PUBLICATIONS

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The Grand Challenges Approach

January 2011

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Acknowledgements

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Executive Summary

This paper, which takes an in-depth look at the Grand Challenges approach, is one of a series of Grand Challenges Canada publications that explore the core components of our activities and operating philosophy.

The Grand Challenges approach is a strategic platform that helps to identify critical barriers holding back progress in addressing critical problems, develops targeted programs to fund teams to develop solutions to overcome these barriers and implements strategies to help to bring these solutions to scale in order to address the pressing challenges of the world's most impoverished nations and communities.

DEFINITION AND HISTORY

The "Grand Challenge" concept has been developed and refined by a range of individuals and organizations over the past century beginning with the work of Dr. David Herbert. Building on this work, Grand Challenges Canada has developed its own definition of a Grand Challenge that reflects our specific use of the term in the context of global health:

> *A grand challenge is one or more specific critical barrier(s) that, if removed, would help solve an important health problem in the developing world with a high likelihood of global impact through widespread implementation.*

Dr. David Hilbert first applied the concept of a Grand Challenge to the field of mathematics in which he identified 23 specific challenges. The concept was revitalized by the Bill & Melinda Gates Foundation who, in 2003, identified 14 *Grand Challenges in Global Health*. In 2008, they also launched a new $100M, five-year initiative called Grand Challenges Explorations, which is an extension of the Grand Challenges in Global Health initiative.

At the same time that the Bill & Melinda Gates Foundation was developing its Grand Challenges Explorations initiative, a group of prominent global health scientists, under the leadership of Dr. Abdallah Daar, identified a set of *Grand Challenges in Chronic Non-Communicable Diseases* that were published in *Nature* November 2007.

Finally, in the summer of 2010, Dr. Rajiv Shah (the Administrator of the United States Agency for International Development – the United States government agency for foreign economic and humanitarian assistance), committed to use science, technology and innovation to address Grand Challenges for Development.

In total, over the past ten years Grand Challenge processes in Global Health, Chronic Non-Communicable Disease and Engineering have identified close to 50 individual challenges.

INTEGRATED INNOVATION

Grand Challenges Canada has developed a concept called **Integrated Innovation** to describe the importance and potential impact of combining scientific/technological, social and business innovation. The core of this concept is that:

> ***Integrated Innovation*** *is the coordinated application of scientific/technological, social and business innovation to develop solutions to complex challenges.*

For Grand Challenges Canada, Integrated Innovation plays a defining role in the types of Grand Challenge themes that are identified; the specific grand challenges that are chosen within each theme and helps to shape the final requests-for-proposals that set out the guidelines for the types of project proposals that are submitted. This holistic approach to innovation is also a defining feature of Grand Challenges Canada and its approach.

GRAND CHALLENGES CANADA AND THE GRAND CHALLENGES APPROACH

In the 2008 Federal Budget, the Government of Canada announced the creation of the *Development Innovation Fund* (DIF) to:

> *Support the best minds in the world as they search for breakthroughs in global health and other areas that have the potential to bring about enduring changes in the lives of the millions of people in poor countries.*

The fund is being delivered by Grand Challenges Canada in a consortium with the International Development Research Centre and the Canadian Institutes of Health Research. Its initial focus is on global health.

In establishing the Development Innovation Fund, Canada is the first country to implement a Grand Challenges approach to global health development in its Official Development Assistance envelope.

Grand Challenges Canada has also established a set of eight criteria which it uses in the identification of broad thematic areas for exploration and specific challenges within these themes:

1. Burden of disease
2. Tractability
3. Impact
4. Integrated innovation
5. Current funding landscape
6. Canadian expertise
7. Branding and niche
8. Potential topics

One unique aspect of Grand Challenges Canada's use of the Grand Challenges approach is that in most of our competitions the principal investigators will come from low- and/or middle-income countries, sometimes working in conjunction with Canadian team members.

BENEFITS AND RISKS OF THE GRAND CHALLENGES APPROACH

One of the most important benefits of the Grand Challenges approach is that it provides a sharp **focus**. A strong Grand Challenge is both highly specific and highly focused identifying a specific barrier preventing progress in a critical area. This focus enables the development of targeted requests-for-proposals and the implementation of effective accountability systems based on clearly defined performance parameters.

A second benefit of the Grand Challenges approach is that by articulating important challenges that have the potential to deliver real impact and by allocating significant resources to address these challenges it **brings the best minds to the table** by engaging world-leading scientists who might not otherwise be engaged in global health-related research.

A third benefit of the approach is that it helps to **build and strengthen communities of innovators – communities that are collaborative, interdisciplinary, and global**.

A fourth benefit to this approach is that it can **capture the public's imagination**. Project teams led by world-leading scientists working to solve pressing challenges can offer compelling storylines to **capture the interest** of media and the public.

A fifth benefit is the ability to use the Grand Challenges approach as a platform **for global health diplomacy and global governance**.

One of the risks in using the Grand Challenges approach is **brand dilution**. Because of the significant and growing interest in the use of the Grand Challenges approach, particularly in the context of global health, it may be difficult to establish and differentiate individual brand entities and to keep the various brands distinct and clear.

A second risk is that as more organizations and agencies begin to implement a Grand Challenges approach to development there could be increasing **transaction costs** as the demand on management time and attention in each organization rises to ensure that activities and challenges are coordinated across organizations.

A final risk is that because of the complexity and ambition of the challenges that are identified, there is **no guarantee of success.** This risk, however, is not specific to the Grand Challenges approach to innovation - it is inherent to all investments in international development and to all aspects of scientific discovery and innovation.

IMPLICATIONS FOR GLOBAL GOVERNANCE AND GLOBAL HEALTH DIPLOMACY

One of the most significant benefits of and opportunities presented by the Grand Challenges approach is that it provides a ready-made platform to enable cross-sector and multi-national collaboration to address different aspects of a single, focused global challenge.

For example, the first Grand Challenges Canada competition on Point-of-Care Diagnostics involves collaboration between a private US foundation (the Bill & Melinda Gates Foundation) and a Canadian not-for-profit organization (Grand Challenges Canada) to provide funding for different aspects of a single challenge. Setting up such collaborations through traditional diplomatic channels could take years while the Grand Challenges approach enabled this collaboration to form in a matter of months. Similar patterns might also emerge around other Grand Challenges.

CONCLUSION

The Grand Challenges approach is a significant innovation in the field of science for development. It provides an effective platform for cooperation amongst funders who wish to pursue common goals. It is a form of global governance that enables countries with divergent foreign policies and interests to take common action to address critical barriers and problems despite their differences. Finally, it provides an operating system for shared development innovation.

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1. Introduction

This paper is one of a series of Grand Challenges Canada/Grand Défis Canada (herein referred to as Grand Challenges Canada) publications that explore the core components of our activities and operating philosophy. The first Grand Challenges Canada publication introduced the concept of Integrated Innovation™. This paper takes an in-depth look at the Grand Challenges approach.

The Grand Challenges approach is a strategic platform that helps to identify critical barriers holding back progress in addressing critical problems, develops targeted programs to fund teams to develop solutions to overcome these barriers and implements strategies to help to bring these solutions to scale in order to address the pressing challenges of the world's most impoverished nations and communities.

In looking at and thinking about this approach it is important to understand its:

1. **Definition and History** – what do we mean when we talk about a Grand Challenges approach, what are its origins and how does Integrated Innovation relate to this concept?

2. **Grand Challenges Canada and the Grand Challenges approach** – how has Grand Challenges Canada implemented the Grand Challenges approach?

3. **Benefits and Risks Associated with the Grand Challenges approach** – what are the opportunities afforded by and the risks associated with the application of the Grand Challenges approach?

4. **Implications for Global Governance and Global Health Diplomacy** – what are the implications of the Grand Challenges approach in terms of the governance of transnational issues and opportunities?

2. Definition and History

A "**Grand Challenge in global health**" has been defined as:

> *"A specific scientific or technological innovation that would remove a critical barrier to solving an important health problem in the developing world with a high likelihood of global impact and feasibility"* (Varmus et al., *Science* 2003)

Or, put more simply:

> *"A specific critical barrier that if removed would help to solve an important health problem"* (Daar et al., *Nature* 2007)

A more general definition of a Grand Challenge is that it is:

> *"Visionary, terribly important, and do-able"* (Charles Vest, U.S. National Academy of Engineering, 2008)

Based on these definitions, the core elements of a Grand Challenge are that:

1. It is a specific and significant bottleneck or barrier;
2. It stands in the way of solving pressing global problems;
3. The barrier is difficult but not impossible to address or overcome; and
4. If solved, it is likely to have global impacts.

Building from these definitions, Grand Challenges Canada has developed its own definition of a Grand Challenge that reflects our specific use of the term in the context of global health:

> *A grand challenge is one or more specific critical barrier(s) that, if removed, would help solve an important health problem in the developing world with a high likelihood of global impact through widespread implementation.*

The key to the approach is to identify the critical barrier or barriers that are preventing progress in the solution of an important global health problem--one needs to know enough to know what one does not know but is yet knowable.

2.1 A BRIEF HISTORY OF THE GRAND CHALLENGES CONCEPT

The Grand Challenges concept was introduced over a century ago by Dr. David Hilbert who set out a list of 23 challenges in mathematical foundations, prime numbers, geometry, algebraic number theory, topology, etc. Examples of Hilbert's Grand Challenges include the 3rd challenge (the first to be solved):

> *Given any two polyhedra of equal volume, is it always possible to cut the first into finitely many polyhedral pieces which can be reassembled to yield the second?*

And the 8th challenge, the so-called Riemann Hypothesis that remains unsolved, although the problem itself is much better understood and characterized than it was when Hilbert first proposed it.

By clearly articulating specific challenges, Hilbert inspired a generation of mathematicians to work to overcome them. His initiative was a great success: nearly all of the challenges he identified have since been solved. Some, however, took more than a century to solve and required the use of immense computer processing power, something that did not exist when Hilbert first articulated his Grand Challenges.

The Grand Challenges concept was revitalized a century after Dr. Hilbert first proposed his challenges by the Bill & Melinda Gates Foundation who, in 2003, identified 14 *Grand Challenges in Global Health*[1]. Since these Grand Challenges were first identified, the Bill & Melinda Gates Foundation has worked with a number of partners including the Wellcome Trust, Canadian Institutes of Health Research, and the Foundation for the National Institutes of Health to invest more than $450M to fund 44 research teams across the world who are developing and implementing solutions to these challenges[2].

In 2008, the Bill & Melinda Gates Foundation launched a new $100M, five-year initiative called Grand Challenges Explorations, which is an extension of the Grand Challenges in Global Health initiative. Both initiatives focus on encouraging innovation in global health research, but the Grand Challenges Explorations grants target smaller projects that are at an earlier stage of discovery. Initial $100,000 grants are reviewed for innovation and their degree of solution-focus and are awarded to further develop "out-of-the-box" ideas to overcome specific challenges.

Subsequent grants of up to $1M are selectively awarded to those initial teams who successfully reach the proof-of-principle stage with promising potential solutions. The Grand Challenges Explorations topics address the same grand challenge goals defined in the original 14 Grand Challenges along with several additional topics that are philosophically aligned with the original challenges.

At the same time that the Bill & Melinda Gates Foundation was developing its Grand Challenges Explorations initiative, a group of prominent global health scientists, under the leadership of Dr. Abdallah Daar, set out to identify a set of *Grand Challenges in Chronic Non-Communicable Disease*. After a rigorous multi-year process, their findings were published in November 2007 in *Nature*[3].

Building on the momentum generated by this process, six of the world's leading health research agencies came together to form the Global Alliance for Chronic Disease. The

[1] The identification process for these Grand Challenges began with an open call for ideas followed by a prioritization process by an international Scientific Advisory Board. The submissions to the identification process were collated and analyzed under the supervision of Drs. Singer and Daar, and Dr. Singer was a member of the Scientific Advisory Board.
[2] www.grandchallenges.org
[3] Daar et al "*Grand challenges in chronic non-communicable diseases"* Nature 450, 494-496 (22 November 2007)

purpose of this initiative is to identify and support clear priorities for a coordinated research effort to address chronic non-communicable diseases like cardiovascular disease (mainly heart disease and stroke), several cancers, chronic respiratory ailments and types of diabetes. The Global Alliance for Chronic Disease has also launched an initiative in mental health, initially through a major research study to identify a set of *Grand Challenges in Global Mental Health* (http://grandchallengesgmh.nimh.nih.gov/).

In the summer of 2010, Dr. Rajiv Shah (the Administrator of the United States Agency for International Development – the United States government agency for foreign economic and humanitarian assistance), committed to the use of science, technology and innovation to address Grand Challenges for development. To this end, he brought together 60 thought leaders for a day and a half long session to identify potential Grand Challenges and discuss how this commitment could be realized.

Finally, the United States National Academies have also identified a set of *Grand Challenges in Engineering* that includes challenges like making solar energy economical and securing cyberspace.

In total, over the last ten years Grand Challenge processes in global health, chronic non-communicable disease and engineering have identified close to 50 individual Grand Challenges. These are listed in Annex I.

2.2 INTEGRATED INNOVATION

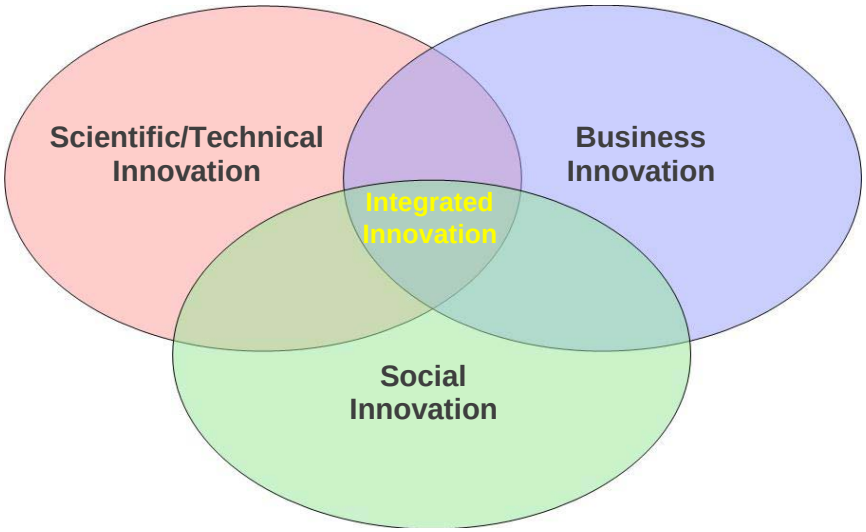
Critical barriers that prevent progress towards the development of important global health solutions can occur at any point along the innovation process from discovery, through implementation and scale-up. It is also common for the solution of one challenge to lead to the identification of additional barriers further along the innovation process. We would argue that in order for technological innovations to go to scale and maximize their impact, they must be combined with appropriate social and business innovations such as economical production and distribution systems for new products or services and new or enhanced health systems to support the delivery of these products or services to individuals in need.

Grand Challenges Canada has developed a concept called **Integrated Innovation™** to describe the importance and potential impact of combining scientific/technological, social and business innovation.[4] The core of this concept is that:

> ***Integrated Innovation*** *is the coordinated application of scientific/technological, social and business innovation to develop solutions to complex challenges.*

[4] For more information on Integrated Innovation™ please see: Grand Challenges Canada, *Integrated Innovation,* September 2010 at: http://www.grandchallenges.ca/files/news/integratedInnovation.pdf

This concept is captured visually in as follows:



For Grand Challenges Canada, Integrated Innovation plays a defining role in the types of Grand Challenge themes that are identified; the specific grand challenges that are chosen within each theme and helps to shape the final requests-for-proposals that set the parameters for the types of project proposals that are submitted. This holistic approach to innovation is a defining feature of Grand Challenge Canada.

There are an increasing number of real world examples of the potential impact of Integrated Innovation-based solutions to global health challenges. In India, for example, the Aravind Eye Hospital has built a highly successful business by redefining the way that poor people receive eye care. By combining innovative products with a new business model and strong leadership, it has lowered the cost of cataract surgery to the point where it is affordable to almost anyone in need of the surgery.

Another example of the potential impact of Integrated Innovation is mobile banking – a technology that is based both on new technological products and on new business and social models. This Integrated Innovation approach is revolutionizing the financial and farming sectors in the developing world, especially in Kenya, which has pioneered this approach.

The following section provides an overview of the application of the Grand Challenges approach by Grand Challenges Canada and explores the role of Integrated Innovation in shaping this approach.

3. Grand Challenges Canada and the Grand Challenges Approach

In the 2008 Federal Budget, the Government of Canada announced the creation of the *Development Innovation Fund* (DIF) to:

> *Support the best minds in the world as they search for breakthroughs in global health and other areas that have the potential to bring about enduring changes in the lives of the millions of people in poor countries.*

The Government of Canada committed $225M to achieving this ambitious goal over five years. The fund is being delivered by Grand Challenges Canada in a consortium with the International Development Research Centre and the Canadian Institutes of Health Research. Its initial focus is on global health.

In establishing the *Development Innovation Fund*, Canada is the first country to implement a Grand Challenges approach to global health development in its Official Development Assistance envelope. As of summer 2010, the United States Agency for International Development is also looking at using a Grand Challenges approach to fuel innovation in international development.

3.1 VISION AND MISSION

Grand Challenges Canada is a purpose-built independent not-for-profit organization whose mandate is:

> *To identify global grand challenges (a specific critical barrier that if removed would help to solve an important development problem) and fund a global community of researchers and related institutions on a competitive basis to address them.*

This vision and mandate are realized through three core principles:

1. Scientific Excellence
2. Competitive Collaboration
3. Accountability for Results

Which, in turn, are applied to achieve three core objectives:

1. Identifying Grand Challenges;
2. Mobilizing the Canadian and international scientific communities to address identified Grand Challenges through the competitive selection and funding of projects; and
3. Supporting the implementation and commercialization of the solutions that emerge.

Grand Challenges Canada is currently in the process of selecting five thematic areas from which specific challenges will be chosen and addressed through funding competitions.

Grand Challenges Canada is led by Dr. Peter A. Singer, Chief Executive Officer and Dr. Abdallah S. Daar, Chief Science and Ethics Officer. Building on their experience with the *Grand Challenges in Global Health* and *Grand Challenges in Non-Communicable Disease initiatives*, Grand Challenges Canada has developed a three phase Grand Challenge identification process.

This identification process draws on the knowledge and expertise of the Grand Challenges Canada Scientific Advisory Board to identify potential thematic areas, based on a set of eight criteria outlined below, for exploration that are brought to the Board of Directors for approval. Staff members, in turn, undertake an extensive and rigorous process of consultation with leading Canadian and international content experts who are asked to identify the most compelling Grand Challenges in the theme, on the basis of a common definition of a Grand Challenge and given a ten year timeframe in which to develop solutions. The Grand Challenges that are identified in this way are then brought back to the Board of Directors for approval. Finally, staff develops a specific request-for-proposals for each Grand Challenge that is brought back to the Board of Directors for final approval. This process is illustrated in Table 1 (found on page 9).

Grand Challenges Canada has also established a set of eight criteria which it uses in the identification of broad thematic areas for exploration and specific Grand Challenges within these themes:

1. **Burden of disease**
   How many are affected? Who is affected? What is the cause of morbidity and mortality? What is the impact of the disease (health, economic, social)? Primary areas of impact (low- and/or middle-income countries versus high income countries)?

2. **Tractability**
   Are there potential solutions?

3. **Impact**
   What is the potential for developmental impact and what is the magnitude of this impact? What is the estimated time to impact? Does it also help to address a Canadian health problem?

4. **Integrated innovation**
   Would the application of integrated innovation be appropriate in its solution? Are there examples of solutions that are consistent with an integrated innovation approach?

5. **Current funding landscape**
   Is there insufficient funding in place at this time to address this theme, or for topics within the theme? Who are the current funders and key organizations in this area?

6. **Canadian expertise**
   Are there existing Canadian strengths in this area? Who are the experts (Canadian and international)?

7. **Branding and niche**
   Is it topical? Could it be a Grand Challenges Canada niche? Would it be engaging for the Canadian public? Does it reflect Canada's brand?

8. **Potential topics**
   In the exploration of the theme, do any potential Grand Challenges present themselves?

One unique aspect of Grand Challenges Canada's use of the Grand Challenges approach is that in most of our competitions the principal investigators will come from low- and/or middle-income countries, sometimes working in conjunction with Canadian team members. We will include innovators from other countries under the leadership of low- and/or middle-income country principal investigators when their expertise is critical to solving the problem.

As with any innovative strategy or approach, the Grand Challenges Canada methodology has both benefits and risks that are described in the following section.

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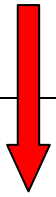
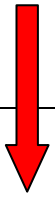
Table 1: The Grand Challenges Canada 'Grand Challenge' Identification Process

	Process	Key Participants
THEME 	• Determine criteria (with advice from Scientific Advisory Board) for selecting Grand Challenges themes • Engage the Scientific Advisory Board on potential themes using the selection criteria as a guide • Synthesis of advice from Scientific Advisory Board by management. • Brainstorm potential partners to co-deliver the grand challenge • Approval of theme by Grand Challenges Canada Board of Directors	• Grand Challenges Canada Management • Grand Challenges Canada Scientific Advisory Board • Grand Challenges Canada Board of Directors
GRAND CHALLENGE 	• In-depth analysis of theme through literature and engagement with Canadian and international experts • Initial draft of 'grand challenge' • Engage potential partners to co-deliver the grand challenge and move towards a partnership agreement leading to a Memorandum of Understanding • Engage the Scientific Advisory Board on the Grand Challenge theme and partnership agreements, if applicable • Synthesis of advice from Scientific Advisory Board and International Experts by management • Approval of 'grand challenge' and partnership agreements/Memorandum of Understanding (if applicable) by Grand Challenges Canada Board of Directors	• Grand Challenges Canada Management • Grand Challenges Canada Scientific Advisory Board • Grand Challenges Canada Board of Directors • Potential Partner(s) • Canadian and International Experts
REQUEST-FOR-PROPOSALS	• Drafting of request-for-proposals in collaboration with partner by Grand Challenges Canada management • Advice and comments from Scientific Advisory Board on draft request-for-proposals • Final edits by Grand Challenges Canada and partner(s) • Approval of request-for-proposals by Grand Challenges Canada Board of Directors • LAUNCH OF REQUEST-FOR-PROPOSALS	• Grand Challenges Canada Management • Grand Challenges Canada Scientific Advisory Board • Grand Challenges Canada Board of Directors • Partner(s), if applicable

4. Benefits and Risks of the Grand Challenges Approach

This section of the paper provides a brief discussion of some of the key benefits and risks associated with the Grand Challenges approach with a specific focus on how to leverage the benefits (and their associated opportunities) and how to mitigate the risks that are identified.

4.1 BENEFITS

One of the most important benefits of the Grand Challenges approach is that it provides a sharp **focus**. A strong Grand Challenge is both highly specific and highly focused. As an example, the first request-for-proposals from Grand Challenges Canada on Point-of-Care Diagnostics included the following specific challenge:

> *"To create point-of-care diagnostic platforms that share common standards for use, development and integration."*

This focus enables the development of targeted requests-for-proposals and the implementation of effective accountability systems based on clearly defined performance parameters.

A second benefit of the Grand Challenges approach is that by articulating important challenges that have the potential to deliver real impact it **brings the best minds to the table**. The Bill & Melinda Gates Foundation's *Grand Challenges in Global Health* initiative, for example, attracted and funded projects involving two Nobel laureates who would not otherwise have been engaged in global health research. The Grand Challenges approach can also inspire exciting young scientists who might not otherwise be engaged in research on global health to develop solutions that can then made available to those in need. These scientists can bring fresh ideas, approaches, technologies and perspectives from a range of different disciplines to bear on pressing global health challenges. Competitions such as the *Canadian Rising Stars in Global Health* program[5] currently being conducted by Grand Challenges Canada, for example, will help to inform and engage emerging Canadian and developing world scientists to focus their research in this regard.

A third benefit of the approach is that it helps to **build and strengthen communities of innovators – communities that are collaborative, interdisciplinary, and global**. A good example of this benefit is the international research community that has coalesced around the challenge to develop genetically modified mosquitoes. Prior to the interest expressed in this area by the Bill & Melinda Gates Foundation, there was no serious or coordinated international community of researchers and practitioners working in this area. The Grand Challenges in Global Health initiative, however, served as a catalyst to bring this community together, achieving results that far surpass those possible by individual research teams prior to this funding. Similarly, the Bill & Melinda Gates

[5] http://www.grandchallenges.ca/funding/

Foundation and Grand Challenges Canada's competitions on point-of-care diagnostics are set to further catalyze the diagnostic community by attracting and engaging leading researchers from low- and/or middle-income countries.

A fourth benefit to this approach is that it can **capture the public's imagination**. Project teams led by world-leading scientists working to solve pressing challenges can offer compelling storylines to capture the interest of media and the public, just as the rescue of Chilean miners attracted global attention in the summer of 2010.

A fifth benefit is the ability to use the Grand Challenges approach as a platform **for global health diplomacy and global governance**. For example, in the *Grand Challenges in Global Health initiative*, the Bill & Melinda Gates Foundation partnered with the Canadian Institutes of Health Research, the Wellcome Trust and more recently with Grand Challenges Canada to create a network of coordinated and engaged funding organizations focused on addressing global health challenges. As a second example, the Global Alliance for Chronic Diseases, founded on the Grand Challenges approach, represents a partnership amongst six national research funding agencies including:

- Australia's National Health Medical Research Council,
- Canadian Institutes of Health Research,
- Chinese Academy of Medical Sciences,
- The United Kingdom's Medical Research Council, and
- The United States National Institutes of Health, specifically its National Heart, Lung and Blood Institute and the Fogarty International Center.

The Grand Challenges approach provides an opportunity to attract and coordinate contributions from governments, charities and the private sector, helping to align their activities and foster collaboration while leaving each organization open to pursue its own part of the collaboration with its own accountability requirements. It provides a simple and discreet mechanism for donors to effectively coordinate their investments and collaborate to achieve outcomes in high priority areas while reducing overlap and duplication.

As more organizations and agencies adopt a Grand Challenges approach to development, there is the potential to realize significant **network effects**, particularly for early movers.[6] The more the approach is used, the greater the benefits to all users. Taking advantage of network effects may be the most effective way for a comparatively small organization to make a significant global impact. For example, Grand Challenges Canada could leverage the network effect to provide leadership in helping to coordinate the contributions of different organizations and agencies to address different aspects of specific grand challenges. The final section of this paper will expand on the implications of the Grand Challenges approach for global governance and global health diplomacy.

[6] A network effect is the impact that each additional user has on the value of a good or service. When a network effect is present, the value of a product or service increases as more people use it. The classic example of a network effect is the fax machine—it has no value as a single machine but produces massive value once a critical level of market penetration had been achieved. A more recent example of the network effect is seen in social media sites such as Facebook or MySpace that become more valuable as their membership grows.

4.2 RISKS AND MITIGATION STRATEGIES

One of the risks in using the Grand Challenges approach is **brand dilution**. Currently there is significant interest in the use of the Grand Challenges approach, particularly in the context of global health. As a result, it may be difficult to establish and differentiate individual entities and to keep the various brands distinct and clear. This brand dilution problem could be particularly problematic in the context of partnerships between better and lesser known Grand Challenge-oriented organizations in which the lesser known or latecomer organization wishes to establish and enhance its own brand value and identity.

One approach to mitigate this risk would be for different organizations that choose to partner on a particular Grand Challenge to take up different parts of that challenge while still forming a single global research community. For example, a Grand Challenge can be segmented by geographic locale - as is the case with the Point-of-Care Diagnostics partnership between Grand Challenges Canada and the Bill & Melinda Gates Foundation where the Foundation is geographically neutral in terms of the location of the principal investigators for the projects that it funds while Grand Challenges Canada is focused primarily on funding principal investigators in low- and/or middle-income countries. This approach could also be applied regionally.

Another way to segment a challenge would be for one group or country to focus on addressing one particular type of barrier, for example, barriers with respect to the health systems aspects of the challenge, while the other organizations focus on addressing barriers relating to different aspects of the challenge, for example, technological or delivery system related barriers.

A second risk is that as more organizations and agencies begin to implement a Grand Challenges approach to development there could be increasing **transaction costs** as the demand on management time and attention in each organization rises to ensure that activities and challenges are coordinated across organizations. This presents a significant potential risk for smaller organizations where the investment of management time and focus on collaboration could potentially distract management from their own core activities and accountability requirements. This risk is offset, however, by the potential for lead organizations to play a catalytic role in shaping the global approach to Grand Challenges. The time requirements to effectively collaborate across organizations can also be reduced by setting clear goals and establishing clear roles for different organizations.

A final risk is that because of the complexity and ambition of the Grand Challenges that are identified, there is **no guarantee of success**. Even the very best scientific teams may not be able to develop workable solutions to some of the challenges that are presented. This risk, however, is not specific to the Grand Challenges approach to innovation - it is inherent to all investments in international development and to all aspects of scientific discovery and innovation - risks that are compounded in development innovation. In fact, the Grand Challenges approach, through its clear focus and milestone based financing approach, is actually a way to lessen this risk.

5. Implications for Global Governance and Global Health Diplomacy

The final section of this paper looks at the Grand Challenges approach as a tool for global governance and global health diplomacy.

Over the past few years an increasing number of global commentators and academics have suggested that the kinds of global challenges that we are facing (in health, food, water, climate change and other sectors) are too complex to be addressed through traditional global governance tools. They argue that new forms of global governance will be necessary to enable the deployment of coalitions of public, private and not-for-profit organizations and agencies to develop and implement the kinds of solutions that can overcome these complex challenges[7].

For instance, Jean-Francois Rischard, former Vice-President for Europe for the World Bank Group, has argued that the dual forces of the demographic explosion and globalization have led to a 'governance gap' between the power and complexity of global public issues and the power of traditional global governance organizations to address these challenges. He recommends the creation of what he calls 'global issues networks' to deal with the twenty most pressing issues facing the world[8]. Similarly, Anne Marie Slaughter, Director of Policy Planning, US Department of State, has argued for the creation of networks that cross sector lines as a response to the increasing complexity of global challenges.[9]

For these approaches to be effective, however, they require a set of tools to catalyze the necessary collaborations that will establish these global networks. One of the most significant benefits of and opportunities presented by the Grand Challenges approach is that it provides a ready-made platform to enable cross-sector and multi-national collaboration to address different aspects of a single, focused global challenge.

Currently, there is a natural experiment taking place that compares three such strategies to address the growing need for development innovation:

> **Canada –** has chosen to implement a Grand Challenges approach through a consortium model with Grand Challenges Canada as a not-for-profit purpose-built organization outside of government to deliver the program. ($225M CDN over five years)

[7] See Singer, P., Daar, A., Dowdeswell, E., "Bridging the Genomics Divide" Global Governance, Volume 9, Number 1, 2003; Acharya, T., Daar, A., Thorsteinsdottir, H., Dowdeswell, E., Singer, P., "Strengthening the Role of Genomics in Global Health", PLoS Med, 2004 December 1(3); Dowdeswell, E., Daar, A., Singer, P., "Getting governance into genomics", Science and Public Policy, Volume 23, Number 6, 2005
[8] Rischard, Jean-Francois, "High Noon: We need new approaches to global problem-solving, fast", Journal of International Economic Law (2001) , 507-525
[9] See the discussion at: http://www.cceia.org/resources/transcripts/4467.html

United Kingdom – the Department for International Development has implemented a dedicated Research and Evidence Division that reports directly to the Minister. (~$405M CDN per year)

The United States - is adopting a Grand Challenges approach in its United States Agency for International Development which has an annual budget of ~ $25B CDN per year, of which a portion would be dedicated to development innovation.

The following sub-section takes a more in more depth look at the Grand Challenges approach as a tool for global governance and global health diplomacy.

5.1 GLOBAL HEALTH DIPLOMACY

Dr. Calestous Juma at Harvard University has argued for the importance of science and innovation as critical tools for global "science diplomacy."[10] In other words, science and scientists can help to bridge the divide between countries and ideologies by identifying common challenges and goals and bringing forward coordinated strategies to address these challenges. The Grand Challenges approach provides a useful framework in this regard through which to organize and coalesce interest and investment that is outside of traditional global diplomacy mechanisms.

As an example of the potential for the Grand Challenges approach to provide a framework for science diplomacy, the first Grand Challenge competition being undertaken by Grand Challenges Canada on Point-of-Care Diagnostics involves a collaboration between a private US foundation (the Bill & Melinda Gates Foundation) and a Canadian not-for-profit organization (Grand Challenges Canada) to provide funding for different aspects of a single challenge (with the U.S. foundation providing funding to principal investigators on a geographically neutral basis while the Canadian not-for-profit focuses on providing funding to teams led by principal investigators in low- and/or middle-income countries). Setting up such collaboration through traditional diplomatic channels could take years of ongoing work and engagement while the Grand Challenges approach enabled this collaboration to form in a matter of months. Similar patterns might also emerge around other Grand Challenges.

[10] www.hks.harvard.edu/news-events/news/testimonies/calestous-juma-testifies-before-congress-on-us-african-relations

6. Conclusion

The Grand Challenges approach is a significant innovation in the field of science for development. It provides an effective platform for cooperation amongst funders who wish to pursue common goals. It is a form of global governance that enables countries with divergent foreign policies and interests to take common action to address critical barriers and problems despite their differences. Finally, it provides an operating system for shared development innovation.

Imagine a world where development agencies from different countries are working together with foundations, companies, and private investors to drive innovation on specific global challenges. That's a world where development goals can be achieved. More importantly, that is a world where mothers and children will not die needlessly because innovation saves lives.

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Annex 1: Current Grand Challenge Identification Processes

Table A1: Grand Challenges in Global Health

Taken from: http://www.grandchallenges.org/Pages/BrowseByGoal.aspx

To improve childhood vaccines:

Grand Challenge 1:	Create effective single-dose vaccines that can be used soon after birth;
Grand Challenge 2:	Prepare vaccines that do not require refrigeration;
Grand Challenge 3:	Develop needle-free delivery systems for vaccines.

To create new vaccines:

Grand Challenge 4:	Devise reliable tests in model systems to evaluate live attenuated vaccines;
Grand Challenge 5:	Solve how to design antigens for effective, protective immunity;
Grand Challenge 6:	Learn which immunological responses provide protective immunity.

To control insects that transmit agents of disease:

Grand Challenge 7:	Develop a genetic strategy to deplete or incapacitate a disease-transmitting insect population;
Grand Challenge 8:	Develop a chemical strategy to deplete or incapacitate a disease-transmitting insect population.

To improve nutrition to promote health:

Grand Challenge 9:	Create a full range of optimal bioavailable nutrients in a single staple plant species.

To improve drug treatment of infectious diseases:

Grand Challenge 10:	Discover drugs and delivery systems that minimize the likelihood of drug-resistant microorganisms.

To cure latent and chronic infections:

Grand Challenge 11:	Create therapies that can cure latent infections;
Grand Challenge 12:	Create immunological methods that can cure chronic infections.

To measure disease and health status accurately and economically in poor countries:

Grand Challenge 13:	Develop technologies that permit quantitative assessment of population health status;
Grand Challenge 14:	Develop technologies that allow assessment of individuals for multiple conditions or pathogens at point-of-care.

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Table A2: Grand Challenges in Chronic Non-Communicable Diseases

Taken from: http://www.nature.com/nature/journal/v450/n7169/full/450494a.html

GRAND CHALLENGES IN CHRONIC NON-COMMUNICABLE DISEASES		
	Grand challenges	**Research needed to address goals**
Goal A **Raise public awareness**	1 Raise the political priority of non-communicable disease 2 Promote healthy lifestyle and consumption choices through effective education and public engagement 3 Package compelling and valid information to foster widespread, sustained and accurate media coverage and thereby improve awareness of economic, social and public health impacts	• Study how to engage governments in partnerships for disease prevention • Develop research activities for health that bridge government departments (for example, transport, civic planning, health, education and environment) • Identify reasons for low awareness and advocacy of chronic disease in societies • Study how to create public forums that sustainably raise awareness of issues relating to chronic non-communicable diseases
Goal B **Enhance economic, legal and environmental policies**	4 Study and address the impact of government spending and taxation on health 5 Develop and implement local, national and international policies and trade agreements, including regulatory restraints, to discourage the consumption of alcohol, tobacco and unhealthy foods 6 Study and address the impacts of poor health on economic output and productivity	• Evaluate the health impacts of agricultural policy interventions • Study the health and economic impacts of comprehensive community-based interventions • Create general population metrics and outcome indicators for policy and programme surveillance. • Quantify impact of chronic non-communicable diseases on domestic economies • Study the international ramifications of changes in food and tobacco consumption • Probe motivations behind domestic expenditures, and how these affect lifestyle choices • Investigate the impact and effectiveness of food-labelling legislation
Goal C **Modify risk factors**	7 Deploy universally measures proven to reduce tobacco use and boost resources to implement the WHO Framework Convention on Tobacco Control 8 Increase the availability and consumption of healthy food 9 Promote lifelong physical activity 10 Better understand environmental and cultural factors that change behaviour	• Do prospective cohort studies to identify risk factors, the magnitude of their effects, and the factors that reduce risk in chronic non-communicable diseases • Evaluate fetal and early-life influences on chronic disease risk • Find and evaluate new or combined medical preparations to prevent cardiovascular disease and diabetes or reduce their morbidities • Evaluate behavioural modifications to reduce risks • Establish metrics, and relationships between metrics, that are culturally and ethnically specific • Investigate cultural and ethnic variation in risk factors to refine behavioural interventions • Quantify personal risk related to phenotypes, genotypes and multiplicative risks • Study the interaction of environment and genes in risk factors and in outcomes • Develop new biomarkers and diagnostics for risk and for early disease detection
Goal D **Engage businesses and community**	11 Make business a key partner in promoting health and preventing disease 12 Develop and monitor codes of responsible conduct with the food, beverage and restaurant industries 13 Empower community resources such as voluntary and faith-based organizations	• Study marketing techniques and marketing data derived from commercial companies on behaviour modification • Investigate mechanisms for consumers and the public to exert a positive influence on the food industry • Research the impact of taste, flavour, packaging, labelling and advertising on choice and health • Create and evaluate community-based strategies to promote healthy living • Identify modes of effective public–private partnerships that support health • Develop better understanding of nutrient benefit in foods
Goal E **Mitigate health impacts of poverty and urbanization**	14 Study and address how poverty increases risk factors 15 Study and address the links between the built environment, urbanization and chronic non-communicable disease	• Investigate the biological basis of health risks related to poverty • Examine the influence of poverty on the adoption of high-risk behaviour • Identify negative effects of economic growth on health • Study how to work with planners, architects and city representatives to enhance the environment for healthier living
Goal F **Reorientate health systems**	16 Allocate resources within health systems based on burden of disease 17 Move health professional training and practice towards prevention 18 Increase number and skills of professionals who prevent, treat and manage chronic non-communicable diseases, especially in developing countries 19 Build health systems that integrate screening and prevention within health delivery 20 Increase access to medications to prevent complications of chronic non-communicable disease	• Develop strategies to integrate health-system management of communicable and non-communicable disease • Form collaborations to find best practices in delivering affordable and equitable health care • Study how to provide more structured knowledge for health promotion • Develop strategies to ensure that medical training and curricula focus on chronic non-communicable diseases • Develop and provide culturally specific and nationally appropriate resources for training health-care workers • Study how best to ensure that disadvantaged communities have adequate resource allocations in health care and in preventative practice • Optimize use of electronic health records for predicting disease and measuring the effect of health interventions • Study how best to develop and establish real-time surveillance tools • Discover and develop tools for screening and stratifying populations according to risk

Table A3: Grand Challenges for Engineering

Taken from: http://www.engineeringchallenges.org/cms/challenges.aspx

1. Making solar energy economical
2. Manage the nitrogen cycle
3. Advance health informatics
4. Prevent nuclear terror
5. Advance personalized learning
6. Provide energy from fusion
7. Provide access to clean water
8. Engineer better medicines
9. Secure cyberspace
10. Engineer the tools of scientific discovery
11. Develop carbon sequestration methods
12. Restore and improve urban infrastructure
13. Reverse-engineer the brain
14. Enhance virtual reality