden legs to glass eyes to prosthetics to eye-socket mounted cameras, mankind has always strived to regenerate the human body. While some laboratories focus on growing muscles or creating artificial arms that can harmoniously integrate with the biological frame of our bodies, others are working to give hope to those severly burnt or with severe skin conditions using a substance created from stem cells to help regenerate skin. From the io9 article,

"The artificial vernix could be used to treat eczema and speed up the healing of wounds".

The possibilities for firemen or soldiers wounded in the line of duty as well as a whole range of patients - from face transplantees to photosensitive subjects - easily come to mind. However, a whole other set of applications aiming at uniting robotics, artificial muscles production and skin generation could help engineers develop solutions to the Uncanny Valley that makes human beings recoil in front of human-like robots by providing a more organic and natural envelope.

"Hey, teachers, leave our kids alone !"

http://signtific.org/en/signals/hey-teachers-leave-our-kids-alone

Tom Maillioux; France

From the Signal:

Once a playground for academics and military types of all kinds, website Lifehacker reminds its readers that it is still possible to educate oneself mainly from the Internet. From the article,

"It's easy to forget these days that the Internet started out as a place for academics and researchers to trade data and knowledge. Recapture the web's brain-expanding potential with these free resources for educating yourself online."

Programming, foreign languages, open-source operating systems and music are some of the fields of knowledge that have been listed on Lifehacker's article. However, is it possible for the Average Joe to turn Internet-accessed data into knowledge, or is the help of a Trained in Educational Artefacts, Cognitics and HeuristicsExpert Researcher still necessary to do so? If this is not the case thanks to the variety of content available online and the pedagogic value of said content, the possibilities for individuals of all ages with the appropriate amount of motivation are limitless - not only for those who are looking to further their education after school age, but also for those who couldn't fit in the frame of government-provided education nor could afford private schooling.

However, this puts the emphasis on connectivity to the Internet in a way that may conflict with the ongoing fight between copyright holders and Internet users on the other. To choose an education, or to choose entertainment—the dice are cast!

Major Downturns Spur Innovation

http://signtific.org/en/signals/major-downturns-spur-innovation

Bradley Kreit, California, USA

From the Signal:

Economist Alexander Field has found that the 1930s (the Great Depression) was paradoxically the decade of the greatest technological advancement of the 20th century, and that, contrary to popular opinion, this innovation took place before, not after, WWII. Field's research suggests that the 1930s saw huge advances in a diverse array of sectors including:

- Telecommunications
- Manufacturing
- Utilities
- Transportation

Field points to several factors that aided the rise. In some instances, advances stemmed from the maturing of longer-term investments in technology. Field also suggests that increasing pressures on companies to innovate--because of limited demand--led to further advances, as did improved planning efforts among university and government officials.

It will be interesting to see if the current downturn speeds the rate of innovation in much the same way.

Researchers report of a brain and spinal tumor following human fetal stem cell therapy

http://signtific.org/en/signals/researchers-report-brain-and-spinal-tumor-following-human-fetal-stem-cell-therapy

Ever9000, United States

From the Signal:

Neural stem cells are currently being investigated as potential therapies for neurodegenerative diseases, stroke, and trauma. However, concerns have been raised over the safety of this experimental therapeutic approach, including, for example, whether there is the potential for tumors to develop from transplanted stem cells.

A case report published in this week's issue of the open-access general medical journal, PLoS Medicine, describes a rare side effect of human fetal stem cell therapy. Ninette Amariglio and Gideon Rechavi from the Sheba Medical Center, Tel Aviv, Israel, and colleagues report the case of a boy with a rare genetic disease, Ataxia Telangiectasia, who underwent human fetal stem cell therapy at an unrelated clinic in Moscow and who, four years after the therapy began, was shown to have abnormal growths in his brain and spinal cord.

This is the first report of a human brain tumor complicating neural stem cell therapy. The findings here suggest that neuronal stem/progenitor cells may be involved in gliomagenesis and provide the first example of a donor-derived brain tumor. Further work is urgently needed to assess the safety of these therapies.

Open Source Drug Discovery

http://signtific.org/en/signals/open-source-principles-offer-opportunities-advance-health-research-aggregating-personal-heal

Vivian Distler, California, USA

From the Signal:

Traditionally, health research has been conducted in academic or corporate laboratories. Today, "anyone with enough science knowledge and computational power now has the ability to contribute to research advances, outside of any institution."

CureTogether.com is a website that promotes an "Open Source Health Research Plan."

With roughly 60 million Americans suffering from a chronic health condition, traditional research progressing slowly, and personalized medicine on the horizon, the time

is right to apply open source to health research. Advances in technology enabling cheap, massive data collection combined with the emerging phenomena of self quantification and crowdsourcing make this plan feasible today.

In recent years, examples of open science have included bird counting, water monitoring, and searching for astonomical phenomenon. "Citizen health research is still in its infancy, with "experimental man" David Ewing Duncan and parents like Hugh Rienhoff pioneering first attempts."

CureTogether helps people anonymously track and compare health data, to better understand their bodies, make more informed treatment decisions, and contribute data to research. (PatientsLikeMe is another website that also facilitates open source health research.) The aggregation of the data people enter about their health conditions will ultimately contribute to new research.

South Korea to build top-speed information highway

http://signtific.org/en/signals/south-korea-build-top-speed-information-highway

Ever9000, United States

From the Signal:

South Korea plans to upgrade their already fast broadband internet access by 2013. The Korean Communications Commission and the National Information Society Agency have teamed up to work out a blue print for the project that will extend upgraded fibre optic cable to every household. "Commission officials said the plan will enable users to transmit data at an average speed of 1 Gbps (gigabits per second) through a fixed line, more than 10 times faster than now." The project also calls for a major wireless upgrade for faster data transmission and multiple services for Internet Protocol enabled phones.

The Korean Communications Commission is sponsoring some of the infrastructure developing but the majority of the upgrade will be paid for by industry. The KCC claims the new improved infrastructure will be the engine of growth for South Korea. Areas for potential impact include e-commerce, IP-based phones, and High Definition Movie content delivery.

I wonder what new business models and e-services might emerge as a result from faster data transmission? Considering that South Korea were early adopters of the now famous triple-play offers. How will this impact online gaming? Lastly, South Korea is already a world leader in 3G wireless technology; will this potential wireless upgrade now push South Korea to be early adopters of 4G wireless technology?

Biomedical applications on the iPhone platform

http://signtific.org/en/node/52944

Attila Csordas, Hungary

From the Signal:

The iPhone SDK and the launch of the App Store created a technological gold rush for the iPhone as a third party development platform. Medical is the newest app category added and here the number of applications are in the range of 100 currently, most of them are paid apps. There are apps for researchers, physicians, students, patients of all kinds. Let's just briefly mention some to show the broad and increasing variety. Many applications are using the nice screen and visual capabilities of the iPhone like the Netter's Anatomy Flash Cards, Netter's Neuroscience Flash Cards ideally suited for medical students.

For researchers Molecules is a 3D Protein Data Bank molecular viewer using multitouch gestures. For doctors there are special image viewers like OsiriX for handling radiology image formats and MIM that can be used to view CT, MR, PT, SPECT scans. There are a lot of utilities like applications for physicians like Epocrates' medical drug encyclopedia called Epocrates Rx and many medical calculators and converters. With iHeart people can easily measure their heart pulse value after running or physical activity, using the built-in accelerometer's sensitivity.

For biologists, chemists, researchers I should highlight two pieces of software that are typical of current day applications: Solutions doing routine calculations needed before making chemical solutions and iCut-DNA, released 2 days ago, that lets you search the Restriction Enzyme Database (REBASE) for enzymes and the DNA nucleotide sequences they cleave.

One problem of the iPhone platform is the lack of open hardware connector APIs which means that the apps can only use the hardware elements already built-in in the current versions and there is no way to officially develop apps that are using the iPhone as the output device of another gadgets like different sensors.

It is hard to imagine the official iPhone version of the iBreath Alcohol Breathalyzer iPod accessory that lets you take your own alcohol breath test. There is a strong open iPhone developer community that can hack jailbroken iPhones to do things that are officially not supported but those hacks cannot appeal to a wider range of users and it is complicated to get paid by developing those hacks.

Biomedical iPhone Apps will have at least two effects in the long run: they will replace desktops and laptops used by health and science professionals in certain tasks by using iPhones as "field devices" and the apps will democratize biomedical knowledge distribution by making it easily available to layman iPhone users.

Understanding The Twitterverse

http://signtific.org/en/node/52943

Jerry Sheehan, California, USA

From the Signal:

One of the leading "killer apps" of Web 2.0 is Twitter (http://www.twitter.com). Twitter is a social networking site allowing users to micro-blog (under 140 characters posts) with content shared with a group of followers. While the Twitter phenomena has been growing exponentially, very little public data has been available about the site, the nature of user's interactions, etc.

HubSpot had done one of the first, if somewhat cursory, analyses of the Twitter in their Q4 200 report, The State of the Twittersphere. HubSpot's analysis reveals that: 70% of users joined in 2008, with an estimated 5 to 10,000 new accounts being added each day. A significant number of users (35%) have 10 or fewer followers while some users (9%) have no followers. The Twitter web site has seen traffic increase 600% in 2008 and is now one of the top 1000 Web sites in the world.

An interesting and intense debate recently erupted on Twitter over the nature of "authority." The debate started innocently enough with a user suggesting that Twitter search results ought to be filtered on the basis of "authority" defined by the total number of followers. A number of prominent Twitters, including Robert Scoble, reacted by calling the idea "stupid" due to the fact that many users game the system to get more followers and the fact that the value (quality of information) of a particular Tweet has no correlation with how many people follow a user.

Since followers have become a common metric to determine the perceived social capital of a Twitter user researchers have become more interested in understanding the social networking aspects of the service. Bernardo Hubermand and his colleagues at the Social Computing Lab at HP Laboratories recently published "Social networks that matter: Twitter under the microscope". In their study of nearly 400,000 users, the researchers examined how users interacted with "friends". Friendship was operationally defined as communication between users in which the "@" sign was used to direct a public message to a specific follower. What the HP researchers found was that with even this weak designation of friendship most Twitter users have a small number of friends compared to their followers/followees. This suggests that there are at least two tiers of social networks that need to be understood to gain a full appreciation of the Twittersphere.

Academic research of Twitter will continue to grow within the next year as marketers, politicians, and individuals struggle with understanding the importance of the answer to the question, "What are you doing?" in the electronic age.

Video phone efficiency in defibrillator usage by untrained laymen

http://signtific.org/en/node/52940

Attila Csordas, Hungary

From the Signal:

Mobile phones with video calling capabilities are relatively cheap and available. This can give rise to the question whether using an automated external defibrillator (AED) with video telephony-directed cellular phone instructions for untrained laypersons would increase the probability of successful performance of AEDs and saving the life of people with life threatening cardiac conditions like different arrhythmias?

Although AEDs are designed to be simple to use for the layman, “real-time communication with visual images can provide critical information and appropriate instructions to both laypersons and dispatchers.”

A group of researchers from the Republic of Korea conducted an observational study to assess this hypothesis:

52 public officers with no previous experience in the use of a defibrillator were presented with a scenario in which they were asked to use an AED on a manikin according to the instructions given to them by cellular phones with video telephony. The proportion who successfully delivered a shock and the time interval from cardiac arrest to delivery of the shock were recorded. RESULTS: Placement of the electrode pads was performed correctly by all 52 participants and 51 (98%) delivered an accurate shock. The mean (SD) time to correct shock delivery was 131.8 (20.6) s (range 101-202). CONCLUSION: Correct pad placement and shock delivery can be performed using an AED when instructions are provided via video telephone because a dispatcher can monitor every step and provide correct information.

Researchers Lay Out Vision for Lighting Revolution

http://signtific.org/en/node/52937

Sean Ness, California, USA

From the Signal:

A “revolution” in the way we illuminate our world is imminent, according to a paper published this week by two professors at Rensselaer Polytechnic Institute. Innovations in photonics and solid state lighting will lead to trillions of dollars in cost savings, along with a massive reduction in the amount of energy required to light homes and businesses around the globe, the researchers forecast.

A new generation of lighting devices based on light-emitting diodes (LEDs) will supplant the common light bulb in coming years, the paper suggests. In addition to the environmental and cost benefits of LEDs, the technology is expected to enable a wide range of advances in areas as diverse as healthcare, transportation systems, digital displays, and computer networking.

“What the transistor meant to the development of electronics, the LED means to the field of photonics. This core device has the potential to revolutionize how we use light,” wrote co-authors E. Fred Schubert and Jong Kyu Kim.

Schubert is the Wellfleet Senior Constellation Professor of Future Chips at Rensselaer, and heads the university's National Science Foundation-funded Smart Lighting Center. Kim is a research assistant professor of electrical, computer, and systems engineering. The paper, titled "Transcending the replacement paradigm of solid-state lighting," will be published in the Dec. 22, 2008 issue of Optics Express.

Researchers are able to control every aspect of light generated by LEDs, allowing the light sources to be tweaked and optimized for nearly any situation, Schubert and Kim said. In general LEDs will require 20 times less power than today's conventional light bulbs, and five times less power than "green" compact fluorescent bulbs.

If all of the world's light bulbs were replaced with LEDs for a period of 10 years, Schubert and Kim estimate the following benefits would be realized:

- Total energy consumption would be reduced by 1,929.84 joules
- Electrical energy consumption would be reduced by terawatt hours
- Financial savings of $1.83 trillion
- Carbon dioxide emissions would be reduced by 10.68 gigatons
- Crude oil consumption would be reduced by 962 million barrels
- The number of required global power plants would be reduced by 280

With all of the promise and potential of LEDs, Schubert and Kim said it is important not to pigeonhole or dismiss smart lighting technology as a mere replacement for conventional light bulbs. The paper is a call to arms for scientists and engineers, and stresses that advances in photonics will position solid state lighting as a catalyst for unexpected, currently unimaginable technological advances.

"Deployed on a large scale, LEDs have the potential to tremendously reduce pollution, save energy, save financial resources, and add new and unprecedented functionalities to photonic devices. These factors make photonics what could be termed a benevolent tsunami, an irresistible wave, a solution to many global challenges currently faced by humanity and will be facing even more in the years to come," the researchers wrote. "Transcending the replacement paradigm will open up a new chapter in photonics: Smart lighting sources that are controllable, tunable, intelligent, and communicative."

Possible smart lighting applications include rapid biological cell identification, interactive roadways, boosting plant growth, and better supporting human circadian rhythms to reduce an individual's dependency on sleep-inducing drugs or reduce the risk of certain types of cancer.

In October, Rensselaer announced its new Smart Lighting Research Center, in partnership with Boston University and the University of New Mexico, and funded by an $18.5 million, five-year award from the NSF Generation Three Engineering Research Center Program. The three primary research thrusts of the center are developing novel materials, device technology, and systems applications to further the understanding and proliferation of smart lighting technologies.

Cheap, user-configurable eyeglasses could improve vision for billions of the world's poor

http://signtific.org/en/node/52936

Alex Pang, California, USA

From the Signal:

An Oxford physicist has developed eyeglasses that can be 'tuned' by the wearer to correct his or her own vision." As the Guardian explains,

[Josh] Silver has devised a pair of glasses which rely on the principle that the fatter a lens the more powerful it becomes. Inside the device's tough plastic lenses are two clear circular sacs filled with fluid, each of which is connected to a small syringe attached to either arm of the spectacles.

The wearer adjusts a dial on the syringe to add or reduce amount of fluid in the membrane, thus changing the power of the lens. When the wearer is happy with the strength of each lens the membrane is sealed by twisting a small screw, and the syringes removed. The principle is so simple, the team has discovered, that with very little guidance people are perfectly capable of creating glasses to their own prescription.

Silver calls his flash of insight a "tremendous glimpse of the obvious" - namely that opticians weren't necessary to provide glasses. This is a crucial factor in the developing world where trained specialists are desperately in demand: in Britain there is one optometrist for every 4,500 people, in sub-Saharan Africa the ratio is 1:1,000,000.

While this might not seem like a development with obvious scientific and technical ramifications, it is. The development of relatively inexpensive eyeglasses, Annales historians argued decades ago, helped reorient European consciousness away from smell and touch, and toward sight. That this paralleled the start of the Scientific Revolution was no accident: good vision is a prerequisite for good observation. More generally, cheap eyewear can have economic benefits that indirectly increase the viability or vitality of science in developing countries.

The implications of bringing glasses within the reach of poor communities are enormous, says the scientist. Literacy rates improve hugely, fishermen are able to mend their nets, women to weave clothing. During an early field trial, funded by the British government, in Ghana, Silver met a man called Henry Adjei-Mensah, whose sight had deteriorated with age, as all human sight does, and who had been forced to retire as a tailor because he could no longer see to thread the needle of his sewing machine. "So he retires. He was about 35. He could have worked for at least another 20 years. We put these specs on him, and he smiled, and threaded his needle, and sped up with this sewing machine. He can work now. He can see."

China's Longxin Microprocessor

http://signtific.org/en/node/52917

Philip Cho; China

From the Signal:

According to Xu Zhiwei, Deputy Director of the Institute of Computing Technology, the Chinese Academy of Sciences will debut its 65 nm Longxin □□III (also known as Loongson or Godson), 4-core (10W) 1.2 GHz microprocessor at the end of the year, and an 8-core (20W) version in 2009. The chip uses MIPS64 cores with 200+ additional instructions for X86 binary translation and media acceleration. Given the low power consumption and less than cutting-edge 65nm silicon process, the Longxin III probably has a low transistor count. This would make it more comparable to Intel's low-end Atom processor than the upcoming Core i7.

Longxin processors are manufactured by STMicroelectronics NV. BLX IC Design Corporation and the CAS jointly produced previous versions including the 32-bit Longxin-1 in 2002 and a 64-bit chip in 2005. A Chinese computer manufacturer, Lemote Technology Corporation (http://www.lemote.com/english/index.html), has claimed to have released a Linux PC called the Fulong Mini based on the Longxin 2F processor. However, the validity of this claim is questionable as the company made a similar claim last year without delivering a single documented unit. China's fastest high performance computer, the Dawning 5000A was also supposed to use a Longxin processor, but instead opted for AMD.

The Chinese government has given high priority to domestic development of microprocessor technology. The Longxin is just one of several projects including the National University of Defense Technology's YHFT64-I EPIC microprocessor and the Shanghai Fukong Hualong Micro-system Tech's Navigation-1 chip to be used in the country's Beidou (Compass) GPS system.

Gaming Provides Another Approach to Open Science Research

http://signtific.org/en/signals/gaming-provides-another-approach-open-science-research

Vivian Distler, California, USA

From the Signal:

Scientists know that proteins fold into unique, three-dimensional shapes. However, predicting the shapes that proteins will take is one of the hardest challenges in biology today, and modeling even a small protein requires making trillions of calculations. Researchers at the University of Washington and the Howard Hughes Medical Institute have designed a game called Foldit, which "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." Any person with a computer and an internet hookup can start building proteins; with this kind of crowdsourcing, the pace of discovery could skyrocket.

What is the the real world benefit? By testing the proteins developed by the game's players, scientists will be able to identify viable candidate compounds for new drugs. Novel proteins also could be useful in a number of other applications, from industrial chemicals to pollution clean up.

According to one of FoldIt's designers, "'Our main goal was to make sure that anyone could do it, even if they didn't know what biochemistry or protein folding was.'" Another has said, "'My dream is that a 12-year-old in Indonesia will turn out to be a prodigy, and build a cure for HIV.'"

Stem Cells Used to Create Organ for Transplant

http://signtific.org/en/node/52915

Alex Pang, California, USA

From the Signal:

One of the potential uses of stem cells is in creating organs for transplant. In principle, stem cells taken from a patient should be recognized by the body, thus avoiding problems with organ rejection. However, creating those organs—particularly anything with a complex, three-dimensional structure—has been difficult. The New Scientist reports that:

A Colombian woman has become the world's first recipient of windpipe tissue constructed from a combination of donated tissue and her own cells.

Stem cells harvested from the woman's bone marrow were used to populate a stripped-down section of windpipe received from a donor, which was then transplanted into her body in June.

"Surgeons can now start to see and understand the very real potential for adult stem cells and tissue engineering to radically improve their ability to treat patients," says Martin Birchall, professor of surgery at the University of Bristol, UK, and a member of the team which constructed the windpipe tissue ...

Spanish doctors started the process by taking a 7-centimetre section of windpipe from a deceased donor.

Researchers at the University of Padua, Italy, led by Maria Teresa Conconi, then used detergent and enzymes to purge the donated windpipe of all the donor's cells. After six weeks, all that was left was a solid scaffold of connective tissue.

Meanwhile, Birchall and his colleagues in Bristol took the stem cells from the patient's bone marrow and coaxed them in the lab into developing into the cartilage cells that normally coat windpipes. Finally, the patient's cells were coated onto the donated tracheal scaffold over four days in a special bioreactor built at the Polytechnic of Milan in Italy. The patient received the finished organ in June at the Hospital Clinic, Barcelona, where surgeon Paolo Macchiarini replaced Castillo's damaged trachea with the newly constructed tissue.

As Ramez Naam comments,

"In principle the same technique could be used to regrow all sorts of organs, though actually growing the organs and having the right scaffolding is still extremely tricky and has only been demonstrated for a few organs. Even so, progress is being made at a remarkable rate."