

What is Large Scale Innovation?

A white paper by John Kao¹
Chairman, Institute for Large Scale Innovation (ILSI)

The purpose of this draft white paper is to present a framework that will support the I20 discussion of large scale innovation during its innovation summit. Subsequent versions will incorporate input from various sources, including the I20 community.

Traditional views of innovation focus on the enterprise, on a breakthrough project or on the innovative efforts of a hot team or a heavyweight champion of new initiatives. Such discussions of innovation tend to be defined by what can be contained within the external boundary of a given enterprise. I think of this as innovation at a micro level.

In contrast, I have coined the term “large scale innovation” to describe what happens when one considers innovation outside the enterprise boundary, moving outward into a societal space; whether it be at a local, regional, national or global scale. I think of this as innovation at a macro level.

Big is back

Consideration of large scale innovation is made more timely by the current financial crisis in which our existing models of how to manage and finance innovation are breaking down. The traditional venture capital model of pricing innovation risk, for example, is sagging under the burden of capital drought. When professional investors cannot raise new capital to fund innovative startups, the nature of the venture business itself must change.

And while innovation continues to flow from thousands of small, upstart enterprises, one cannot fail to note the resurgence of large players – national governments, international agencies and NGO's - in the innovation process.

Size it seems does matter after all when it comes to innovation. The traditional narrative of the innovator's dilemma holds that incumbents, hampered by their size and established cultures, are at risk of being out-innovated by small insurgents who swarm the space with the freedom to disrupt the existing playing field like Lilliputians without the constraints of any form of legacy in terms of business models, management approaches, or institutional cultures.²

The truth is more complex. Large scale science projects like the supercollider, ambitious manned space flight and the human genome project require massive, concentrated resources, a

¹ kao@jamming.com, 1-415-994-0843

² Lohr, Steve, [Who Says Innovation Belongs to the Small?](#), New York Times, May 24, 2009

critical mass of infrastructure, enabling technology, talent and financial resources beyond the reach of any individual venture. So will societal priorities like the reinvention of health care, education reform, and the application of digital technology to citizen-government interaction.

Today, while models of innovation insurgency and open innovation may be in vogue, the truth about innovation lies not at the extremes, but with the blends, the "also's." History shows that large and small are both needed in the innovation ecosystem. For example, Hollywood, which started out as the vertically integrated "dream factory," is now a complex ecosystem in which monolithic studios hold sway over finance, distribution and technical skills, while the creative sparks come from a cloud of independent producers who combine and recombine into project teams to suit the needs of the creative work. Despite the vision of the citizen auteur who can distribute his or her creations on the Internet and find a business model through the "long tail"³ of increasingly tailored matchmaking between product and customer, scale is still a business model for innovation.

This analysis may shed light on why governments are increasingly involved in the innovation game. Governments arguably must set the agenda in terms of the broad trajectory along which society must progress. In this effort, societal purpose and entrepreneurial energies must align. Governments can apply a critical mass of financial resources to large scale societal purposes, applying a level of resources to a moving wave front of innovation that is simply not comparable to the efforts of a few venture capitalists and venture backed startups. Government can also apply fiscal policies to free up capital and sponsor large scale platforms for innovation such as Singapore's Biopolis or San Francisco's Mission Bay complex. Innovation thus results from a complex interaction among a group of stakeholders that includes a community of entrepreneurs fueled with the incentives to create new things and government players who shape the rules of engagement and set forward agendas.

In general, it may be said that governments are the arbiters of societal purpose. If one looks at the government of Finland as an example, there is an explicit blending and balancing of three core priorities in the public sector vision: economic growth, wellbeing in the deepest sense of quality of life, and sustainability (both environmental and social)⁴. The perspective of large scale innovation definitely introduces the question of values – and thus of ethics – a word seldom heard in the early days of the 21st century but which is critically important as we make choices. Today we are faced with a host of existential choices about how we are to live, whether we will rise to the challenges of the day, whether our children will continue to experience progress or fall backwards into a miasma of environmental, economic and social hardship. And introducing the question of values requires the need for constant balance and adjudication in addressing the challenges of a large scale innovation agenda.

Yet the institutions of the nation state often seem increasingly anachronistic in the face of accelerating change. A senior government official from an Asia country recently remarked to me that he preferred Goldman Sach's work on energy futures to that of the CIA. The pace of innovation exemplified by the venture development hothouse that is Sand Hill Road in Silicon Valley would seem to argue against having government bureaucrats pick winners for the innovation marketplace. The relevance and agility of traditional institutions of national governments are even

³ Anderson, Chris, *The Long Tail*, Hyperion Publishing, 2006

⁴ http://ec.europa.eu/invest-in-research/pdf/download_en/finland_national_innovation_strategy.pdf

more of a concern in the realm of international collaboration where simply defining common terms and rules of engagement can prove daunting even in the face of life threatening challenges such as global warming and infectious disease. The haphazard nature of much of today's innovation collaboration might make one throw up one's hands in despair, although there are the occasional rays of sunshine from, for example, the successful global resolution of the ozone crisis.

The size of the challenges before us should not slow us down; they are opportunities in disguise. For example, we will need a fresh approach to large scale innovation in order to address what I call next generation societal services, the basic entitlements of a citizen regardless of where they live that lead to health and wellness, education, support with a sustainable lifestyle, provisioning of clean water and food, access to government services and information and so on.

Addressing such next generation services will depend on a more robust approach of social innovation than what is practice today. It will also require new user centered design capabilities, new mechanisms for bridging business and technological discovery, new large scale funding mechanisms to assume long term risk of development, effective use of transformational technology, such as new convergences of mobility, internet and social media. Most importantly, it will require alignment among public, private, NGO and civil society and the cultural intelligence and facilitation skills to lead useful results. In short, it will need a facility with large scale innovation.

The Domain of Large Scale Innovation - A Taxonomy

It may be useful to offer a taxonomy of large scale innovation in terms of societal level – national, regional and urban – as well in terms of arena of activity.

The term large scale innovation certainly characterizes the efforts of a number of countries such as Finland, Singapore and China to establish coherent national innovation agendas. At present more than a dozen countries around the world have explicit national strategies that are being driven by innovation. Each represents an experiment in linking together political, societal and business interests around a large scale, end-to-end, innovation process and objective. Each also expresses a set of investments in global collaboration, for example, Denmark's innovation offices in Munich, Silicon Valley and Shanghai, or Singapore's Biopolis. Each reveals assumptions about how a given country chooses to compete on the global stage through the development of innovation capability. And each expresses a point of view about metrics and outcomes. Traditional approaches to national innovation as merely another class of economic asset that relates to measurable productivity outputs pales before the complexity and richness of innovation as it is practiced in many parts of the world today.

Large scale innovation may also be a lens usefully applied to regions. The EU and OECD as regional political entities have given considerable attention to innovation policy. InnoBasque is a leading example of a non-nation that has embraced innovation as a driving force and has shown sophistication in seeing innovation not just as science and technology, but as a societal and cultural phenomenon as well. Another regional example can be seen in the Andean countries with their emerging pattern of collaboration among a cluster of nations. What I call the Baltic innovation zone is yet another example of a diverse set of players united by a common interest in innovation. Helsinki is the focal point of the Baltic innovation area that includes Estonia which is only a short ferry ride away as well as also St. Petersburg with its abundance of talented scientists and

engineers. As another example, Malmö, Sweden is the hub of a regional and multinational life sciences cluster.

The dissemination of innovation capability draws on a variety of historical and cultural causes. For example, because of the egalitarian ethos of Nordic countries, there has historically been an effort to regionalize innovation capability, for example to move it from well-endowed, urban environments like Helsinki to other parts of Finland. Finland's Silicon Valley is not located in Helsinki, but rather 600 km miles away in Oulu, with its blend of university, private sector and venture capital resources. Similarly in Norway, a conscious decision has been made to place the leading science and technology oriented university not in Oslo but in the more remote city of Trondheim.

Large scale innovation also happens in cities, where more than 50% of the world's population now lives. One striking example of this is the city-state of Singapore, which occupies a mere 655 square kilometers of land at the tip of the Malay Peninsula. Singapore has capitalized on what would be an apparent disadvantage, namely its compact size, to create a level of efficiency, social cohesion and agility that is the envy of many countries. Another leading example is Helsinki, which has an explicit innovation strategy, an innovation manager and an agenda for building up innovation capabilities. San Francisco is another example of a city with an innovation strategy that focuses on three emerging areas: life sciences, digital media and clean tech, each of which is supported by a physical platform: life sciences are supported by the large Mission Bay complex and digital media in the San Francisco Presidio; while clean tech is envisioned to unfold at Hunter's Point, a former Navy base.

Large Scale Innovation – Exploding Technologies, Wicked Problems

Large scale innovation also characterizes what happens when a variety of players come together in an exploding wave front of new science and technology. This is very much the case for example, with synthetic biology, a new discipline that represents a marriage between advanced life sciences and information technology. The cradle for synthetic biology is QB3⁵, an interdisciplinary research institute located in Mission Bay as part of the University of California at San Francisco's School of Medicine.

Synthetic biology has captured the attention of start-ups, venture capitalists, established companies, academic research scientists, thought leaders, policy makers, healthcare domain experts and others. It is a rapidly evolving field, in which the critical mass of talents still resides within San Francisco, although, perennial attention is being given to the globalization of synthetic biology. One of QB3 director Reg Kelly's biggest decisions is what to do about the pile of invitations he has received to establish working alliances around the world.

At heart, large scale innovation phenomena are in a sense, expressions of what Horst Rittel described three decades ago as "wicked problems."⁶ In his lexicon, tame problems are those that have a rational and linear pathway to a solution, the problem is relatively easy to define explicitly

⁵ <http://qb3.org>

⁶ Rittel, Horst, and Melvin Webber; *Dilemmas in a General Theory of Planning*, Policy Sciences, Vol. 4, pp. 155-169, Elsevier Scientific Publishing Company, Inc., Amsterdam, 1973

and can be understood by a variety of people. The appropriate process for addressing the problem is also explicit and easily understood. Success metrics are correspondingly explicit and there is a sense that when the problem is solved, the task is completed. In other words, the process may be brought to closure. An example of this would be purchasing a car; you know you need a car, because your old car doesn't work well anymore. You do your analysis by looking through consumer reports and test-driving several options, and then you make a purchase decision. Problem solved.

In contrast, Rittel described "wicked problems," as those that are hard to define and whose nature remain ambiguous and elusive while efforts to solve the problem were underway. Such wicked problems often involve a large number of diverse stakeholders who do not see the problem or indeed much of anything else in the same way. They might be separated by disciplinary boundaries, by values, or by their role within a system, i.e. government versus private sector. Another characteristic of wicked problems is that one does not necessarily know they have been solved, except in hindsight. One might add that the complexity of global problems that transcend national borders, cultures and social systems are by their nature likely to be wicked.

Addressing wicked problems is daunting under the best of circumstances. Rittel maintained that the only way of resolving one was by bringing all owners of the problem, no matter how different their perspectives, into "the same room" and applying an intensive creative process to addressing the challenge.

By this definition, wicked problems are everywhere in the world and include those challenges most significant for global civil society: climate change, energy dependence, global security, education, health and wellness, food security, fresh water, poverty, and so on. Similarly, the question of innovation in a large scale system is also a wicked problem, since many stakeholders must come together to achieve alignment, if not agreement, in order to pursue a strategy. Specifically, they must share a sense of why the journey of innovation is necessary, how it is to be undertaken and what its goals are.

Large Scale Innovation and Stewardship⁷

Large scale innovation emerges from stewardship, which connotes an approach to process, a group of diverse participants and a set of values around how to address wicked problems. Stewardship may result when a variety of players - government, private sector, thought leaders, divergent thinkers and citizens, and domain experts - come together in often emergent social compacts or agreements to drive an innovation initiative. We have seen this in the movement to address climate change, for example, the successful effort to preserve the ozone layer. What distinguishes stewardship at its heart from governance is the diversity of participation required, the bottom up as well as top down quality of the process, and the need for collaborative as opposed to directive decision-making. By their very nature, wicked problems cannot be successfully resolved by top-down directives; they must be negotiated through an interactive and inclusive process.

The collaboration challenges involved in stewardship are substantial. Four sectors must have a seat at the societal wicked problems table – the public sector, private sector, NGO's and

⁷ Kao, John, White Paper on Stewardship, Institute for Large Scale Innovation, 2009

civil society - each of which has their own norms and standard operating procedures. The description and understanding of innovation will vary according to the point of view of a particular stakeholder. This is even more true of approaches to the stewardship and management of innovation at a large scale, which depend on individual perspective as well as local culture, business climate, political and social system, and regulatory conditions to name but a few influences. Achievement of a meaningful level of collaboration among these communities in service of some ambitious goal is often far from straightforward and requires creative approaches to facilitation and process design in terms of how the work is to be carried out.

Stewardship of innovation becomes an even bigger challenge when one considers how innovation might work at the level of global civil society. In 1968, the Club of Rome⁸ embarked on an effort to look at planetary systems through the lens of systems science, borrowing Buckminster Fuller's metaphor of earth as a spaceship with finite resources and delicately balanced systems. A similar mental exercise may be applied to the question of innovation. How can innovation work at a global level? What are the relevant systems that must be considered? Who would be involved in providing stewardship and where would they get their legitimacy from? How would investment decisions be undertaken? How would priorities be set? How would collaboration among nations, regions, cities and other players be accomplished? How could innovation capability be harnessed in service of the global good? What would the metrics of success be and how would we know when we were being successful? It is hoped that the first I20 Innovation Summit will tackle some of these questions.

Generally speaking, there are three key core ingredients for innovation: talent, capital and ideas. Historically, these resources have been captive to boundaries defined by the politics of the nation state. Smart countries have always known how to create hospitable environments for innovation. However, in the 21st century these resources are flowing across borders more fluidly and rapidly than ever before, to shape in effect a global innovation ecosystem. Countries need to reevaluate and evolve their positioning and value proposition within a global competition for talent. Provision of capital, high quality environment and infrastructure are some of the relevant magnets.

Distinctive Characteristics of Large Scale Innovation

Large scale innovation is different from innovation at an enterprise level. First, there is a heightened level of complexity and scale, both because the range of tasks are more diverse as are the players involved, and because the issues under consideration tend to be wicked, not tame. The innovation process is arguably more complex as well, given that a value chain relevant to a particular innovation arena may involve a large number of players and elements.

Large scale innovation when spread over a global canvas implies arbitrage opportunities, in such terms as bringing knowledge, innovation inputs and skills from one location to another to realize value. This can occur in terms of a particular value chain for innovation, or in terms of translational research, brokering or other mechanisms for bridging between diverse communities to drive innovation. Such arbitrage can also occur more locally by creating a culture that embraces diversity and creates mechanisms for blending professional cultures.

⁸ www.clubofrome.org

The stewardship of large scale innovation has its own unique characteristics. Top-down must be leavened by bottom-up involvement and by the ability to source input from outside of the immediate system, whether it be through consultants, "red team" or contrarian experts or other mechanisms to keep the process authentic. No group of senior people can know it all.

Establishing a sense of urgency necessary for action to result at a large scale level is also a challenge. Crafting a narrative that is relevant at a national or global level is different from an attitude of "let's get the bastards before they get us," which is the often unfortunate summation of strategy at an enterprise level.

Then, there is a need for persuasion and negotiation, not direction and control, as a leadership style. One must be entrepreneurial when in a position of large scale innovation stewardship, because one is constantly in a position of using resources over which one does not have control. There is plenty of "we don't know what we know" and "we don't know what we don't know." So the management style has to be one of trust, letting go of the need to control at all times and being able to tolerate the disorder and messiness inherent in the innovation process. This is especially true when looking at innovation as a global systems issue. Certainly, the ability to participate in alliances is a key success factor. The cultural intelligence, mindset and other resources needed to make alliances come alive are important. Countries like Chile and Denmark for example have leveraged their facility with alliances to create a positioning strategy within the global innovation economy.

Large scale innovation involves putting together a larger community and a network over which conventional leaders do not have complete control. There is a need for building a wider coalition, for putting together coalitions of the willing. A potential positive outcome is a heightened ability to sense emerging threats and opportunities and unknown unknowns. For example, there is a dictum in the open source movement that "in a world of many eyeballs all bugs are shallow." This literally means that you are likely to catch errors (bugs) if you deploy a large number of testers (eyeballs). The open innovation movement has taken this to mean that the more you include diverse perspectives, the more it is possible to form a full picture of what is actually happening and what the opportunities are.

There is also a need for new financing models in relation to the kinds of risk profiles and time horizons that characterize large scale innovation initiatives. A company may have fairly parochial approaches to investment in innovation and well-defined metrics for evaluating outcome. In contrast, large scale innovation investment requires the kind of long term investment that is hard to benchmark in terms of conventional outcome metrics. Basic science and seed investments in high-risk/high-return ventures do not yield success metrics on a quarter-by-quarter basis. Large scale innovation involves a different approach to pricing risk – balancing long term goals and agendas with support of a specific venture.

Intellectual property works differently with large scale innovation as well. In the corporate realm, there is a high need for proprietariness, walling off IP so that it can only be used by insiders for competitive advantage. An "us versus them" mentality can be used to drive competitive energies. Such an approach is obviously moderated somewhat by the advent of open innovation as a practice. But even there, new approaches to open innovation must be tempered by a certain guardedness in allowing one's intimate secrets to be shared by outsiders. In the large scale system,

IP often achieves its full economic and societal value by being used over and over again. In a sense, IP obeys a kind of increasing returns model, in which the more you use something, the more valuable it becomes and where the reusability of certain kinds of IP can lead to the ability of many people to generate wealth. So instead of "us versus them," it is increasingly about "all of us." And instead of legacy notions of zero sum competition, the model may evolve in the direction of "guarded openness"⁹ for the benefit of all as described by John Arquilla.

The Future of Large Scale Innovation and its Stewardship

Large scale innovation, especially at the global level, is at present an orphan issue. Traditional institutions of global governance, such as the U.N., and the World Bank are not addressing issues of global innovation stewardship explicitly. One senior U.N. official, when I asked him about the U.N.'s approach to innovation said he didn't know who handled it, but he thought it probably had to do with intellectual property management. Certainly at the global level there are forums such as Tallberg, the World Economic Forum, Bilderberg and others. But no one has systematically looked at the world as a global innovation system.

So at the end we are left with more questions than answers.

- Who will step forward to provide stewardship for global innovation and what will their sources of legitimacy be?
- What are some prototyping opportunities for global innovation stewardship to engage in?
- What will the effect of open innovation be on innovation flows that transcend the borders of nation states?
- What would an innovation strategy for global civil society look like? Would there turn out to be significant redundancy in global "grand" science projects?
- How is talent flowing globally and what are the implications?
- How is this being influenced by new patterns of quality higher education?
- How would science policy change if viewed from a global perspective?
- How would investment in innovation change if viewed from a global perspective? How would the pricing of risk change? What might new mechanisms for funding large scale innovation be, especially with regard to venture investing and financial harvests?
- What are the leadership and facilitation skills required to handle large scale innovation challenges?

Barriers to the Practice of Large Scale Innovation

Our efforts to pursue large scale innovation initiatives today are hampered by our decidedly imperfect understanding of innovation itself. Certainly innovation has been one of the glories of human endeavor. But, the serious study of innovation is still a young discipline; we are still in what I would call a pre-Copernican universe, where innovation is concerned – we can plot movements and make predictions, but we lack comprehensive understanding of the underlying dynamics of much of how innovation actually works at the macro level.

⁹ Arquilla, John, Ronfeldt, David, In Athena's Camp. Rand Corporation, 1997

In addition, we are hampered by the fact that the bulk of work on innovation is focused on the micro-domain – individual creativity, team effectiveness and innovation strategies for the enterprise. Relatively little attention has been paid to fostering innovation at a large scale. Those efforts to describe innovation at, for example, a national level are also hampered by the methodologies employed. The tendency is often to look at innovation through a technocratic and rational lens; to focus on it as if it were simply another measurable factor of production, and to harness it to parochial goals framed in such terms as competitiveness.

The fact of the matter is that innovation as a set of capabilities in the 21st century is much more than science and technology, more than what can be measured using quantitative and technocratic instruments current within a well-defined public sector. Innovation is also about human passions, gut feeling and the willingness to enter into the unknown. In a sense, innovation has always been about taking a heroic journey, beginning with the call, known since the time of Odysseus, to embark on a journey whose outcome is unknown and to triumph by dint of courage, appetite for risk, luck, imagination and finally, an ability to transition from the rigors of the journey to the return home.

In the knowledge economy of the 21st century, innovation is the key driver of economic growth and prosperity. In fact, innovation may be seen as the engine that creates wealth, especially if wealth is defined not only as goods or tangible assets, but also the agility and capability to achieve the desired future state itself.