Myelin Repair Foundation

Collaboration. Acceleration. Results.

BREAKTHROUGHS TO CURES

Promoting Novel Ways to Accelerate Medical Research

An Initiative of the Myelin Repair Foundation
Produced in Partnership with the Institute for the Future

INSTITUTE FOR THE FUTURE

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pioneer
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About the Myelin Repair Foundation
The Myelin Repair Foundation (MRF) -http://www.myelinrepair.org -is a Northern California-based, non-profit research organization focused on accelerating discovery and development of myelin repair therapeutics for multiple sclerosis. Its Accelerated Research Collaboration™ model is designed to optimize the entire process of medical research, drug development and the delivery of patient treatments.

About the Institute for the Future
The Institute for the Future (IFTF) is an independent, nonprofit research group with 40 years of forecasting experience. IFTF focuses on identifying emerging trends and discontinuities that will transform global society and the global marketplace. We provide 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, CA.

About the Robert Wood Johnson Foundation and the Pioneer Portfolio
The Robert Wood Johnson Foundation focuses on the pressing health and health care issues facing our country. As the nation's largest philanthropy devoted exclusively to improving the health and health care of all Americans, the Foundation works with a diverse group of organizations and individuals to identify solutions and achieve comprehensive, meaningful and timely change. Projects in the Pioneer Portfolio are future-oriented and look beyond conventional thinking to explore solutions at the cutting edge of health and health care. When it comes to helping Americans lead healthier lives and get the care they need, the Foundation expects to make a difference in your lifetime.

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EXECUTIVE SUMMARY

On October 7–8, and November 9–10, 2010, Institute for the Future (IFTF), in cooperation with the Myelin Repair Foundation and the Robert Wood Johnson Foundation, hosted a Foresight Engine thought experiment called Breakthroughs to Cures. Designed as an open, non-partisan environment where models for innovation in medical research can be freely explored and developed, the purpose was to generate "outlier" ideas and strategies that could lead to more effective and efficient ways to fund and conduct medical research with the goal of speeding up the development of patient treatments and cures.

Foresight Engine is a crowdsourcing platform designed to engage people from all over the world in participatory forecasting. It involves a three-step process of scenario development, community engagement in creation of micro-forecasts, and analysis of themes emerging from those forecasts.

The Breakthroughs to Cures game took place over two trial periods. During the two games, more than 400 players including students, professors, and corporate executives participated with other players in North and South America, Asia, Europe, and Australia. Between the two trials, players generated approximately 3,000 ideas—brief, 140 character brainstorms—about how to accelerate medical research.

The following is a representative sample of some of the key ideas that emerged from the two trials:

Bring mobility to clinical trials to make them more accessible. The issue of very rapid, large-scale clinical trials was addressed with two main strategies: a mobile lab and mobile patient. Mobile labs could be centered around vans, and participants also suggested the use of Skype video, in-home tele-monitoring, and body sensors that automatically report back to centralized data repositories. In addition, mobile health coaching could support clinical trials in a variety of ways, including real-time responses to in-home sensors. Finally, the group looked at mobile tools as a way to organize crowdsourced approaches to the study of disease and its treatment.

Use open and linked data standards to develop broader health records. While there is widespread agreement that health outcomes stem from a broad range of environmental, social, behavioral, and biological factors, health and medical researchers lack access to anything but a small sliver of one of these data sets. Players saw opportunities in linking these data sets into a broader database to create more robust data sets that transcend these traditional research silos. Critically, game players saw opportunities for individuals to contribute their own details—from self-tracked health information to social networking data—as new forms of information that could be used as the basis of advanced data mining and to pinpoint hidden contributing factors to disease progression and cure effectiveness.

Design, build, and maintain a global non-profit public knowledge garden. One person suggested the idea of a "knowledge garden"—a global topic map of the Internet that enables people to draw links between concepts and ideas—that was supported by many participants. This focus on topics and their relationships distinguishes the knowledge garden from an encyclopedia like Wikipedia. While most participants argued for a public knowledge garden (or gardens), others noted that it could also be developed as a private resource within an organization.

Use spare capacities to enable new research projects. A variety of projects outside of health care—such as peer-to-peer car sharing and food sharing networks—have emerged as ways for people to collectively make more efficient use of resources. Borrowing from this concept, many game players identified other spare everyday and infrastructure resources that could be used to advance medical research. For example, several players suggested enlisting computers in sleep mode to help process and analyze large, complex datasets. Others looked at physical resources and suggested that lab spaces and other facilities be opened up to graduate students and hobbyists to make more optimal use of powerful and expensive equipment.

Facilitate cross-disciplinary and other creative research through fun, informal exchanges. Many players suggested offering researchers opportunities to break from intense independent work to experiment in more enjoyable, less formal settings. Ideas in this vein ranged from encouraging virtual gameplay in worlds such as *Second Life* to the creation of more open physical spaces designed for researchers in different fields to socialize and consider each other's work. These ideas focused on using gaming and social spaces to facilitate discussion, interaction, and brainstorming in less pressure-filled and more open ways.

INTRODUCTION

Over the past several years IFTF has led a variety of projects to develop crowdsourcing tools and games that enable large groups of people to participate in thinking about and impacting the future. As part of this work, the Institute has also developed a game-like environment, the Foresight Engine, to conduct thought experiments that engage diverse participants in forecasting the future of science and technology.

Participation in the Foresight Engine begins with a future scenario presented in video format that introduces a set of assumptions about the future. Participants then play a series of "cards," which are 140 character micro-forecasts about the best and worst things that could happen in that particular scenario. They can also play "Momentum cards" that build on other forecasts, "Antagonism" cards that disagree with forecasts, "Adaptation" cards that suggest a variation on a theme, and "Investigation" cards that pose questions about forecasts. Participants earn points for cards they play and also earn points for cards that others play in response to their forecasts. Additionally, they can win special honors and awards that are either granted automatically by the system or conferred by lab guides who monitor the thought experiment in real time and mark forecasts as "Super Interesting," "Scenario Fail," or "Common Knowledge."

In collaboration with the Myelin Repair Foundation and with funding from the Robert Wood Johnson Foundation, IFTF ran two trials of a thought experiment, focused on the future of medical research, Breakthroughs to Cures. While earlier thought experiments engaged a broad range of diverse participants, many of whom lacked expertise in the domain of the thought experiment, Breakthroughs to Cures engaged networks of scientists, researchers and other experts interested in developing innovative and disruptive ideas to invent the future of medical research.

The trials were held on October 7–8 and November 9–10, 2010, and engaged more than 400 participants. This report summarizes the results of those trials.

THE SCENARIO: BREAKTHROUGHS TO CURES

While the real world physical, emotional, and financial impacts of chronic illness and disease are enormous, the pace of medical research remains decidedly slow. The Breakthroughs to Cures scenario stretched participants to think outside of their daily constraints to imagine how they could accelerate the pace of medical research in the case of a widespread, incurable pandemic.

The scenario was developed in conjunction with staff of the Myelin Repair Foundation. The goal was to present participants with an urgent challenge in the form of a deadly disease that could kill tens of millions of people. The process involved challenging participants to imagine how, in the face of this daunting challenge, researchers could break through traditional boundaries and obstacles to find a cure for the disease.

The video scenario put game players into the following world:

- A newly discovered disease called Krushner-Sedeekee Disease has infected as many as 100 million Americans, and potentially hundreds of millions globally.
- The disease has an incubation period of seven to 10 years.
- The disease is incurable—and fatal.
- In response, the President of the United States has put together an advisory board called Breakthroughs to Cures to find new approaches to develop treatments.
- The President's instructions to his advisors are: "As of today, anything and everything is on the table. I'm asking scientists, researchers, corporations: What do you need? What do you want? What must we change? What must we do away with? Business as usual is over. We will invent a new, faster way of innovating medical treatments and cures. Because we have to."

Participants were then given a series of current statistics and forecasts of real-world illnesses to help ground the scenario in the reality of current health and medical challenges. These points include:

- One in three Americans live with chronic and/or life-threatening diseases.
- There are no cures for neurodegenerative diseases like Parkinson's, Alzheimer's, multiple sclerosis, or ALS (amyotrophic lateral sclerosis, known as Lou Gehrig's disease).
- The estimated impact of these diseases is $1.3 trillion annually and growing.
- In 2008 only 21 new drugs were approved by the FDA. That number is no greater than it was 50 years ago.

Finally, players were challenged with the following on their cards/screens:

- YOU can help. Imagine that YOU are on the President's advisory board in 2020—and in this future, any change is possible.

- What if you could …
  Get any resource you needed?
  Remove any obstacle?
  Change any practice?
  Collaborate across any boundary?
- What would give YOU the ability to help find cures, faster?
- This is your chance to forecast the best-case scenario for medical research, and then tell us exactly what needs to happen to make it real.

Goal of the Scenario:

Designed to bring a renewed sense of urgency to the challenge of accelerating medical research, this scenario was developed to encourage players to break out of their traditional research silos, mental constructs and pressing day-to-day challenges to imagine how they would approach medical research in the face of the threat of a global pandemic.

Its aim was to encourage players to imagine how they would reinvent the world of medical research given an opportunity to create a research system with no constraints. These ideal conceptions led to the emergence of a series of concrete, realistic themes and strategies that institutions and researchers can use to accelerate the pace of their own work.

KEY THEMES AND STRATEGIES

The micro-forecasts that emerged from the Breakthroughs to Cures scenario ranged from specific innovations in technology to ideas about how to facilitate social and cultural changes that could advance collaboration. In this section, we highlight key themes and provide sample forecasts that are notable in scope or scale or in their ability to stretch imaginations to the world of outlier possibilities.

This section consists of three separate but complimentary analyses. By looking at word use patterns and idea frequency, IFTF examined key themes that emerged during both game play trials. From there, the investigators looked at additional series of keywords that emerged in only Game 1 or Game 2. Doing so enabled the identification of common themes between the games as well as outlier ideas from the two trials.

KEY THEMES AND STRATEGIES SPANNING BOTH TRIALS

Over the two game trials, several recurrent themes emerged. These ranged from divergent thoughts about how to reshape financial incentives for researchers, research subjects, and companies for the purpose of advancing medical research to discussions about how to facilitate social trust that encourages collaboration.

The themes that cut across both trials were:

- Idea flows
- Incentives
- Multi-sector partnerships

These broad themes include several specific strategies to accelerate medical research. After each strategy, we have reproduced some of the specific ideas that were generated during game play.

Idea Flows

Some of the most notable discussions spanning both trials of the game considered how ideas and concepts move from person-to-person and group-to-group. As such, a variety of different ideas emerged regarding how to facilitate these exchanges, as well as how to capture, classify, test, and disseminate small-scale experiments and bring them to the broader community.

Bottom-up global innovations, including self-experiments, point toward emerging low cost but effective treatments that require more rigorous testing. In considering the vast range of micro-experiments that people already conduct on themselves several participant suggestions focused on putting these experiments through more rigorous scientific studies. Others pointed for the need to simplify global peer-to-peer knowledge

or resource exchange.

Some of the ideas generated through game play include:

- Create a massive funding source that fuels research across the world. Legal restrictions - update global database daily w/ progress & discoveries.
- Enlist 1 billion humans in global life-monitoring project, providing mobile sensor paks & aggregating massive datasets for analysis
- Prioritize the development of patient reported outcomes that correlate well with objective biomarkers so we can measure globally for free.
- Think about more imaginative, low-cost, low-tech solutions (see e.g., Afrigadget.com). A vitamin may work just as well as a $50000/yr drug!
- Create a free online inventory database to easily share or trade reagents, antibodies, cell lines, and media so that science = cheap.
- The freely available patent literature can be a great source of ideas that others are free to build on and publish on.
- This could be like a "cold case" team. A network of research interns that apply modern tech to oldest failures & work forward to present

Understand local community assets and the strategic efforts of external research communities to optimize resources and practices. Several players pointed toward specific standards in other professional communities, including physics and open-source software development. These examples suggest the need for immediate concrete actions and standards that biomedical researchers can explore to advance their own work. Others pointed to the need to leverage community intelligence and the perspectives of local communities to better identify promising research targets.

Some of the ideas generated through game play include:

- Consider what the physics community does: publish all papers online before submitting to journals. That gets the ideas out sooner
- Sounds a lot like the \open source\" platform. Should we look closer at the Linux community?"
- Sci-fi lit has track record of predicting future changes, tech, etc. Develop entire design community to model the possibilities.

Leverage computational methods and sciences to develop virtual patient panels, segment trial populations more effectively, and hone patient criteria and experiment methods. Several players pointed toward the use of robust data tools and computational analysis to identify potential patients to enroll in trials. These computational tools can also open up opportunities to more effectively identify subpopulations where specific treatments are expected to be successful.

Some of the ideas generated through game play include:

- Design drug trials where the population is genetically unique, multiple promising

drugs are used, and multiple legs are run simultaneously
- Lots of work being done is computer aided drug design & related areas. One example company: http://q-pharm.com/
- scientists need better experimental design to avoid unnecessary experiments and save$. could "designers" from other fields aid this process?
- Entelos is working on \virtual patient panels\" precisely such comp modeling of body systems to pops. This could be expanded on a grand scale"
- \virtual patient panels\" (see enteleos) that model variation in body systems & pops will speed trials
- Develop a white-hat botnet of 100M personal computers to aid in computational drug analysis
- Design drug trials where the population is genetically unique, multiple promising drugs are used, and multiple legs are run simultaneously
- Create a visual relational database of all of the science and medicine we have already discovered as a resource for future discovery.

Incentives

Game players were intrigued by different ways to shift the incentives in the academic and pharmaceutical research communities: to improve creativity, boost productivity, encourage risk taking, and eliminate the stigma of failure.

Experiment with different models of financial incentives—and with incentivizing different actors—to advance research. While participants in both games identified flawed financial incentives as a major barrier to medical research, there was little agreement about how to best encourage and improve research collection. Some of the more innovative ideas suggested using X PRIZE-style contests to encourage discovery and to look at shifting incentives for software developers to promote more open systems for exchanging information. In total, these ideas point to the need for more diverse experimentation with funding models and efforts to help spur collaboration.

Some of the ideas generated through game play include:

- Financial compensation and survivor benefits for test subjects who enroll for medical tests. Test subjects save lives by risking theirs.
- Plenty of research doesn't generate directly obvious financial reward. Sometimes it takes years for old research to develop new strategies.
- Provide incent. to developers of proprietary software to wk together to create interoperable systems. Promote open = financially rewarding
- non-profits could be used as IP holding companies, with different impact measures for licensing (vs purely financial)
- Financial support for this to cover living costs of participants would allow some amazing collaborative projects to be undertaken.
- Deliver financial incentives to companies sharing their ongoing research databases, that result in scientific breakthroughs
- X-prize it! Allow government to give subsidies, or financial "reward" to the first 3

companies to develop FDA verifiable cures.
- make diagnostic test development financially lucrative. Early detection is not lucrative and hence not invested in my pharmas.

Improve trust to offset the social cost of failed experiments. In spite of the trial and error nature of scientific research, it is difficult for researchers, as well as organizations, to admit to mistakes and research dead-ends. Game players said they saw enhancing trust as key to disclosing failures more transparently and as a critical means for encouraging collaboration across disciplines.

Some of the ideas generated through game play include:

- Communication in health as well as rapport/trust to foster collaborative relationships can certainly benefit from this.
- Fraud is eventually discovered and public trust in scientific research falls leading to reduced overall funding.
- Trust is a crucial metric in collaboration for a safe environment; you won't get slammed if you put up a bad answer.
- To truly collaborate, we need to trust each other...that ALL are working for a cure & not for profit/gain, but for the sake of helping ALL
- Thought it fit Dark intuition definition: \What's the biggest obstacle to making this change?\" The obstacle is lack of TRUST & selflessness"
- understanding the points of view of each person. along the innovation pipeline builds trust. Innovation is social
- All Scientific research is published and freely available. Trust and respect for discoveries and work allows for the elimination of Patents.
- Selection first: create new research excellence group unrelated to current standing - then trust: no reporting/verification, let them work.

Multi-sector Partnerships

In addition to looking to shift the nature of incentives, some players suggested stretching the traditional boundaries of organizations to use multi-sector collaborative efforts to change traditional barriers to knowledge and understanding.

Create public-private partnerships and multi-sector partnerships to enhance collaboration between networks. Several respondees pointed to the possibility of expanding relationships between nonprofits, for-profits, and governments to improve patient recruitment for clinical research. Others suggested modeling charity efforts after One Laptop per Child, where consumer purchases would generate funds or resources to expand the range of research efforts.

Some of the ideas generated through game play include:

- Gov't/Private sector ptnrshp - buy a computer and a 2nd one is donated to be committed part of network (similar to the $100 laptop).

- NGOs have access to the patient networks -- can facilitate RCTs and eventual implementation once tx is approved.
- So next gen npo is innovative at using multiple social networks and getting disparate grps together...crosses channels frequently
- Non-profits could help researchers get in touch with test subjects through social networks and raising awareness on new treatments.
- Agree. That's adding a point to other cards suggesting social networking among researchers, clinicians, schools, and patients.

GAME 1 THEMES

In addition to common discussion threads that emerged across trials, there were ideas that emerged in one game but not the other. This section summarizes the thematic and strategic ideas that generated significant discussion in the first game.

The themes that emerged in Game 1 but not Game 2 were:

- Engaging the Public
- New Exchanges
- Enhanced Data Mining

These broad themes include several specific strategies to accelerate medical research. After each strategy, we have reproduced some of the specific ideas that were generated during game play.

Engaging the Public

Some of the most active discussions from Game 1 focused on finding different ways to engage non-scientists in scientific research. These players also pointed toward innovative, and often low-effort, ways to bridge relationships between formal institutions and hobbyists.

Create tools to enable data donorship and exchange. Fearing privacy violations and loss of control over personal medical or research records, a variety of players pointed toward ways to encourage data donorship. Ideas here ranged from enabling non-medical professionals to offer their own self-tracked data to research groups to giving researchers tools to mark their research with a Creative Commons-style license. As part of these discussions, players suggested that data donorship could be connected with some sort of reciprocity in which research built on top of data in the commons would be open to encourage ongoing data donation.

Some of the ideas generated through game play include:

- A group of disease advocates decides to forgo anonymity and make its genome and phenotypic data public. Aw, never mind...it'd never happen.
- Genome sequencing should be available free of cost. & the data should be made available in a publicly searchable database (names redacted).
- Data is contributed by a more diverse set of patients (in a consistent format) than if it were limited only to brain scans and blood tests.
- re-imagine a framework for IP such that its value is a function of sharing, not holding.
- Who would administer this framework for IP sharing? Is it an extension/analog of Creative Commons?
- Open access to data would prevent 'ownership' of data, results, patents, etc. Need to evolve new incentives based on people cured.

- I would give patients the power to self report. Media such as facebook, twitter and social network would allow for rapid mining
- We figure out good anonymization strategies that allow us to see the big patterns without compromising individual privacy

Look for diverse opportunities to engage the public and encourage public participation in research. Recognizing that many non-scientists would like to contribute to advancing medical research but lack avenues for participation, players looked for ways to allow the public to contribute to research. Besides data donation, other ideas considered opportunities for crowdsourced information collection and analysis including citizen-driven mapping projects. Other players suggested that engaging non-scientists in collaborative brainstorming sessions could force researchers to re-examine their assumptions and gain insight into their own work.

Some of the ideas generated through game play include:

- Instead of wearing colored ribbons to support medical research, the fashion industry designs wearable microarrays & other sensors 4 support
- Work with gaming industry specifically - largest touch point with youth, largely works on collaboratively model for gamers.
- Enlist 1 billion humans in global life-monitoring project, providing mobile sensor paks & aggregating massive datasets for analysis
- Create an on-line, real-time environment (ie. Second Life) for medical researches to exchange ideas, 1 full day per week (20% rule).
- Develop sensors and ambient technology that can monitor activities of in daily life continuously reported and supplemented by self reports
- enable gyms to become data collection hubs. augmented with gaming and sensors local neighborhood gym becomes a clinical data machine.
- Ptnr with Disney to create massive World of Science park -edutainment and opp to interact with researchers at work. 1/2 park 1/2 campus.

Develop formal programs to underwrite and engage the efforts of recreational biologists and other outlier efforts. While hobbyists and professional scientists occasionally come into contact, many citizen science pursuits remain largely beyond the radar of professional researchers and granting organizations. Many Game 1 players suggested the opportunity to engage interested hobbyists, biology tinkerers, and other nontraditional research groups in more formal ways. In part, players suggested that small grants for hobbyist scientists could expand the types of research and numbers of researchers looking into advancing basic and translational science. Additionally, some players suggested setting aside certain portions of grant funding to fund unusual ideas that might break from traditional research.

Some of the ideas generated through game play include:

- A public microgrants platform should be developed to support rapid, low-cost DIYBIO innovation & prototyping

- Existing academics could provide supervision for experimental course work at a community hack space in exchange for research assistance.
- Engage the local community in these collaborative research models to extend the idea space beyond academia.
- Current communities usually go the non-profit route. Creating more DIY BIO and open science specific grants could help propel them further.
- Encourage crowdsourced mapping of symptoms, potential disease incubators, sightings of vectors via Ushahidi platform
- Build and encourage independent community driven research facilities. Like library, but with equipment and no special interests driving.

New Exchanges

Another important theme emerged around finding new ways to exchange information and resources. Some suggestions considered how shifts in practice—including making it more enjoyable to collect and publish research—could advance opportunities to collaborate.

Facilitate cross-disciplinary and other creative research through fun, informal exchanges. Many players suggested offering researchers opportunities to break from intense independent work to experiment in more enjoyable, less formal settings. Ideas in this vein ranged from encouraging virtual gameplay in worlds such as *Second Life* to the creation of more open physical spaces designed for researchers in different fields to socialize and consider each other's work. These ideas focused on using gaming and social spaces to facilitate discussion, interaction, and brainstorming in less pressure-filled and more open ways.

Some of the ideas generated through game play include:

- make local playgrounds, parks as places of idea generation and exchange. create an idea force which collects ideas
- Protected time 2 play in a 2ndLife open source global research "lab" - knowledge across boundaries --> a collective source for innovation
- Chance encounters, personal relationships will lead to powerful collaborations. Like the relationships that found cause of colony collapse.
- Harnessing the power of friendly competition among individuals within social networks & achieving the right balance of ambitious compassion.
- Kickstart global research co-op 2 aggregate finding & progress in2 open visual data -> empower smart ppl who don't work here 2 find the cure
- Research publications aren't about getting paid. The issue is research behind paywalls of for-profit journals hurts collaboration.
- Problem solvers supported w/ focused time, funding & resources 2 explore solutions collaboratively --> end goal = finding cure (not self)

Use spare capacities to enable new research projects. A variety of projects outside of health care—such as peer-to-peer car sharing and food sharing networks—have emerged as ways for people to collectively make more efficient use of resources. Borrowing from this concept, many game players identified other spare resources that could be used to

advance medical research. For example, several players suggested enlisting computers in sleep mode to help process and analyze large, complex datasets. Others looked at physical resources and suggested that lab spaces and other facilities be opened up to graduate students and hobbyists to make more optimal use of powerful and expensive equipment.

Some of the ideas generated through game play include:

- Build a networked game to fold proteins, to make a prion to restore brain function by fixing the proteins that the bad prions misfolded.
- Redirect all supercomputing resources, google servers etc to computational drug discovery & testing
- Communities could "fuse" their economical resources if they are developing the same research.

Enhanced Data Mining

While there was a greater focus on technology in game 2 than in game 1, players in game 1 were interested in technology tools that could be used to advance research efforts. In particular, players were interested in new ways of looking at data—to pool resources to act and to identify with whom to work.

Use open and linked data standards to develop broader health records. While there is widespread public agreement that health outcomes stem from a broad range of environmental, social, behavioral, and biological factors, researchers lack access to anything but a small sliver of one of these data sets. Players saw opportunities in linking these data sets into a broader database to create more robust data sets that transcend these traditional research silos. Critically, game players saw opportunities for individuals to contribute their own details—from self-tracked health information to social networking data—as new forms of information that could be used as the basis of advanced data mining and to pinpoint hidden contributing factors to disease progression and cure effectiveness.

Some of the ideas generated through game play include:

- Take the yrs of past patient data and leverage the vast govt computing powers to develop 'interactive disease' models for Research.
- deidentified records availability could speed up easily with EMR, without privacy concerns.
- Notions of privacy r changing rapidly - ppl check in on 4square about health, not sure what privacy advocate will mean in 5 yrs
- Create a visual relational database of all of the science and medicine we have already discovered as a resource for future discovery.
- Epidemiology, plus habitat, food sources,& environmental factors could be studied, too.

- Include pharma and create therapy database allowing researchers and pharma to collaborate directly

Look at reputation scoring and reputation economies to facilitate collaboration. A number of responses looked at how to take advantage of social data to advance medical research. One discussion thread focused on emerging reputation economies that rely on social capital metrics to identify researchers who effectively work and collaborate across research and institutional barriers. It's critical to consider that these scores could help researchers identify peer reviewers and other collaborators who would more effectively help them advance their work.

Some of the ideas generated through game play include:

- Awesome idea! Adapting the power of social influence for medical innovation doesn't need funding from government to implement.
- Academia commits to branded departments for firms w/ high firm reputation. They feed biopharma best minds. Pharma feeds back % of profits.
- Bridge the gap btw academic and biopharma via reputation economy. Firm reputation will reflect the commitment to find the cure.
- However, researchers wouldn't be so eager to try risky/innovative ideas as they could ruin their reputation.
- What if you used risk taking reputation score as a metric for funding?
- Reputation points for transparent failing.
- Make anonymised data from this experiment downloadable to study collaboration under pressure - models of informational reputation economy

GAME 2 THEMES

In addition to common discussion threads that emerged across trials, there were ideas that emerged in one game but not the other. This section summarizes the thematic and strategic ideas that generated significant discussion in the second game, but not the first.

The themes that emerged in Game 2 but not Game 1, were:

- Focus on Technology
- Knowledge by Design
- Ethics and Safety

These broad themes include several specific strategies to accelerate medical research. After each strategy, we have reproduced some of the specific ideas that were generated during game play.

Focus on Technology

Participant reactions to Game 2 were more focused on technology than Game 1. This was reflected in clusters of cards around cloud computing, mobile tools, software, virtual systems, and EHR. Themes embodied in these clusters included:

Bring mobility to clinical trials to make them more accessible. The issue of very rapid, large-scale clinical trials was addressed with two main strategies: a mobile lab and mobile patient coaching. Mobile labs could be centered around vans, and participants also suggested the use of Skype video, in-home tele-monitoring, and body sensors that automatically report back to centralized data repositories. In addition, mobile health coaching could support clinical trials in a variety of ways, including real-time responses to in-home sensors. Finally, the group looked at mobile tools as a way to organize crowdsourced approaches to the study of disease and its treatment.

Some of the ideas generated through game play include:

- Make participation in trials easier...mobile vans visit pts at homes to conduct routine labs
- Clinical trial participants could participate with in-home labs or take samples and mail to labs instead of relying on a mobile van
- Virtual in-home labs, mobile devices, and in-home tele-monitoring systems could be used too :D
- Provide a centralized database that collects clinical trial data in real-time from computers and mobile devices
- Aggregated physiological data from mobile-based sensor body networks work to collect, compile, analyze and predict abnormalities in body.
- Never-ending and perhaps always accessible (take to mobile devices for on-the-go participation during breaks).
- IP-enable everything that can provide real-time impact to health (e.g. removal of ice cream from fridge alerts mobile health coach)
- Build technology tools that help people change their behavior, including effective mobile coaching.
- Organize patients & families thru web, mobile and ehealth TV channels to \Crowdsource\" studies about the disease and potential treatments."

Create a cloud computing platform to support coordinated research data worldwide. Cloud computing has emerged as a technical foundation for the kind of large-scale, coordinated data repository necessary to support broadly accessible data in studies and so-called “bio-banks.” While some of these proposals focused on proprietary platforms managed primarily for professionals, gamers pointed out that similar capacities have already been proven with semantic web applications and peer-to-peer infrastructures like seti@home. The importance of global access was emphasized.

Some of the ideas generated through game play include:

- Cloud harnesses virtual nature of internet (limitless storage and processing). Simply upload data and use software to mine for solutions.
- Use of cloud computing to efficiently and effectively process the data and provide predictive intelligence based on trends in research.
- Cloud computing among privately own corporations to help speed up research and long mathematical models. Having only access to doctors.
- All public sector/government computers to run distributed computing research software to speed up research time.
- Global repository of data from studies + \bio banks\" = gold mine for researchers. This can be implemented thru cloud-based systems"
- Infrastructure with regards to 4G may be costly for many nations. Simple tools such as internet, SMS, the cloud can work.

Focus on new tool development to speed research. Some gamers argued that tool development was, in some ways, more important than additional research funding because it would create the foundation for more effective research. The suggestions ranged from tools and software to provide specific kinds of analysis to more general strategies for creating incentives for the conception and creation of new tools. Games like Foresight Engine also got support for collaborative and crowdscourced projects.

Some of the ideas generated through game play include:

- Increase spend[ing] leads to linear progression not exponential progression as funding is spent on research not developing new tools for analysis
- Use molec analysis techniques and software to determine statistically significant diff in disease v norm
- And to focus more efforts on transmission vectors, use dx [diagnostic] tool (see video) to identify sources of disease and remove sources
- We have a dx tool per video. This implies we can target molecule. Nd to understand how to use/modify tool to destroy/prevent spread of dis[ease]
- We'd need data management tools to be 1) based on current clinical and biomedical knowledge. 2) responsive to new discoveries.
- Software to analyze data, to prepare summaries,provide a global repository of linked data, knowledge artifacts as they are discovered.
- They enter this data into mol analysis software or Excel spreadsheets to determine statistical signifc. This is \biomarker.\"
- Provide incent. to developers of proprietary software to wk together to create interoperable systems.Promote open = financially rewarding
- Robert Blum pointed the way to this with his RX phd at Stanford. Software to harvest from longitudinal studies.

Support adoption and enhancement of electronic health records (EHR). The potential of more widespread use of EHR to provide a broad clinical basis for research was obvious to gamers, but they were particularly interested in enhancing the patient-side of the equation—including the standards for patient reporting.

Some of the ideas generated through game play include:

- But there should always be ways to extract rx info and follow-on symptom data from EHRs and share this data widely
- Create more benefits for docs adopting EHRs, Uniform software, compatible with multiple mobile devices. Training for nurses, staff, & pts
- Not just records from health centers appear in EHR, but more detail events can be stored in it for further sign and symptom mining
- Adaptation to EHR brings the data home to the pt, but data needs to be available, sanitized, for general research and learning.
- I think there is no specification for patients side-effects from a medicine in EHR standards... or is?
- PatientsLikeMe.com has interesting take on patient-side reporting on medications. Not full EHR, but can be exported or shared w. physician.

Knowledge by Design

Ways of organizing information and knowledge got a lot of coverage in Game 2. In particular, the ideas of knowledge gardens and topic maps generated large amounts of dialogue. Other kinds of maps and mapping also emerged as focal points for medical discovery.

Design, build, and maintain a global non-profit public knowledge garden. One person suggested the idea of a "knowledge garden"—a global topic map of the Internet—that was supported by many participants. This focus on topics and their relationships distinguishes the knowledge garden from an encyclopedia like Wikipedia. While most participants argued for a public knowledge garden (or gardens), others noted that it could also be developed as a private resource within an organization.

Some of the ideas generated through game play include:

- Grand Summary: create and maintain a global, public collaboration/federation knowledge garden. Details follow.
- Knowledge garden is a topic map with many stakeholders described here:
- Federate all such communities with a knowledge garden, a topic map that curates all topics from all communities.
- Thanks! I define a knowledge garden as a topic map plus facilities that provide domain-specific user experiences. More next.
- A knowledge garden is a map, a topic map, not the territory. Wikipedia is territory.
- A knowledge garden is larger in size, scope, and technology than Wikipedia. Points made in the child cards.

- In the knowledge garden, nobody edits the work of others. Your \work\" is that of adding tags
- Garden should facilitate: foraging on the web for resources, annotating resources, connecting ideas, and structured conversation
- Garden should facilitate, as a service, structured conversation games such as this one.
- Garden must provide a topic-centric map of all ideas, connections, debates, and other resources found on the web.
- In an imagined garden, consider subscribing to feeds from those who seem to be doing interesting stuff.
- With the garden, you can serve K-12, college, university, research labs, g'ments, and grandmothers. In all languages.
- Indeed. There is no reason that enterprises [can't] implement a \knowledge garden\" inside
- There is a concept done by IDEO call \Coupland\" that touches on an internal \"knowledge garden\" that can be shared with a public audience."
- Engage all levels of research in a public knowledge garden. Share everything that is discovered, and debate what is controversial there
- How to change the model 4 academia to reduce the threat of good ideas being \scooped\"? ie how do we make knowledge gardens protected space?"
- Gardens should NOT be protected places. I think you might be arguing from an ancient epistemology that needs serious overhaul.

Refine the technology of the topic map as the centerpiece of a knowledge garden. A core component of the knowledge garden is a topic map in which the relationships among topics are also topics. This ability to highlight relationships as topics creates the possibility of tracking new paths of cause and effect. It also shifts the emphasis of knowledge management away from discrete content and toward the relationship among different kinds of content.

Some of the ideas generated through game play include:

- A topic map is a structure that represents topics with containers that hold property types and values (color: red). More next.
- A topic map requires that there be just ONE \place\" in the map for each topic (think Wikipedia)"
- A topic map accumulates links to resources, even controversial ones.
- A topic map allows aggregations of all \names\" for the topic in all languages"
- A topic map can have structure such as taxonomies and all other kinds of relationships among topics.
- A topic map represents relations as topics. This means you can use a relation as a topic for debate. A causes B. Can debate that cause.
- A topic map represents relations as topics. This means you can use a relation as a topic for debate. A causes B. Can debate that cause.
- It is possible to federate disparate conversations that matter into a uniform map of expressed worldviews.

- The topic map is thus a community memory.
- #mashup platform merging asset map (identifies ppl/skills/resources in a community) & better means (tracks value of input in collaborations)

Support development of medical mapping tools and technologies. Beyond knowledge management and access, mapping as a discipline is coming into its own. Specific types of medical mapping that gamers saw as critical to medical discovery and cures were brain mapping and gene mapping—especially family gene mapping. Increasingly medical mapping is finding support among the public, and one gamer even suggested that family gene-mapping could be an incentive for people to participate in clinical trials.

Some of the ideas generated through game play include:

- Exactly! That is the point! The more computing power we have the faster we can solve many problems such as Neurological Brain mapping.
- Other patient recruitment incentives: gene-mapping of families of patients.
- con: free health insurance + gene-mapping is expensive as heck. It's already expensive to put 1 patient thru clinical trial. pharma says no
- Regardless of expense, gene mapping families is crucial. Consider pts with HH and all that entails...
- Could data like family gene-mapping propagate ideas of \genetic superiority\"?"

School. The Game 2 community advocated lots of school reforms and innovations as a way to grow medical knowledge faster.

Some of the ideas generated through game play include:

- Move research increasingly down in the education system, eventually including primary schools in research; start training earlier
- Disease-Science Fairs in every school, nation wide. Best projects get to showcase their findings at next level. Ex: Brownie points 4 cllge
- Actively including high school students in research as an extra curricular activity.
- Perhaps include high school students in research as a part of an integrated curriculum.
- train interested amateur scientists, high school and college students, etc. have them work on individual subproblems scientists face
- Allow citizen scientists/amateurs to use lab space at high schools/universities when not in use by those institutions.

Ethics and Safety

Game 2 also focused heavily on ethics and safety. These issues arose in the game primarily in the quest for faster cures and hence short-cutting procedures that have been established to protect the safety and rights of patients and the general public. The gamers

did not manage to move beyond the basic dilemmas that seem to limit solutions here, though a couple concrete ideas did surface.

Use larger public data resources to improve both safety and efficacy. In Game 2, the discussion of public access and public contribution to data included a specific focus on safety and ethics. Embedded in this discussion were suggestions to separate safety and efficacy to take advantage of larger public data sets; relaxing of ethical rules concerning payment for participation by healthy volunteers; tracking records worldwide; and even reconsidering the interests of ethics committees. Each of these suggestions raised counter arguments, enhancing the overall discourse.

Some of the ideas generated through game play include:

- Clinical practice provides pragmatic way of increasing safety database for a new drug - that could be a primary driver for \full\" approval"
- I'd separate questions of safety and efficacy. Validity of an animal model of efficacy frequently more suspect than model of gross toxicity
- Subject could be included as part of safety assessment, but excluded from an efficacy analysis (e.g. because of concommittant meds)
- (CNS) Drugs with track records of safety anywhere in the world are screened individually and in (limited) combination for effects on disease
- Encourage research partic as volunteer wk/donation, but 2 get healthy sbjcts *relax* ethics rules against payment & allow market 4 subjects
- Right: subjects r volunteers, not patients. So what constitutes an ethical offer 2 participate in voluntr wk? Resrch ethics shld match that.
- Changes to legislation and safety/ethics regulations result in public concerns of rights infringements, utilitarianism etc
- I have \ethical\" problems with an attitude that says \"grab data where you can find it\". For this to work
- Ethics committees restricting research based on their moral values and not the overwhelming public need.

Develop tools to support public and personal risk assessment. One idea that follows from the greater public participation in medical research is greater public access to the information. One player hinted at a possible advance in the tools for the public not only to access this information but also to use it to interpret their personal risks.

Some of the ideas generated through game play include:

- Approval based on surrog endpt + safety, BUT, efficacy/safety info could be shared w public & public decides their risk/reward profile.
- (CNS) Drugs with track records of safety anywhere in the world are screened individually and in (limited) combination for effects on disease

Animal experiments. In Game 2, participants suggested several ideas about innovation that attempted to eliminate or reduce the role of animal experiments in the medical process.

Some of the ideas generated through game play include:

- Just playing off Kate's card - yes skip safety and efficacy studies in animals. Go straight to humans.
- Creation of new stem cell lines/ability to potentiate specific human tissue groups = reduced need for animal models = less risk to humans
- Progress this to the next step, potentiate stem cells into tissue cultures so these can be used instead of live subjects or animal models.
- Agreed. Perhaps using a human model in a computational environment to simulate or model findings, but no skipping animal studies.
- Entelos is working on \virtual patient panels\" precisely such comp modeling of body systems to pops. This could be expanded on a grand scale"
- In an apocolyptic healthcare situation no valid animal models, glacial disease latency period a Therapeutic Development Draft is instituted

Placebos. Gamers pointed to the increased industry attention on placebo effects, both because it interferes with research based on broader clinical and public data and because the effects could be informative in actually addressing diseases.

Some of the ideas generated through game play include:

- Placebo effect and other issues raised by FDA need to be reduced to allow wider range of trial results to be applied.
- Placebo response is certainly a huge (and growing) issue in executing successful randomized controlled trials
- We *should* want to investigate placebo effects; we're not fighting \snake oil\" vendors these days. We're fighting serious diseases."
- In clinical practice we (should?) want to harness placebo effects in concert with direct (mechanistically driven) drug effects to treat dis
- In current placebo-controlled trial practice we're generally obligated to minimize placebo response to show statistical sig. effect of drug
- I agree we need to need to understand how placebo responses impact (confound, augment - additively?, synergistically?) our drug candidates

CONCLUSION

The two trials of the Breakthroughs to Cures Foresight Engine game were aimed at using game dynamics to produce crowdsourced ideas about the future of medical research as it relates to productive collaboration. The game trials sought to bring together a diverse group of players into conversation with one another and to use these conversations to generate ideas about how to more effectively conduct drug discovery and research. To generate these ideas, the Breakthroughs to Cures scenario stemmed from the concept that research funding wasn't an issue but that the urgency of a growing pandemic required new and immediate thinking about innovative ways to use these resources.

Game play resulted in a series of micro-forecasts. While these limited snapshots may seem superficial or limited at first glance, the chains of discussion generated creative and diverse perspectives about how to better navigate many of the challenges that have plagued traditional biomedical research. As we have highlighted throughout this report, players focused on ideas about how to take advantage of current and emerging technological infrastructure to capture, classify, and make sense of critical health data at a much faster speed. Not only did game players capture the technological opportunities involved in improved data collection, but they also identified creative ways to turn this data into a public resource. They conceived of ways to make it accessible and comprehensible to a wider array of academic disciplines and researchers through concepts such as knowledge gardens.

In addition to considering technological responses, game players identified a variety of strategies that could be used to enhance collaboration. They ranged from finding ways to more efficiently use spare capacities and lab resources to build partnerships between different sectors, varied disciplines, and even between amateur scientists and established professionals.

In sum, what game play pointed to was a variety of opportunities—particularly in terms of technological infrastructure and in terms of the types of relationships that could be built to bring new ideas to basic science research and to make better use of current resources. Many of these ideas point toward long-term opportunities to facilitate connection and accelerate, and in this sense, provide the outlines for actions to take over time to accelerate medical research.

APPENDIX: GAME STATISTICS

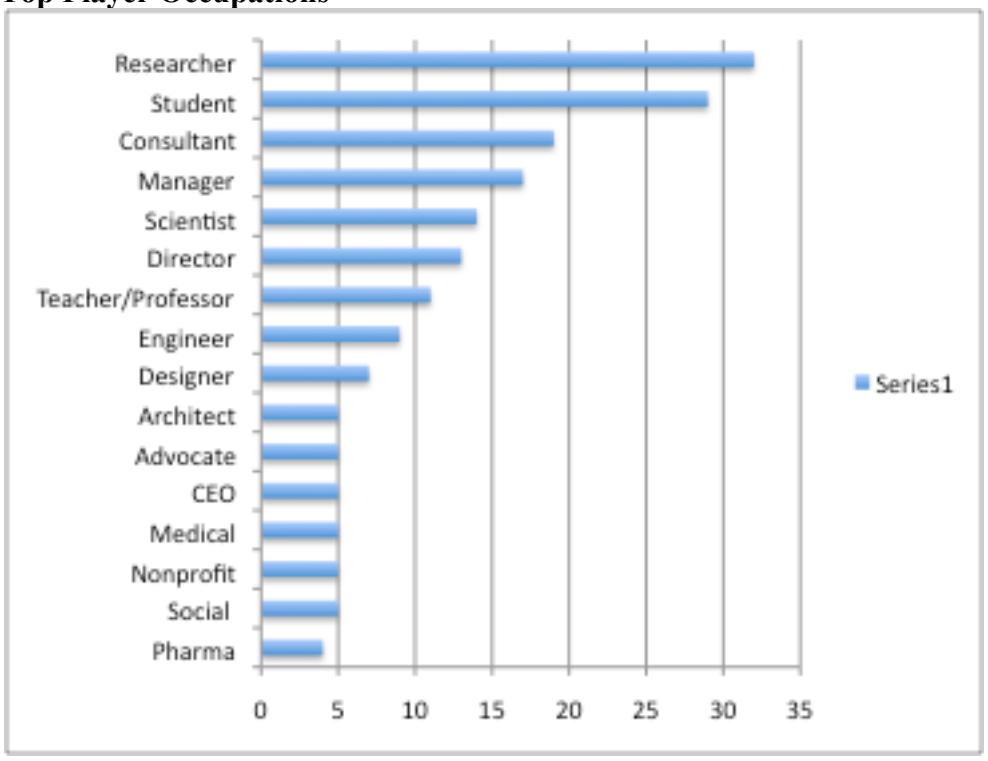
This section summarizes game play statistics from the two trials of the Breakthroughs to Cures game. The statistics here are presented separately for each trial. Game 1 refers to the trial that took place on October 7–8, 2010, and game 2 refers to the trial that took place on November 9–10, 2010.

GAME 1 STATISTICS

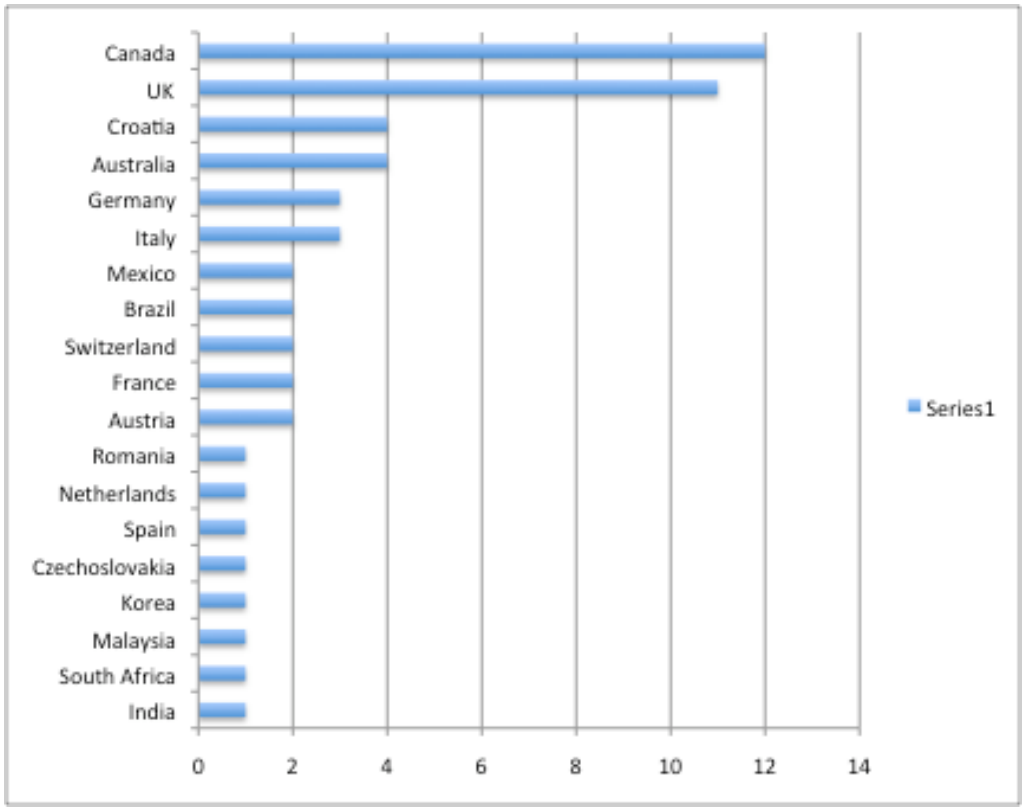
- 335 people signed up to play
- 241 people played at least one card
- 1,594 cards were played
- Positive Imagination to Dark Imagination ratio: 3:1
- 312 Investigation questions
- 463 Momentum cards
- 150 Adaptation cards
- 234 Antagonism cards

Game 1 Player Data

Top Player Occupations



Non-US Player Locations

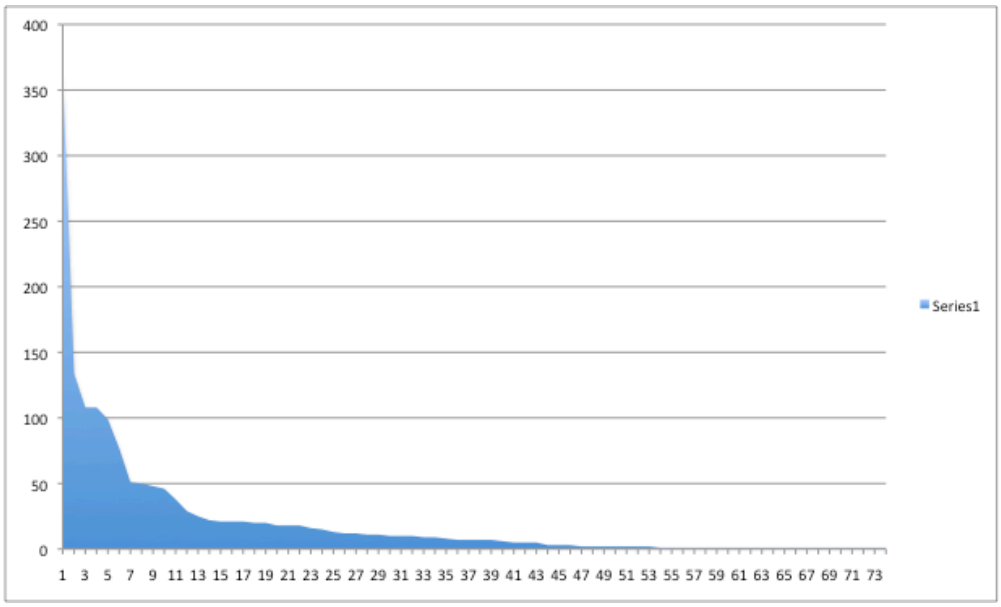


GAME 2 STATISTICS

- Total cards played: 1,957
- Players signed in: 129
- Players who played at least one card: 73 (57%)
- Positive Imagination to Dark Imagination ratio: 10:1
- Investigation questions 598
- Momentum cards 105
- Adaptation cards 203
- Antagonism cards 440

Game 2 Player Data

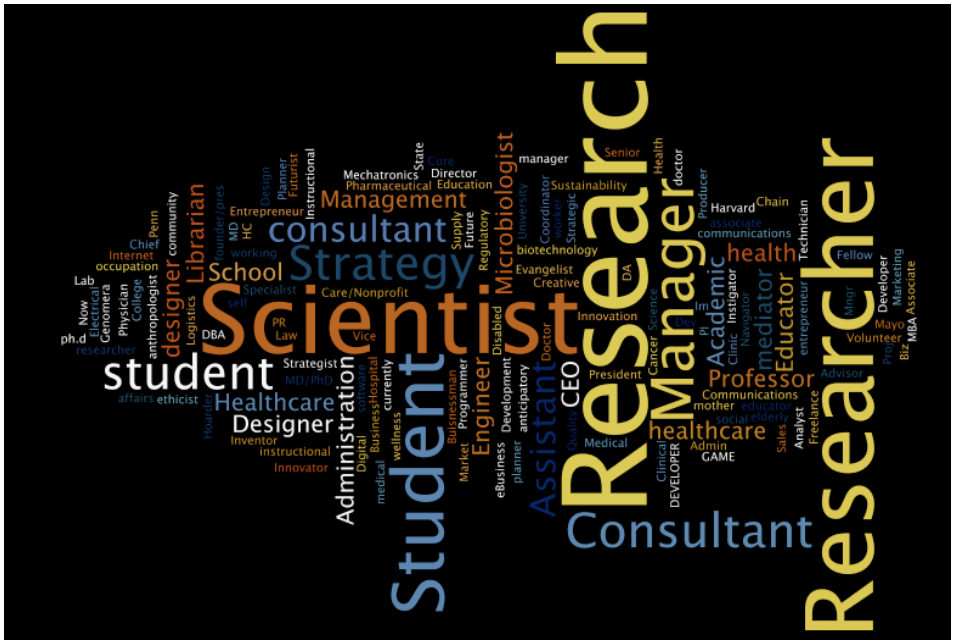
Distribution of cards played, by player



Player Locations

Non-US Player Count:
Australia, 5
Canada, 3
Denmark, 1
Germany, 2
France, 1
India, 1
Korea, 2
Mexico, 1
Spain, 1

Player Occupations



Stated Player Occupations, by Number:

Strategist, 1
Supplier, 1
Sustainability, 1
Technician, 1
University, 1
Volunteer, 1
Wellness provider, 1
Worker, 1
Working, 1
Academic, 2
Administration, 2
CEO, 2
Communications, 2
Developer ,2
Doctor, 2
Engineer, 2
Entrepreneur, 2
Instructional, 2
Librarian, 2
Management, 2
Mediator, 2
Medical, 2
Microbiologist, 2
Planner, 2
Professor,2
School, 2
Educator, 3
Health, 3
Designer, 4
Healthcare, 4
Strategy, 4
Manager, 6
Consultant, 7
Scientist, 8
Researcher, 9
Research,10
Student, 1

NB: Not all players submitted occupation information.

Most frequently used phrases

This word cloud shows the most frequently used words among the longest chains of game play.