NATIONAL INNOVATION INITIATIVE

# 21st Century Innovation

## Working Group Final Report

Council on Competitiveness

# Innovation

*The New Reality for National Prosperity*

## 21st Century Innovation Working Group Recommendations

**Version 2.1**

## December 15, 2004

## Integration of Interim Reports

**Draft Interim Report (v 1.63), June 1, 2004**
**Interim Report (v.1.4), September 22, 2004**

***Prepared for:***
**National Innovation Initiative**

***Prepared by:***
**21st Century Innovation Working Group**
**Nick Donofrio, Chairman**

# SUMMARY OF RECOMMENDATIONS

## *Recommendation 1*
## National Innovation Leadership Network [1]

**Innovation is a process of shared responsibilities requiring motivation and integration of many different resources within and among firms, the private sector and governments at all levels. The 21st Century Working Group recommends creation of a National Innovation Leadership Network consisting of members drawn from public sector, industry, research, labor and academia. The purpose of the Network is to provide an on-going mechanism to urgently address the need for more effective innovation policies and metrics to reflect today's knowledge based, dynamic and globally networked economy.**

**Innovation will be the principal driver of economic growth, standard of living and national competitive advantage in the 21st Century. The Leadership Network will be a transformational force aimed at ensuring that the US continues to be the most fertile and attractive environment for innovation in the world. The major activities of the Leadership Network include:**

- **To produce a biennial Innovation Scorecard assessing the nation's innovation performance in the global economy. High quality, relevant and timelier metrics that recognize the globally interrelated features of the innovation will enhance public understanding, help policymakers benchmark and monitor the nation's performance, and thereby, improve policymaking and business strategies.**

- **To establish a public-private partnership for a National Innovation Medal and Prize recognizing outstanding innovation performance by businesses (large and small), government entities, research and educational institutions that have contributed to the development and diffusion of new products, services and processes. The Medal would be presented by the President of the United States with the private sector providing innovation criteria, independent evaluators and prizes.**

- **To give rise to an Innovation Commons to sustain long- term public support for innovation, build dynamic collaboration within the innovation ecosystem and undertake aggressive Outreach and Advocacy to inform continuously the media, public and policymakers on the benefits of innovation and strategies to realize these benefits.**

**This initiative should be holistically framed and managed across all stakeholders and coordinated when appropriate with international organizations. The Leadership Network should be launched as a private sector initiative.**

[1] Prepared by Egils Milbergs, Center for Accelerating Innovation with major contributions from Nicholas Vonortas, George Washington University, September 22, 2004

# *Recommendation 2*
# Building Innovation Skills for the Future[2]

**Innovation within all enterprises, both large and small, whether public or private, is key to the future wealth and stability of the United States. Yet, we are currently not providing our students and workforce with the up-to-date skills they need to contribute creatively every day in their workplace. Innovation can be learned, but only through experience. We propose a National Support Network with the long-term goal of providing every student in high school and college the opportunity to gain these vital skills. Based on the proven pedagogy of Problem-based Learning (PBL) the network will harness the power of the Internet to solve the major structural and resource barriers currently preventing this necessary major addition to the education of the nation. Up to ten regional universities, already committed to innovation education, will form the backbone through "innovation learning centers." These centers will support the educational jurisdictions in their region by:**

**1) agreeing on and acquiring an information infrastructure to support the network,**
**2) installing course management software and PBL course materials at each node,**
**3) creating Innovation Learning Centers at each node for "training the trainers",**
**4) establishing and supporting outreach at each node to the following communities of interest – departments of education, school districts, 2 and 4 year colleges, teachers and faculty,**
**5) documenting the institutional barriers to adoption of PBL at institutions of higher education with case studies of successful implementation while developing marketing and outreach on the success of PBL and the models that support its adoption,**
**6) offering assistance to States to review academic standards for high school graduation to incorporate and highlight the importance of PBL and innovation.**

**Open access to this supportive "train-the-trainer" model will spread innovation learning across the nation at all levels by significantly reducing the barriers to change and, through sharing of materials and best practices, minimize the investment needed to implement this vital addition to the nation's education. The centers will also support workforce retraining in innovation skills.**

[2] Prepared by: Dr. Anthony C. Warren. Director of the Farrell Center of Corporate Innovation and Entrepreneurship. Smeal College of Business, The Pennsylvania State University. September 2004

# *Recommendation 3*
# Government Policy Coordination for Innovation[3]

**Innovation policy is the new pathway to building prosperity and national competitive advantage for advanced industrial nations. The 21st Century Innovation Working Group recommends an aggressive public policy strategy that energizes the environment for national innovation.**

**We believe that innovation is an issue that merits the time of the President. We recommend that the President establish a focal point within the Executive Office of the President to frame, assess, and coordinate strategically the future direction of the nation's innovation policies. This could be either a Cabinet level interagency group, or a new distinct mission assigned to the National Economic Council.**

**We recommend that the President give consideration to the following action items:**

- **Establish an explicit innovation agenda. Direct his Economic Advisors to analyze the impact of current economic policies on U.S. innovation capabilities and identify opportunities for immediate improvement.**

- **Direct his Cabinet Officers to undertake a review of Department programs and policies to determine their impact on the nation's innovation performance. Use this as an opportunity to break down "stovepipes" and foster closer collaboration among the agencies to meet clear national needs.**

- **Clarify and expand the role of existing mechanisms, such as the National Economic Council, the Office of Science and Technology Policy, the Domestic Policy Council and, the National Security Council to upgrade and strengthen the consideration of policy choices on innovation.**

[3] Prepared by Kathleen Kingscott, IBM and Alice B. Gast, MIT v.2.8 September 2004

## *Recommendation 4*
## Retooling Skills for Innovation[4]

**Education, both at the college level and in K-12, needs significant changes to prepare students to be leaders and innovators in the coming years. The system needs to be re-aligned to promote a competitive, 21st century definition of student achievement. One essential target for reform is in the area of curriculum, where creative and integrative instruction based on Problem-Based Learning (PBL) should be developed and implemented within multi-disciplinary and diverse teams, including distributed teams where possible. Additionally, Standardized Technology Platform(s) to support PBL using interchangeable course modules should be developed and deployed to solve the scalability, and complex course management issues that PBL raises. New methods of teacher training, school organization, governance, incentives and accountability must also be addressed to support and sustain the newly-aligned system.**

## *Recommendation 5*
## Catalyzing Collaborative Investments in Innovation[5]

**Innovation requires research investment and collaboration between many parties, including large, medium and small companies, universities, and government. Collaborative arrangements can result in higher innovation productivity. Effective collaboration demands new mechanisms. The 21st Century Working Group's recommendations in this area include:**

1. **Strengthen knowledge networks between appropriate partners, both virtual and real by establishing a National Innovation Portal, an open-source forum for innovation that matches companies with appropriate partners.**
2. **Enhance federal and state funding for research and innovation, especially merit-based programs (cf. NSF, NIH, DOD, DOE, DOC, and state programs) that match or provide funding in all technology areas according to technological and commercial promise.**

[4] Prepared by: Valerie Taylor, Texas A&M, Anthony Warren, Penn State, Matthias Preschern, IBM.
[5] Prepared by: Richard Seline, New Economy Strategies. Anthony Warren, Penn State University. Kenneth L. Simons, Rensselaer Polytechnic Institute.

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# CONTENTS

# INNOVATION: The New Reality for Prosperity[6]

## 1. Introduction

Innovation is the pathway to future prosperity. By most historical measures the US is the leading innovator in the world. It has in place most of the fundamental capacities for future innovation. However, the present challenge is one of insight on the nature of global innovation--whether we understand the new realities of the knowledge based, networked economy and how well we can redesign our innovation polices to sustain a long-term rise in US living standards. The advanced industrial economies of Europe and Asia have made innovation a top priority to secure their success in the global economy. Developing economies such as China, India, Brazil and Russia are committing substantial resources to move up the innovation value chain and are becoming important players in the marketplace. The United States must meet this challenge in ways we *all* participate and *all* benefit.

### *21st Century Innovation Working Group*

The 21st Century working group has focused its effort on discovering the attributes of innovation success, identifying priority issues and connecting our insights into an overall framework for guiding innovation policy. This report makes a case for the importance of innovation, proposes a definition for innovation, describes the changing nature of innovation and makes action recommendations.

Our analysis and recommendations suggest that a dramatic change in the nation's approach to innovation is now required if we wish to sustain our long term economic growth and competitive advantage. The recommendations are proposed as part of an overall framework aimed at creating a more robust environment for both the private and public sector to innovate, collaborate and rapidly respond to the growing spectrum of technology and market opportunities. Government polices should facilitate, not impede, this market driven transition to an *"innovation based economy"* that is global, creative, adaptable and continuously nurtures, commercializes and supports *"new-to-the-world"* technologies.

We realize that our analysis and recommendations are not the last word on the path forward. Innovation is inherently dynamic and constantly evolving. Perhaps no innovation framework can or should be definitive and final.

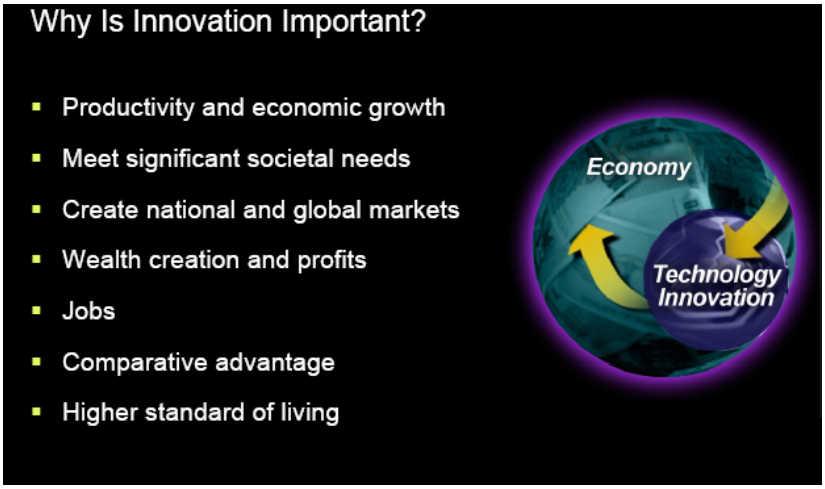
## 2. The Global Innovation Challenge

### *WHY INNOVATION IS IMPORTANT*

Historically, large economic advances in the US were built on multiple advances in technology and their application in the marketplace. Breakthroughs such as electricity, mass production of automobiles, telephone, television, microprocessors, computers, genetic engineering, wireless devices, etc, were followed by substantial increases in business activity, economic growth, productivity and living standards.

[6] Integrated by: Egils Milbergs, Center for Accelerating Innovation and Taffy Kingscott, IBM Corporation

According to leading economists, nearly half of US productivity growth is accounted for by technological progress, capital investment and the skills and experience of the workforce (Solow, Kendrick, Denison, Jorgensen and Romer). International comparisons of economic performance indicate that the *intensity of national innovative activity* is correlated with higher rates of productivity growth and standards of living (Porter, Furman, and Stern).




Successful innovation creates customer value through new products and services, gives rise to new markets, and generates growth for enterprises. Innovation improves existing products and processes, thereby contributing to higher productivity, lower costs, increased profits and employment. Firms that innovate have higher global market share, higher growth rates, higher profitability and higher market valuations. Innovation also generates spillover and cascading effects as competing firms absorb new innovations. Customers of innovative products and services gain benefits in terms of more choices, better services, lower prices and improved productivity. As innovations are adopted and diffused, the "knowledge stock" of the nation accumulates, providing the foundation for market growth, long-term wealth creation and higher living standards.

### *THE NEXT INNOVATION WAVE*

For the US to maintain high levels of economic growth and job creation, it must be a global leader in the development and commercialization of *"new-to-the-world"* technologies. Incremental improvements, imitation and adaptation continue to be important for competitiveness. However, this is not a sufficient foundation for long-term competitive advantage, economic growth and rise in living standards. The nation must now develop a true innovation capability and generate exponential rather than linear improvements.

During the 1980s the United States faced a competitiveness challenge primarily from Japan. To meet this challenge, policy attention was focused on cost reduction, operational efficiency and quality improvement. The economy successfully transitioned from a mass-production to a quality-management culture, where ideas such as lean, six sigma, TQM, do it right the first time and supply chain optimization created the productivity marvel of the world. Today, cost and quality are the minimum ante to be a player. The forces of global economic integration and advances in technology are creating a different and more complex challenge. Sustaining competitive advantage requires moving beyond efficiency

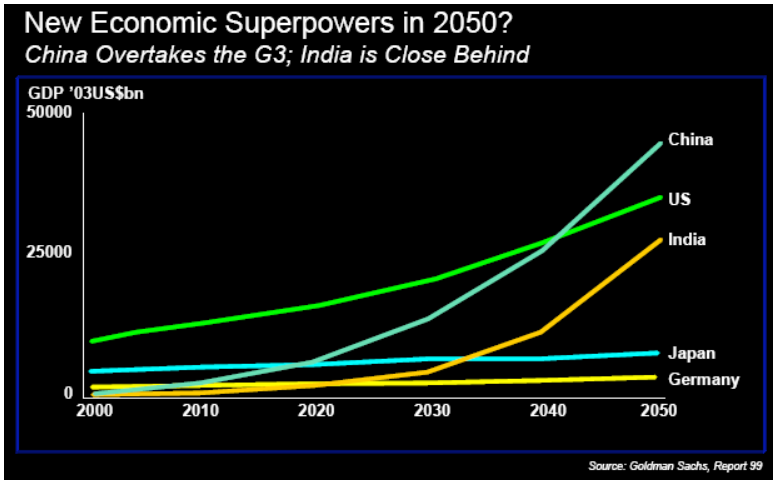
and quality toward creating new markets, increasing value to customers and innovating continuously on a global basis.
The US must create the conditions that will stimulate enterprises to innovate and take the lead in the next generation of technologies and launch the economy onto new growth curves. The transition to a globally integrated economy portends to be more disruptive in its reach, scope and scale than prior waves of innovation such as the shift from mass production to quality management. But it is a challenge we must meet.

While innovating enterprises are the prime agents of knowledge transformation and commercialization, innovation is increasingly a global and interactive activity among many stakeholders, including customers, government, academia, the financial sector, research centers and partnerships. The 21st Century Working Group examination of innovation points us toward an integrated policy framework which gives major consideration to factors not only *internal*, but also *external* to the enterprise, including *market demand*, *public policy environment* and the *innovation infrastructure.* These are recognized as important determinants of national innovation performance.

### *GLOBAL INNOVATION CHALLENGERS*

The US remains the world's economic superpower, accounting for a third of global economic activity. We cannot lose sight of that. However, we are entering an unprecedented new era of global competition. .Other nations are now viewing innovation as the key to their future growth and economic well being. During this past decade the European Community has focused policy attention on building more creative innovation systems (Lisbon Strategy). Their innovative capacity is being strengthened with the EU accession of 10 talented and motivated countries of the former Soviet Union. Individual nations, such as the United Kingdom, Germany and France, are also establishing national innovation strategies. Japan, Taiwan, Singapore and South Korea are systematically focusing on the next wave of technologies to drive their economies to become even more competitive in international markets. China is an emerging nation, although representing just four percent of the global economy today, but it is growing rapidly. India has established a major foothold in software development, manufacturing and high tech outsourcing.

Our future is indeed being challenged. The time is <u>now</u> to get our act together. Over the next 50 years, Brazil, Russia, India and China—the BRICs economies—are forecasted together, in US dollar terms, to be larger than the G6 countries of the US, UK, Japan, Germany, Italy, and France. By 2025 they could account for over half the size of the G6 and by 2025 only the US and Japan may



be among the six largest economies.
If the assumptions of the forecast hold up, the BRICs will become a major engine of new demand growth. This growth is a global opportunity – a chance to raise the standards of living of millions. As Americans, we should welcome this, because prosperity increases markets and breeds stability. However, we need to make thoughtful choices across many dimensions to ensure that Americans compete effectively in a hyper-competitive global economy and continue to enjoy the high standard of living they expect. The US challenge is to put in place policies, strategies and investments that allow us to participate in a way that all benefit.

## 3. Innovation Defined

The traditional conception of innovation is a linear progression from research to invention, from engineering to product, and from manufacturing to marketing. That model would suggest that the method for increasing innovation by increasing R&D inputs (technology push) would be sufficient. Innovation, however, is much more complex than a sum of knowledge inputs. It is about successful market outcomes and the process by which those outcomes are generated. Accordingly, the 21st Century Working Group has defined innovation as follows:

***"Innovation transforms insight and technology into novel products, processes and services that create new value for stakeholders, drive economic growth and improve standards of living."***

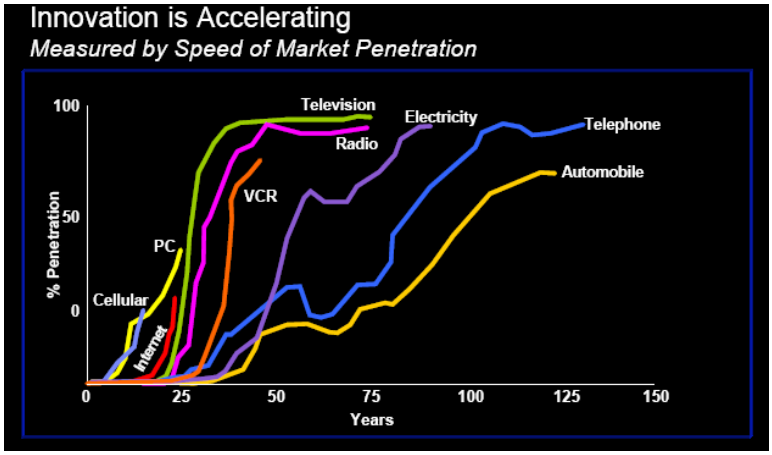
The definition respects the fact that innovation is a complex and multidimensional activity that cannot be characterized by a single input measure. Our understanding of innovation is significantly hampered by currently available (and inadequate) measurements that largely reflect the industrial era and less so the demand driven, knowledge economy unfolding around us: they largely reflect products and artifacts rather than ideas, processes and customer value creation.

- Innovation is much more than technology – many other complementary resources and services are essential for market success;
- Like human health, there isn't any single attribute adequate to capture innovation's dynamics and multiplicity of features;
- Innovation success and diffusion is ultimately determined by the demand side (how the customer values innovation) not just technical inputs and product features.
- Companies are moving beyond the dichotomy of technology push and market pull and are embracing both sides of the equation by collaborating more with customers, partnering with external sources of innovation, networking resources into new business models and focusing innovation on global market opportunities.
- Non-linear dynamics characterize the entire innovation value chain end-to-end at the national level and at the firm level.

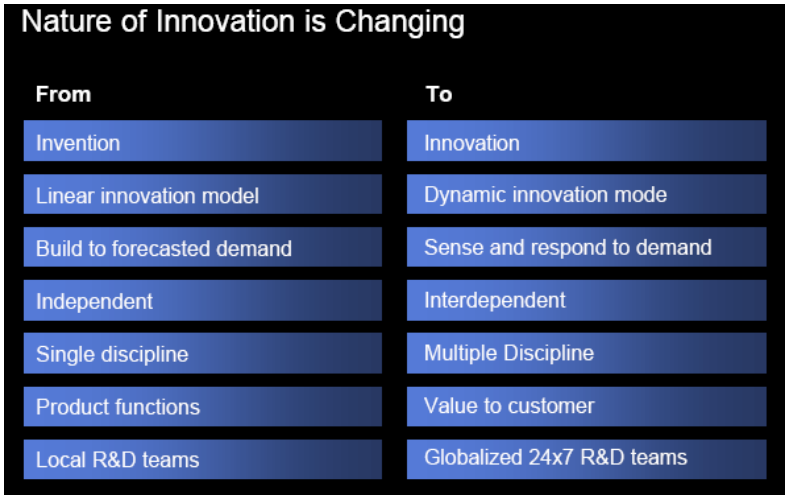
## 4. The Nature of Innovation is Changing

### *ACCELERATION OF INNOVATION*

Historically, innovative devices have transformed our society and economy at a relatively slow rate. However, the penetration rate of these devices is accelerating dramatically, as indicated in the following chart. It took the automobile 100 years to penetrate 50% of the global market. It took the telephone 75 years and electricity took 50 years. By comparison, the rise of cell phones, for example, has been nothing less than meteoric -- faster than the personal computer ... faster than the Internet.




With the slower pace of innovation, the traditional linear innovation model worked pretty well. However, today's model is more dynamic. In the past, we built to forecast and demand. Today, we must sense and respond "on demand." To do that, we can't be independent workers in silos anymore. We have to think in an inter-dependent, collaborative way. We have to think across disciplines and collaborate at the intersections between them. Contemporary innovation requires that we move beyond our earlier concerns of, "How can I make my product better?" Today, our focus must be on the value a product or service brings to the customer. What do customers value most now and in the future?



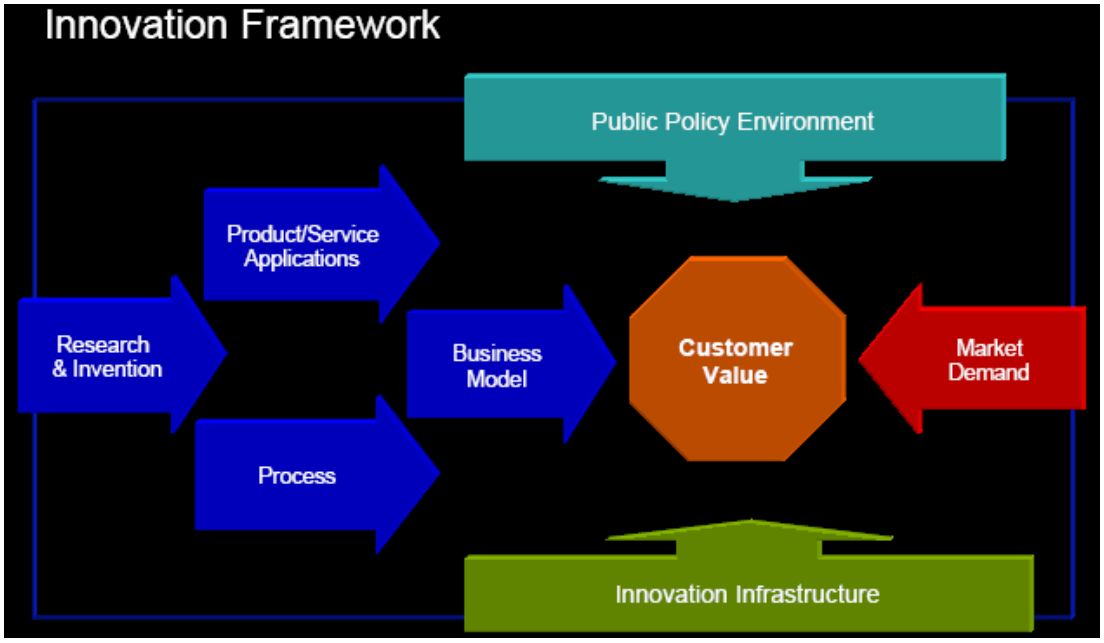

### *INNOVATION FRAMEWORK: BEYOND INVENTION*

With these observations in mind the Working Group has evolved a comprehensive perspective on the nation's innovation system. Traditionally, innovation policy has focused on inputs--in terms of research and invention and in terms of training scientists and engineers and creating the skills they will need. With those resources, it has been assumed that the United States would be able to create competitive products and services and related production processes. We also, in more recent times, have focused on business models and customer relationships processes. However, these are only "inputs" to the

market. Today, we need to think about moving beyond those isolated inputs by approaching innovation in terms of customer value creation.

The framework presented below helps describe the "national innovation ecosystem." and focuses attention beyond invention to key measurements and policy issues. The framework recognizes the importance of:

- Both technology inputs and market demand (outputs) as factors influencing the rate of innovation.
- Attributes of the innovation infrastructure and public policy environment as important determinants of national innovation outcomes.
- Processes, management practices and linkages between the inputs and outcomes.




More insight on *market demand* and *customer value creation* will increase the search for innovative solutions, help manage risk, accelerate diffusion (take-up) and significantly mobilize the nation's innovation resources.

The innovation framework also helps us ask important questions. For example if the nation's *infrastructure* is adequate to the task:

- Do we have the right collaborative mechanisms and methods of bringing university industry partnerships together?
- Is our research infrastructure adequately funded and organized effectively to support innovation?
- Are we investing in the physical sciences, as well as in the life sciences?

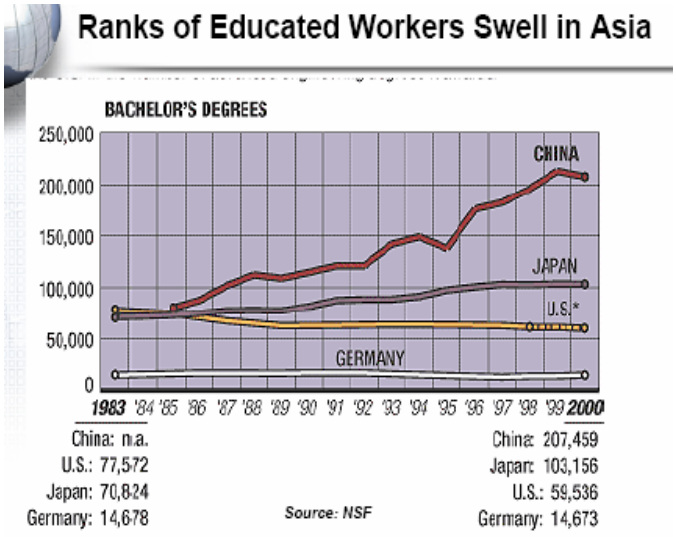
Equally important, we need to ask whether we have the right *public policy environment* to facilitate innovation processes and enable continuous delivery of value. A broad array of

government polices from research funding to taxes to market access have important impacts on the innovation process. Presently these policies managed vertically in silos and are not examined or integrated horizontally by the government from the perspective of innovation.

## 5. Key Trends and Issues Make Innovation Vital

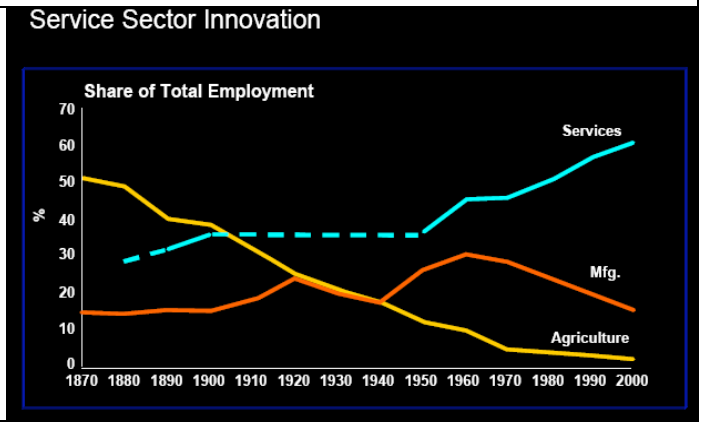
***Global Talent Pool***

Several nations are producing more educated workers than the US. As a result, we no longer can rely solely on US talent. Nor should we want to. We want to benefit from a diversity of talent ... a diversity of culture ... a diversity of thought and insight. We want to draw people from all over the world into our innovation networks. The research capabilities of universities are growing -- both here, and in other nations. To take advantage of global talent, we should encourage the growing focus on collaboration as a "win-win value proposition" that engenders benefits for all partners. For the US workforce, a central challenge for educators is how to radically redesign our education pedagogy and curriculum to produce lifelong learning skills so current and future generations can be more flexible, mobile and prepared to compete successfully in the globally competitive knowledge intense economy.



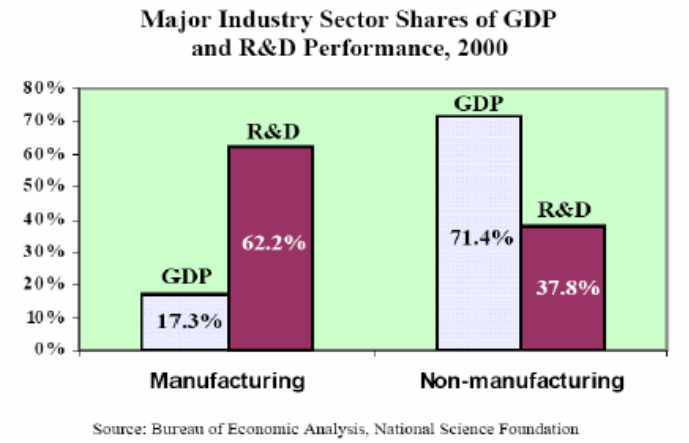

***Service Sector Innovation***

Our *services* economy is growing, while the *manufacturing* portion of our economy is declining. A key issue is whether our education system is training young people to participate in this new kind of business structure. We need the correct statistics in place to measure the many changes that go along with this shift toward a knowledge based services economy?



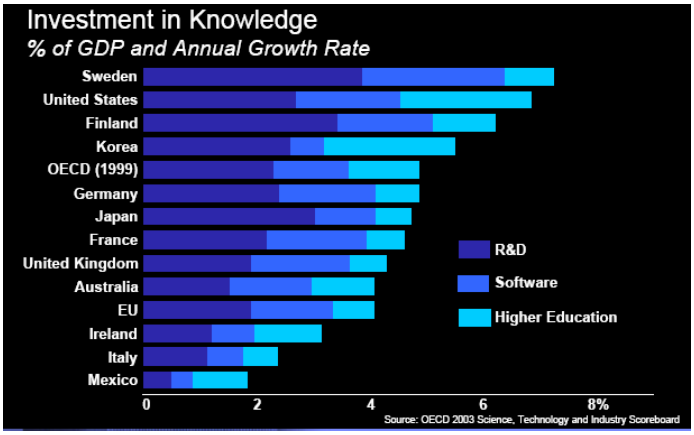
### *Services R&D Significantly Below Manufacturing*

Innovation policy needs to address the proper balance in research investment. Manufacturing represents just 17% of our economy. Yet, we're devoting nearly two-thirds of our research to it. Over 71% of our economy is represented by Services, but we are investing only a 37% of our research investment to it. A better alignment may be in order.



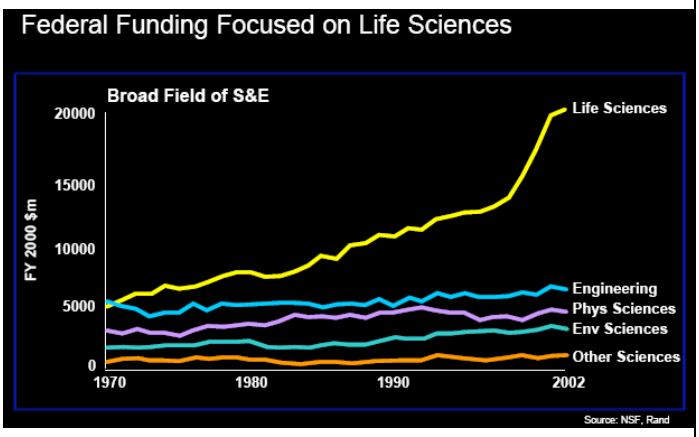

### *Investment in Knowledge*

The United States is second only to Sweden in percentage of GDP in knowledge. Looking to the future, we will be required to bring together a range of disciplines to drive the production, aggregation and distribution of knowledge through Information Technology.




### *Federal Funding Focused on Life Sciences*

Life Sciences are the hotbed of discovery and innovation right now, and perhaps one of the great drivers of economic growth and customer value in the future. On the other hand, we are virtually ignoring the physical sciences that will enable growth of the engineering and Information Technology fields -- which are critically important elements of the innovation infrastructure.

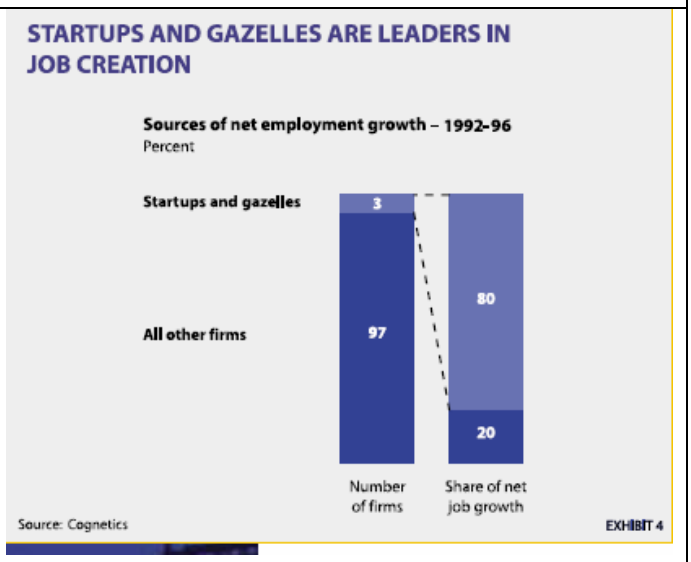


### *US is Global Leader in Venture Investing*

Although higher risk investment capital has diminished since the exuberant stock market days of the late 1990s, the US continues to lead the world in venture investments for innovation. However a growing proportion of those investment dollars are from non-US citizens. Steps are needed to maintain a high level of venture capital investment in the US especially considering the large trade deficit and falling value of the dollar.

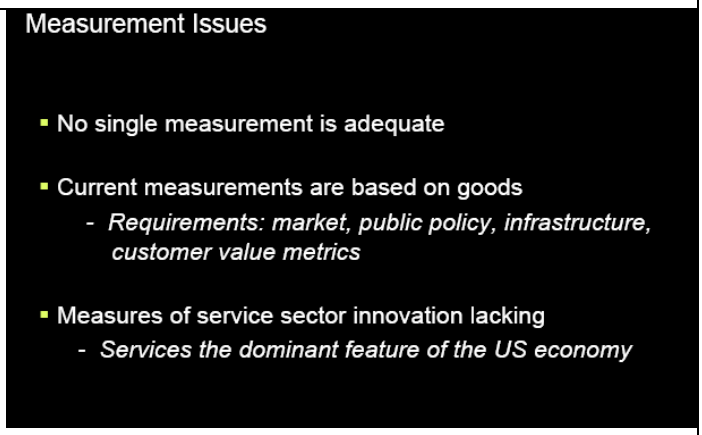

### *Small Firms are the Job Creators*

Most new jobs come from a relative handful of fast-growing companies. During the 1990s startups and gazelles within knowledge- and technology-based sectors of the economy were the primary engine of job growth. New businesses and gazelles – companies growing at over 20 percent a year over a four-year period – accounted for 80 percent of net employment growth from 1992 to 1996 And knowledge economy sectors are expected to generate nearly three times more jobs than the older industries, growing 3.6 percent annually from now through 2008.



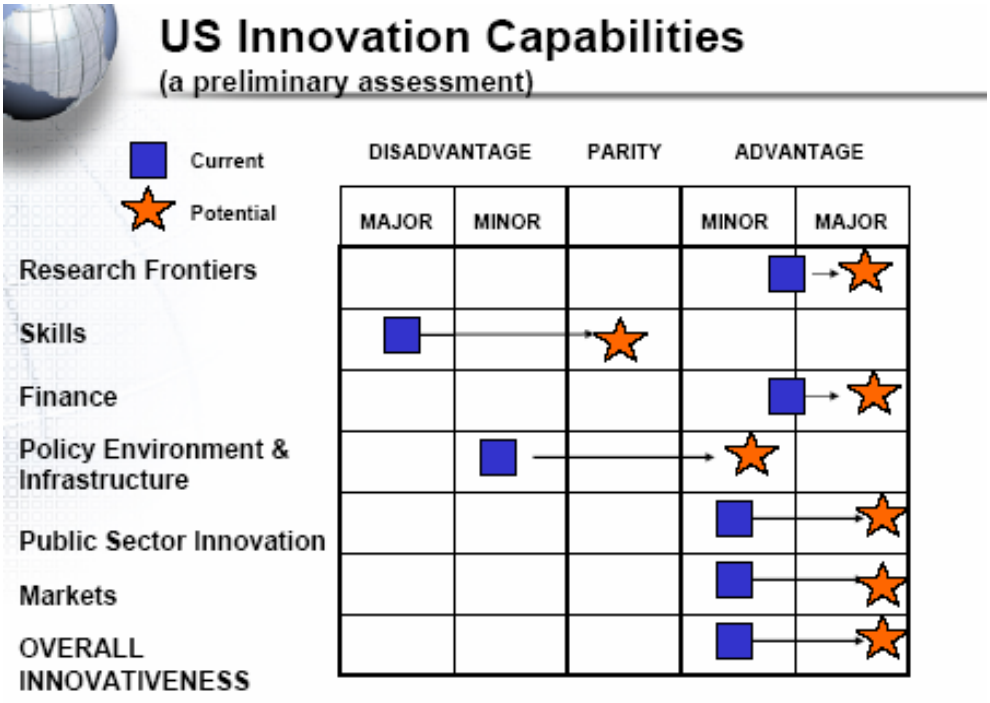

### *Innovation Metrics*

Another key aspect of the new innovation ecosystem is measurement. If you can't measure something ... you can't drive it. It's clear that a myriad of measurements exist for economic indicators, but there's no single integrated database to give us a look at the economy through a new lens --- the lens of innovation. Government and the private sector, working on an international basis, must step up work on defining the metrics most appropriate for the new innovation economy.



## 6. Overall Innovation Assessment

Based on a qualitative synthesis of metrics available to the Working Group, we have concluded that overall the US is the world innovation leader. The strongest capabilities are the US investment in the frontiers of research and financial capacity. It also maintains a leadership position in public sector innovation, the size of its national market and a substantial competitive position in global markets. The areas of major concern are in the areas of innovation skills, the policy environment and the infrastructure which supports the innovation process.




### *Strategic Policy Implications*

To strengthen overall US innovation performance the following are strategically important national goals:

- Maintaining global leadership in scientific frontiers and emerging technologies.
- Fundamentally retooling human capabilities to learn, upgrade skills and adapt to global workforce dynamics.
- Implementing fiscal/ monetary policies to ensure an adequate supply of "innovation risk capital" and the incentive for rapid commercialization and diffusion.
- Elevating the innovation agenda, removing policy barriers to innovation and accelerating investment in supporting infrastructure.
- Modernizing government services through innovation.
- Expanding global markets for innovation.

## 7. General Principles for Innovation Policy

Today's de facto policy framework for innovation is obsolete and needs to be updated to reflect the emerging realities of global innovation. The Working Group believes certain general principles must be kept in mind as the NII formulates its recommendations:

- Private sector has the central role in transforming knowledge/technology into products, services and processes that meet the test of world markets.
- Government sets an overall economic environment and also impacts innovation as an enabler, facilitator, rule setter, international commerce negotiator, etc.
- Innovation policy should build on our strengths and minimize our weaknesses.
- Innovation policies should be balanced with respect to inputs as well as outputs.
- Research and technology inputs are necessary but insufficient for innovation success. Demand (market signals) can induce and accelerate innovative outputs. NII should examine policy approaches that enlarge the *markets* for innovation (e.g. market access, open competition in monopolistic/regulated markets, standards, intellectual property protection, technology investment incentives for users, etc.
- Modernization of our innovation policy framework requires *public and private leadership and the participation of broad array of stakeholders.* .

### *Innovation Stakeholders*

The framework suggested by the 21st Working Group has important implications for stakeholders. The Innovation Economy is not the responsibility of any single organization or group of individuals. Maintaining innovation leadership, bolstering our technological, human and financial resources and ensuring a positive investment climate for innovation is the obligation of every citizen, every worker, every company, every educator and every policy maker.

# 8. RECOMMENDATIONS FOR ACTION

The following sections present the action recommendations of the 21st Century Innovation Working Group:

**Recommendation 1: National Innovation Leadership Network**

**Recommendation 2: Building Innovation Skills for the Future**

**Recommendation 3: Government Policy Coordination for Innovation**

**Recommendation 4: Retooling Skills for Innovation**

**Recommendation 5: Catalyzing Collaborative Investments in Education**

# *Recommendation 1*
# National Innovation Leadership Network [7]

**SUMMARY**

**Innovation is a process of shared responsibilities requiring motivation and integration of many different resources within and among firms, the private sector and governments at all levels. The 21st Century Working Group recommends creation of a National Innovation Leadership Network consisting of members drawn from public sector, industry, research, labor and academia. The purpose of the Network is to provide an on-going mechanism to urgently address the need for more effective innovation policies and metrics to reflect today's knowledge based, dynamic and globally networked economy.**

**Innovation will be the principal driver of economic growth, standard of living and national competitive advantage in the 21st Century. The Leadership Network will be a transformational force aimed at ensuring that the US continues to be the most fertile and attractive environment for innovation in the world. The major activities of the Leadership Network include:**

- **To produce a biennial Innovation Scorecard assessing the nation's innovation performance in the global economy. High quality, relevant and timelier metrics that recognize the globally interrelated features of the innovation will enhance public understanding, help policymakers benchmark and monitor the nation's performance, and thereby, improve policymaking and business strategies.**

- **To establish a public-private partnership for a National Innovation Medal and Prize recognizing outstanding innovation performance by businesses (large and small), government entities, research and educational institutions that have contributed to the development and diffusion of new products, services and processes. The Medal would be presented by the President of the United States with the private sector providing innovation criteria, independent evaluators and prizes.**

- **To give rise to an Innovation Commons to sustain long- term public support for innovation, build dynamic collaboration within the innovation ecosystem and undertake aggressive Outreach and Advocacy to inform continuously the media, public and policymakers on the benefits of innovation and strategies to realize these benefits.**

**This initiative should be holistically framed and managed across all stakeholders and coordinated when appropriate with international organizations. The Leadership Network should be launched as a private sector initiative.**

[7] Prepared by Egils Milbergs, Center for Accelerating Innovation with major contributions from Nicholas Vonartas, George Washington University, September 22, 2004.

**BACKGROUND**

The ***NII Interim Report: Innovate America*** points out that the national innovation system is a complex array of stakeholders and institutions – public and private. The system consists of many federal agencies that fund R&D activities and many areas of policy which impact the effectiveness of innovation. It consists of thousands of business enterprises, large and small who have the primary responsibility for transforming research and new knowledge into the marketplace. It consists of universities, colleges and research organizations, regional technology entities, various kinds of infrastructure –transportation, telecommunications, health care and others. To optimize the nation's innovation performance all these stakeholders need to perceive themselves as part of an ecosystem—which means not only optimizing internal innovation processes but also optimizing externally – the intersections and linkages with stakeholders.

No single institution in government or the private sector has the "horizontal" responsibility for strengthening the innovation ecosystem at the national level—it is and always will be a shared responsibility.

What is proposed is creation of a new platform called the **National Innovation Leadership Network.** This leadership network would have a stewardship role to advance a national innovation agenda during the next few years. The network would bring together the major stakeholders in the ecosystem to discuss ways to improve the innovation environment and to measure, recognize, analyze and inform policymakers, media and the public on the status of innovation nationally and globally. The overall goal is to continuously build public understanding and support for innovation as the principal driver of the nation's economic performance and competitiveness in the 21st Century.

The following major activities are proposed for the National Innovation Leadership Network:

1. Produce biannually a **National Innovation Scorecard** assessing the nation's innovation performance, including international benchmarks.
2. Establish a **National Innovation Medal and Prize** in partnership with the federal government.
3. Create an Innovation **Commons** and aggressively implement **Public Outreach and Advocacy** to sustain long term national commitment to innovation.

Each of these activities is elaborated in more detail below.

## 1. National Innovation Scorecard

**Rationale**

A key component of an effective national innovation policy is measuring the factors that drive innovation performance and monitoring results. This requires establishing a baseline or benchmarks as a starting point and tools for assessing the impact of policies over time. Innovation measurement systems do not adequately reflect the contemporary dynamics of

an increasingly knowledge based, networked global economy. To establish a new baseline it is recommended that a **National Innovation Scorecard** be produced on a biannual basis to boost policy attention and sustain a public-private dialogue on ways to continuously adapt the environment for innovation.

This private sector initiative will work with government and private sector research and statistical organizations to advance the definition, quality and timeliness of innovation metrics. A key objective is to look beyond inputs and the manufacturing sector and toward outcomes and quite importantly, innovation processes. Particular attention needs to be given to defining consistent and internationally comparable metrics for innovation demand, knowledge flows, intangible assets, public policy factors, regional innovation networks, infrastructures and management practices. For the 21st Century such a multi-dimensional view is essential to sound policy analysis and decision-making.

Implementation of this recommendation will require a close working relationship with federal statistical agencies, trade associations and professional societies, private research/survey organizations and international organizations. A number of resources are already available to begin the process of integrating this new generation of innovation metrics. *Attachment 1 is a synopsis of selected resources.*

***"Innovation is a process through which the nation creates and transforms new knowledge and technologies into useful products, services and processes for national and global markets – leading to both value creation for stakeholders and higher standards of living."***

Definition developed by the 21st Century Innovation Working Group 2004

The Innovation Scorecard would not only go beyond just presenting metrics but also would identify areas of public policy and other factors relevant to innovation performance. These findings will act as a force to close gaps in the nation's innovation ecosystem, enhance advocacy and promote a long-term public-private consensus toward superior and integrated innovation policies.

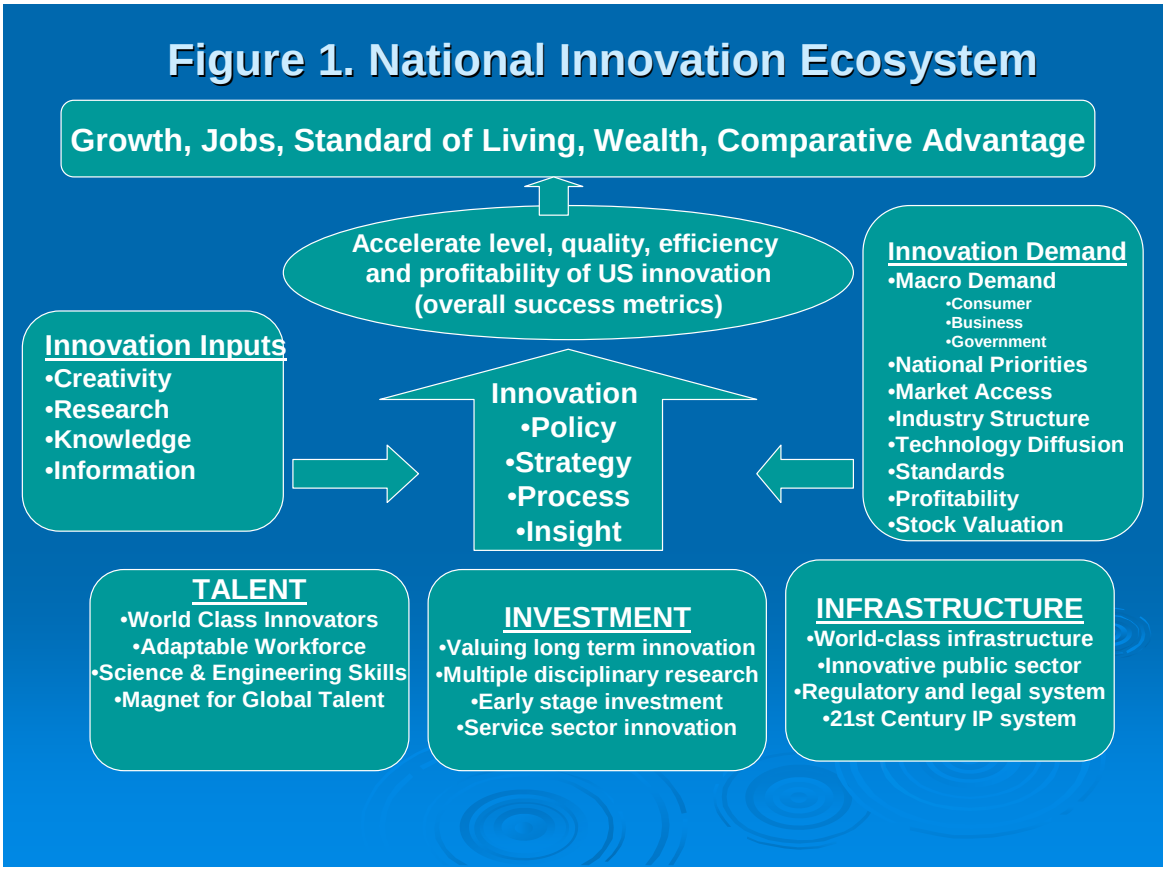
**Background**

Sound innovation decision-making requires credible, timely and relevant measurements. "What you get is what you measure." Bad metrics can lead to bad diagnosis, which in turn results in bad or poorly designed policies with unintended consequences.

Innovation is a complex and multidimensional activity that cannot be measured directly or with a single indicator. Like human health, there isn't any single measurement adequate to capture innovation's multiplicity of features. Innovation is much more than technology inputs. Many other complementary resources and conditions are essential for market success. The drive for improved indicators stems from the understanding that currently available measurements largely reflect the industrial era and less so the knowledge economy unfolding around us: they largely reflect products and artifacts rather than ideas

and processes. A fresh perspective and "real-time" performance metrics are needed to reflect the new paradigm of a global, knowledge based networked economy.

A new metrics baseline needs to be framed comprehensively with a national ecosystem outlook. The framework presented below (Figure 1) recognizes that innovation consists of input as well as demand factors which drive innovative activity. A balanced scorecard must take into account measures of macroeconomic conditions, national policy priorities, access to markets, industry competitive structure, standards, stock market valuations and other factors. It is primarily the role of the private sector to match and join technological opportunity with customer needs and market expectations. When innovation policies, strategies and processes are successfully aligned with supply and demand, the output is financial returns to firms and ultimately broader economic and social benefits, such as economic growth, jobs and rise in standard of living. The "push and pull" of innovation supply and demand, however, do not occur in a vacuum. We also need insights on how the innovation process is influenced by the public policy environment and the quality and access to talent, capital and infrastructure.




We need to push hard towards doing a better job in measuring the dynamics of the innovation ecosystem, including knowledge flows, innovation strategies and processes, the demand for innovation, service sector innovation, public policy impacts and the intersection of manufacturing and services that are increasingly integrated in advanced economies.

This effort does not need to start from scratch. The advancements in understanding the innovation process are improving the availability, breadth, and usefulness of science, technology and innovation (STI) indicators. STI indicators can be roughly categorized into four 'generations', progressively becoming more complex and meaningful as illustrated in Table 1.

**Table 1: Evolution of Innovation Metrics by Generation (Examples)**

| 1st Generation Input Indicators (1950s-60s) | 2nd Generation Output indicators (1970s-80s) | 3rd Generation Innovation Indicators (1990s) | 4th Generation Process Indicators (2000 + emerging focus) |
|---|---|---|---|
| • R&D expenditures<br>• S&T Personnel<br>• Capital<br>• Tech intensity<br>• | • Patents<br>• Publications<br>• Products<br>• Quality Change<br>•<br>• | • Innovation surveys<br>• Indexing<br>• Benchmarking innovation capacity<br>• | • Knowledge<br>• Intangibles<br>• Networks<br>• Demand<br>• Clusters<br>• Management techniques<br>• Risk/Return<br>• System Dynamics<br>• |

- The **first generation** of metrics reflected a linear conception of innovation focusing on ***inputs*** such as R&D investment, education expenditure, capital expenditure, research personnel, university graduates, technological intensity, and the like.

- The **second generation** complemented input indicators by accounting for the ***intermediate outputs*** of S&T activities. Typical examples include patent counts, scientific publications, counts of new products and processes, high-tech trade.

- The **third generation** is focused on a richer set of ***innovation indicators and indexes*** based on surveys and integration of publicly available data. The primary focus is on benchmarking and rank ordering a nation's capacity to innovate. A main difficulty at the moment is the validity of international data comparisons and incorporating service sector innovations (where the process is the product) into the surveys.

All these indicators fit into the classic economist's mold of a production function, Y = f(X), where X is a set of inputs and the Y stands for the innovation output. The middle part (function f) dealing with the transformation of one into the other is still largely untouched, a 'black box', in terms of meaningful indicators.

Relevant **fourth generation** metrics currently at an embryonic stage include:

- **Knowledge indicators**. We still count machinery, tons of steel, transactions, number of PhDs, patents. We should rather account for the knowledge that underlies their creation and the ways it is developed and diffused.

- **Networks**. Most contemporary innovations involve a multitude of organizations and networks. An important priority is developing composite network indicators accounting for both contractual agreements like strategic partnerships, intellectual property licensing and for informal collaboration and knowledge exchange such as working relationships of individuals across organizations.

- **Conditions for innovation**. Economic demand, public policy environment, infrastructure, social attitudes and cultural factors are critical for successful innovation. What is called for here is building systemic innovation metrics that capture the context in which organizations form and match expectations and capabilities to innovate.

## ***New Policy and Strategy Analysis Tools***

A new generation of innovation metrics opens opportunities to apply new analytic tools for assessing policy and strategic choices.

- **Growth Accounting**—economists will be able to better estimate the nation's productivity performance in terms of contributing factors and outputs.
- **Knowledge Economy**—composite knowledge indicators will improve investment decisions for R&D, education and capital resources.
- **Financial Reporting—**financial reports could provide a balanced scorecard of physical as well as intangible assets.
- **Valuation of Innovation**—business executives and financial markets could better value R&D activity and related intangibles, estimate financial results, improve long term stock market valuations and predict outcomes.
- **System Dynamics**—expanding the range of "real-time" innovation metrics would help build more robust systems dynamics models and policy simulations. .
- **General Purpose Technology (GPT)** — improved analysis of the strategic contribution of GPTs which set the stage for incremental innovation and have the inherent potential for pervasive application in a wide variety of industries.
- **Tech-led Regional Development and Clusters**— shift the emphasis from strengthening inputs to the innovation infrastructures toward improving the efficiency, rate and output of innovation.

***International Effort is Required.*** To the extent that they exist, these 4th generation metrics of the knowledge based networked economy remain ad hoc and are, thus, of limited analytical value. They can be improved only through a concerted, coordinated and *internationally visible effort.* Many innovative companies have acquired global logic. Going with national indicators only would misrepresent what is going on. The US should tap and extract the expertise of international organizations that conduct extensive policy research and innovation metrics work, such as the OECD and European Commission. US innovation metrics initiatives should capture the experience of other nations' innovation surveys with respect to business sector targets, sample size, variable definitions, data collection methods, analysis procedures and dissemination techniques. Metrics definitions and innovation models need to be harmonized or at least made comparable internationally for benchmarking purposes.

***Major Benefits.*** A National Innovation Scorecard offers a number of major benefits:

- Reinforces the public case for a long-term National Innovation Agenda,
- Benchmarks US innovation performance regionally and internationally,
- Expands public awareness and understanding of the benefits of innovation,
- Focuses policymaker attention to critical issues, innovation barriers and alternative policy responses,
- Supports decision-making to drive economic growth, employment and business competitiveness,
- Signals emerging opportunities and threats
- Provides for significantly improved, better calibrated data for investment analysis, reporting on intangibles and risk management,
- Establishes evaluation criteria for government innovation programs, and
- Enables further progress in our understanding of innovation which has been severely constrained on the empirical side due to the lack of appropriate metrics for linking innovation inputs, process and outputs.

***Innovation Metric Stakeholders***

***US government statistical agencies*** primarily the Bureau of Census, the Bureau of Economic Analysis, the National Science Foundation (Science and Engineering Indicators), the Bureau of Labor Statistics, and the Department of Education.

***Financial Standards and Reporting Entities*** have an interest in accounting for intangibles, innovation and risk. Domestic firms that are registrants with the *Securities and Exchange Commission (SEC)* must file financial reports using U.S. generally accepted accounting principles (GAAP). The *Financial Accounting Standards Board (FASB) and the International Accounting Standards Board (IASB)* are focused on improving standards of financial accounting and reporting to investors and the public.

***Trade and professional associations*** which include the Industrial Research Institute, the Semiconductor Industry Association, the National Association of Manufacturers, the National Academies and hundreds of other associations and societies that collect data on behalf of their members.

***State and local agencies*** that collect repurpose and disseminate information on the innovation infrastructure and economic performance of regional economies.

***University, private research centers and consultants*** which survey, integrate and analyze technology, market and financial trends, generally organized on an industry or regional basis.

***International organizations*** of which major players include the Organization of Economic Cooperation and Development (OECD), the European Commission, United Nations agencies, the World Economic Forum, and the World Bank. In addition, many national governments (primarily OECD member countries) have started systematic innovation indicators projects and high level policy initiatives to position their nations at the forefront of innovative performance.

## 2. National Innovation Medal and Prize

**Rationale**

Another important activity of the Network would be to recognize outstanding models of innovation in the public and private sector. This could be done by establishing a **National Innovation Medal and Prize** similar to the Baldridge National Quality Award. The Baldridge Award has played an important role since the 1980s in meeting the Japanese quality challenge and has helped educate thousands of companies that applied for the award for the latest thinking in quality and productivity improvement.

The National Innovation Medal should be more than recognition of novel products and services. It should more importantly recognize the underlying innovation processes and organizational environments that generated these products and services. The *Innovation Criteria*, to be developed for assessing applicants, could play three important roles:

- To improve innovation performance practices, capabilities and results,
- To facilitate communications and sharing of best practices information among US organizations of all types, and
- To serve as a working tool for understanding and managing innovation and guiding organizational strategy, planning and opportunities for learning.

The Medal would be awarded by the President of the United States. The private sector would have responsibility for developing the Innovation Criteria, provide expert judges to review Medal applicants and create a self-sustaining endowment for cash prizes. The National Innovation Medal program should be much more than a contest. The intent is broader by raising awareness about innovation and encouraging all US businesses and organizations to adopt innovation as a major component of competitive performance whether or not they intend to apply for the award.

A broad variety of manufacturing and business service sectors should be eligible for the medal as well as education, health care, state/local government, and federal organizations. All sectors of society have the potential for higher levels of innovation. It is suggested that the National Innovation Medal recognize outstanding contributions with as many winners as worthy applicants. With Baldridge the competition is against other applicants and only two awards are available per eligible category. An alternative approach for the Innovation Medal is to recognize all applicants that achieve world class performance standards and confirmed by independent evaluators.

To make the medal program self-sustaining it could be supported by a foundation endowment, fees from applicants, and fee based services, such as innovation conferences and training. The eligibility criteria, selection process and Presidential presentation should be coordinated and possibly integrated with the National Medal of Science, National Technology Medal and Baldridge Award.

**Background**

There is a strong sense that as a society we do not sufficiently honor or learn from those who innovate and transform scientific and technological discoveries into useful product, services and processes. National recognition awards, medals and prizes are a method for increasing the adoption of new management practices and performance measures. These awards are typically assessed by independent examiners on the basis of written submissions and, in some cases, site visits and presentations. Award winners are recognized at special Presidential and celebratory events, which give visibility to the sponsoring organization, the award winners and sponsors. Information about award winners is made publicly available so that examples of strategies, techniques and performance can be utilized around the country.

Major stakeholders relevant to the design of a National Innovation Medal and Prize include the Baldridge Award, the Presidential Medal of Science and the National Technology Medal. A brief discussion of each follows.

**Malcolm Baldridge National Quality Award** was created by legislation in 1987. The award is given by US Presidents to business, education and health care organizations and recognizes outstanding organizational achievements in quality improvement based on explicit performance criteria. Over the 16 years it has been in operation it has raised awareness about the importance of quality and performance excellence and has accelerated the adoption of quality and productivity "best practices" as a means to compete more effectively in the global markets. The US Commerce Department's *National Institute of Standards and Technology (NIST)* in partnership with a private foundation manages the Baldridge Program. The $5 million public investment is leveraged by a contribution of over $100 million from private sector organizations.

The process established for the award consists of a number of steps. Each year the criteria are established. Organizations make written application outlining in their submission their merits relative to the criteria. Integral to the process of selecting winners is a team of external adjudicators that review applications, conduct site visits and provide applicants with an extensive feedback report, citing strengths and opportunities to improve. Baldridge Award winners also have a charge to be quality advocates and have given over 30,000 presentations to thousands of organizations.

The Baldridge Award enjoys broad, positive recognition among leaders in eligible sectors: manufacturing, service, education, health care and small business. More than 70 percent of leaders surveyed among Fortune 1000 companies said they are likely to use the Criteria for Performance Excellence. With regard to award recipients they saw a comparable or even greater benefit from feedback received through the application and review process. When asked about the benefits or advantages of winning the Baldridge Award, respondents listed the marketing, publicity and networking that accompany the Award as an overwhelming benefit.

Participation in state and local award programs has increased to 44 states having or establishing award programs modeled after the Baldridge Award process. Internationally,

nearly 60 quality programs are in place. Australia, Europe and Japan, for example, all offer quality improvement recognition with a similar process.

**National Medal of Science** was established to be given to individuals "deserving of special recognition for outstanding contributions to knowledge in the physical, biological, mathematical or energy science. In 1980 Congress expanded this recognition to include the social and behavioral sciences. A Committee of 12 scientists and engineers, appointed by the president, evaluate nominees for this award. Since its establishment the Medal has been awarded to 409 distinguished scientists and engineers. The laureates have made major impacts in fields of science and engineering through career-long, ground-breaking achievements and on the individual disciplines for which the awards are given.

**National Medal of Technology** is the highest honor awarded by the President of the United States to America's leading innovators. Established by an act of Congress as part of the Stevenson-Wydler Technology Act in 1980, the Medal of Technology was first awarded in 1985. The Medal is given annually and has recognized over 146 individuals and companies for their outstanding contributions to the Nation's economic, environmental and social well-being through the development and commercialization of technology products, processes and concepts, technological innovation, and development of the Nation's technological manpower.

The purpose of the National Medal of Technology is to recognize those who have made lasting contributions to America's competitiveness, standard of living, and quality of life through technological innovation and to recognize those who have made substantial contributions to strengthening the Nation's technological workforce. The Medal also seeks to inspire future generations of Americans to prepare for and pursue technical careers to keep America at the forefront of global technology and economic leadership.

The National Medal of Technology Evaluation Committee reviews and evaluates all nominations for the Medal of Technology. Nominations for the Medal can be made for an individual, a team of up to four individuals, a company or an organization, or a division thereof. The Committee makes its recommendations for Medal candidates to the Secretary of Commerce, who in turn, makes recommendations to the President for final selection.

## 3. Innovation Commons, Public Outreach and Advocacy

**Rationale**

Implementation of a new national innovation agenda will require a tremendous public outreach and advocacy effort. The challenge is no less than a transformation of the nation's innovation culture, public attitudes and strategic policies. One of the major issues addressed by the 21st Century Innovation Working Group was the lack of a national platform for innovation advocacy and a fresh approach for collaboration on innovation issues. A purposeful and dynamic working relationship among the major stakeholders in the national innovation ecosystem can help provide long-term stewardship and a sustained national commitment to innovation. The central concept is to give rise to an **"Innovation Commons"** –a new kind of infrastructure for constructing creative collaborations,

information sharing, consensus-building, advocacy and public outreach and exploring all facets of innovation.

For many Americans innovation, technological advance, globalization, productivity and service economy are not terms that resonate with their future economic security. To turn this situation around members of the Innovation Commons should launch a major multi-year outreach and advocacy initiative aimed at expanding public understanding of the benefits of innovation. The Innovation Commons will give prominence to the role and obligation of leaders from all sectors of society to pursue innovation as a means of generating economic opportunities and prosperity for all Americans. This outreach activity is aimed at unleashing a wave of creative potential that is inclusive of all economic, government and social sectors and ties innovation inextricably into perceptions of enhanced U.S. competitiveness, maintaining U.S. leadership and creating more U.S. jobs. Public support in combination with nimble and intelligent collaborations within the innovation ecosystem will accelerate the transition to an innovation economy.

**Background**

Today, Americans are expressing a great deal of uncertainty about the economy -- uncertainty that is much more pronounced than a few years ago. Many factors have contributed to this sentiment: the war in Iraq, the dot-com bust and ensuing economic recession, widespread layoffs that are impacting both blue and white collar workers, and the outsourcing of jobs to foreign countries. As a result, there is a tremendous concern about losing personal control, longer working hours with fewer rewards, and dislocation of jobs.

Given this current environment, it is not difficult to see that the topic of "innovation" is not only deemed by the public to be not critical – but also is even considered a threat by many Americans due to its association with offshoring jobs that would have otherwise remained in this country. There is a real sense by American workers that we might be on the losing end of the emergence of a "global economy." Importantly, people are not comfortable talking about a world without borders. It presents both economic and national security (post-9/11) concerns. Without positive public attitudes and understanding, the transition to an innovation driven economy will be severely constrained at the micro (firm level) and macro policy level.

Innovation research has increasingly recognized the powerful role that "civic and social networks" can provide in building public support and a nation's innovation capacity. The 21st century Working Group proposes to expand the influence of these networks across the nation through creation of an **"Innovation Commons."**

The design of the Innovation Commons infrastructure needs to be flexible and adaptable—always boundary spanning to draw in a wide range of individuals and organizations to participate and, thereby, become advocates for sound innovation policies and practices. The goal is for all sectors of society to rub shoulders, virtually and face-to-face, with the most active, brightest and fertile minds and organizations in the field of innovation. The Commons would utilize a combination of virtual and face-to-face techniques to expand

interactivity and the influence of innovation stakeholders. A central component of the commons architecture would be a web-based knowledge exchange grid to enable collaboration, sharing of information, partnering with innovation resources, public outreach and access to the policy process.

***Regional Innovation Systems.*** A particular opportunity is at the state and local level. The national system of innovation can be thought of as a sum of several regional systems. These regional systems of innovation are strong for some areas of the country but weak in other areas because of a lack of leadership networks and effective inter-organizational linkages. An Innovation Commons can strengthen these regional networks by creating more efficient access to innovation markets, policymakers and resources.

***Open Systems.*** A networked "open systems" model for the Innovation Commons has the potential to be more adaptable and robust than traditional hierarchically based approaches. Innovation by its very nature changes and disrupts institutional relationships. An open systems organization can deal with incremental innovation strategies in times of relative stability and revolutionary innovation strategies between historical periods.

**The Innovation Commons Functions**

1. Periodically review global innovation trends, the national innovation scorecard and frame the issues most likely to create future strategic challenges.
2. Assess the current state of knowledge about these issues, pinpoint research gaps and address barriers to sound innovation policies, strategies and implementation.
3. Create advocacy networks around national research priorities, human capital, workforce development and mobility, innovation financing, globalization of intellectual capital, regional innovation cohesion and other subjects important to the nation's innovation policy and culture.
4. Find innovative ways to share the findings, better practices and proposals and be a source of innovation information for elected officials, journalists, educators, the general public and other stakeholders.
5. Strengthen the nation's intellectual capital through dialogue, teamwork and partnerships among the members of the innovation commons.
6. Provide vision, leadership, support, incentives, visibility and motivation to the next generation of world class innovators—individuals and organizations in both the public and private sector.

***Public Outreach.*** The members of the Innovation Commons can be an influential force in explaining the extraordinary range of innovation opportunities and address the public's anxieties about the challenges that lie ahead. With adequate explanation, foresight and understanding public attitudes will become more adaptive to the requirements of an economy driven by innovation and continuous change in how we work, live and play. Implementation of this recommendation will facilitate:

- Broader acceptance of innovation initiatives in public policy,
- Heightened awareness of need to improve US innovativeness, and
- Transformed economy based on innovation and creativity.

# Attachment 1: Selected Innovation Metrics Reports (v.1.1)

## 1. Science and Engineering Indicators – National Science Foundation

The National Science Board submits this biennial report. The Science Indicators series is designed to provide a broad base of quantitative information about US science, engineering and technology for use by public and private policymakers.

The framework consists of presenting information in 7 broad areas:

1) elementary and secondary education with 19 indicators;
2)higher education in science and engineering with 44 indicators;
3) science and engineering labor force with 24 indicators;
4) US and international research and development with 55 indicators;
5) academic research and development with 54 indicators;
6) industry, technology and global marketplace with 21 indicators; and
7) science and technology public attitudes and understanding with 8 indicators.

The 2004 report contains a chapter on state-level science and engineering activity with 25 indicators.

Benchmarks for US indicators are global country rankings, trends and averages and major regions of the world primarily European Union and Asia/Pacific. Individual country comparisons are frequently with Japan, China, Germany, UK and South Korea. State level indicators are benchmarked to national averages and compared by state.

## 2. Science, Technology and Industry Scoreboard 2003 -- OECD

This biennial report prepared by the OECD Directorate for Science, Technology and Industry (DTSI) integrates the latest internationally comparable data on the knowledge based economy.

The framework consist of presenting indicators in four broad areas:

*1. The growth in the knowledge base of OECD economies:* investment in knowledge, human resources and international mobility of scientists, research and development, innovation measured by patents and the importance of emerging areas such as biotechnology and nanotechnology. 29 indicators.

*2. The information economy:* resources and infrastructure for the information economy, the diffusion and use of Internet technologies and electronic business, the contribution of the ICT sector to economic activity and international trade. 14 indicators.

*3. The global integration of economic activity:* key channels of economic integration and technology diffusion, such as direct and portfolio investment, the role of foreign-owned affiliates, cross border ownership of inventions and international co-operation in science and innovation, as well as analysis of trade competitiveness in industries by technology intensity. 14 indicators

*4. Productivity and economic structure:* comparison of OECD economies in terms of income, productivity and industrial performance, the growing importance of technology and knowledge-intensive industries, the interaction of manufacturing and services, and the role of firm turnover. 12 indicators.

Benchmarks are international comparisons primarily of OECD country averages and individual comparisons and rankings.

## 3. UK Productivity and Competitiveness Indicators—UK Department of Trade and Industry (DTI)

This 2003 report prepared by the UK government tracks the competitive performance of the UK economy relative to major industrial economies.

The framework consists of 6 broad areas identified as important to formulating government policies and investment strategies:

1) overall economic outcomes with 15 indicators;
2) investment with 6 indicators;
3) innovation with11 indicators;
4) skills with 8 indicators;
5) enterprise with 6 indicators; and,
6) competitive environment with 18 indicators.

UK indicators are benchmarked against G5, G7, OECD and EU countries with primary attention to G7 countries which includes the UK, the US, Japan, Germany, France, Italy and Canada countries.

| **4. Executive Index of the Massachusetts Innovation Economy—Massachusetts Technology Collaborative** |
|---|
| Annual publication that is currently based on a set of 15 quantitative indicators that track the performance of the state's innovation Economy. The Index for 2003 has a reduced number of indicators from earlier years and is more aligned with the innovation process and the resources that support it. |
| The framework consists of three very broad fields:<br>1) employment with industry cluster employment indicators;<br>2) the innovation process with 7 indicators; and,<br>3) resources with 7 indicators. |
| Benchmarks for the state are national averages and comparisons with leading competitive states. |
| **5. Defining the Canadian Advantage—Conference Board of Canada** |
| This annual assessment of Canada's challenges and policy choices is the Conference Boards flagship publication comparing the countries performance to the top 12 countries in each benchmarked category. |
| The framework for the *2003-2004 Performance and Potential* report includes 100 indicators in six categories:<br>1. Economy (10),<br>2. Innovation (16),<br>3. Environment (16),<br>4. Education and Skills (17),<br>5. Health (25)<br>6. Society (16) |
| Canada is benchmarked to 24 OECD countries and the top half of this group was submitted to further analysis on their record as being the best 12 countries of the 24 in each of the six categories of indicators. Approximately 90 per cent of the data used are supplied by the OECD. |
| **6. Global Competitiveness Report—World Economic Forum** |
| This annual report evaluates the economic competitiveness of 102 countries focused on two complementary approaches: 1) Growth Competitiveness Index (GCI) developed by Jeffrey Sachs of Colombia University and the Earth Institute; and, 2) the Business Competitiveness Index (BCI) developed by Michael Porter of Harvard University. Both indexes combine available hard data and data from the Executive Opinion Survey conducted annually by the world Economic Forum. |
| The framework of the GCI is based three composite indicators driving national competitiveness:<br>1) the macroeconomic environment with 11 indicators;<br>2) quality of public institutions with 5 indicators; and,<br>3) technology with 18 indicators.<br>With respect to technology the GCI divides the sample of countries into two groups; the "core" and "non-core" using the threshold of 15 patents per million population separating these groups.<br>The framework for the BCI is based on two sub indexes which measure:<br>1) the sophistication of company operations and strategy and<br>2) the quality of the national business environment. |
| All 95 to 102 countries are compared and rank ordered based on available and comparable data. |
| **7. State Technology and Science Index—Milken Institute** |
| The 2002 and 2004 reports focus on California's position in technology and science, stressing the need for states to recognize the new realities of the intangible economy as states economic futures are determined by their technology prowess. State and regional economic performance is determined by how effectively it uses its comparative advantages to create and expand knowledge assets (intangibles) and convert them into economic value. |
| The state Technology and Science Index is composed of five equally-weighted major composites. There are 75 individual indicators that comprise the five major composites indexes.<br>1. Research & Development Inputs with 18 indicators,<br>2. Risk Capital and Infrastructure with 9 indicators,<br>3. Human Capital Investment with 20 indicators,<br>4. Technology and Science Workforce with 18 indicators and<br>5. Technology Concentration and Dynamism with 10 indicators. |
| All states are benchmarked and rank ordered based on composite score rankings. Each indicator is adjusted for the absolute size of a state's economy based on factor such as population, GDP, # of establishments. |

## 8. Bureau of Labor Statistics (BLS) – US Department of Labor

The BLS is the principal fact-finding agency for the Federal government in the field of labor economics and statistics and collects processes, analyzes and disseminates statistical data relevant to innovation performance particularly its Productivity and Technology series.

Data of particular interest to measuring innovation:

1. Quarterly Labor productivity indexes and related cost measures for major sectors of the economy, including business, nonfarm business and manufacturing.
2. Multi-factor Productuctivity annual indexes for industries and major sectors of the economy that relate output to labor, capital and other inputs.
3. Industry productivity annual indexes for detailed industries.
4. Foreign labor statistics which provided comparative information by country on productivity and unit labor costs; compensation; labor force, employment and unemployment and consumer prices. Comprehensive employment and wage data by industry and geographic area, occupational employment statistics for about 750 occupations and 400 non farm industries.
5. Occupational data by geographic area, unemployment trends, job openings and labor turnover, time use surveys, employment provided training, and job gains and loss data (new).

BLS is a primary data source for benchmarking US productivity across industries and internationally The BLS strategic plan calls for expanding its intelligence and research function that identifies new economic trends and to enhance its guidance to policymakers. A goal is support the building of a demand-driven workforce system.

## 9. Bureau of Economic Analysis (BEA)—Department of Commerce

BEA prepares national, regional, industry and international accounts on key innovation issues such as economic growth, regional economic development, inter industry relationships, trade and investment and the US position in the world economy. A key objective is to develop more timely, relevant, comparable and integrated information

The cornerstone data series is the national income and product accounts (NIPAs) featuring the estimates of gross domestic product (GDP) and related measures. Data clearly show the growth of the services and financial sector relative to manufacturing sector. BEA data is essential for measuring the value of innovative activity and for addressing issues such as foreign outsourcing, tracking growth of output and prices of the service sector, trends in wages, salaries and income, profit measures, trade in goods and services, and changes in quality.

BEA data is the “gold standard” for benchmarking US economic performance regionally and globally. GDP data is one of the most influential measures that affect US financial markets. A key challenge is integrating GDP data with input-output accounts and improved ability to cross walk between BEA industry accounts and BLS productivity accounts

## 10. R & D Trends Forecast – Industrial Research Institute (IRI)

IRI is a business association of leading executives with companies conducting research and development. Data for this annual forecast of industry R&D trends is collected from questionnaires returned by official representatives of the 201 IRI member companies based in the US. Respondents estimated the relative annual change of member company intentions. The data are helpful but imprecise because the balance of respondents across industries changes from year to year.

The framework consists of 12 indicators based on four categories of activity:

1. R&D Expenditures
2. R&D Effort Allocation
3. R&D Personnel
4. Other R&D trends

The indicators are time series essentially showing change in intentions, not actual performance.

## 11. Research and Development Annual Report---American Association for the Advancement of Science (AAAS) and the Intersociety Working Group

This annual report is a comprehensive compilation of the $120 billion plus federal agency R&D investment in the national innovation system.

The framework is focused on overall R&D budget trends with detailed breakouts by federal agency and disciplinary area. The quantitative data is supplemented by extensive policy analysis.

The data is benchmarked as a time series presenting patterns of change in the nation’s R&D priorities.

| **12. Education at a Glance – OECD Indicators** |
|---|
| This annual report provides comparable and up to date array of indicators that reflect a professional consensus among professionals on measuring the state of education internally. The focus of the 2003 report is on the quality of learning outcomes, the policy levers and contextual factors that shape these outcomes. |
| The framework for presenting the indicators consists of four broad categories:<br>1. Output of educational institutions and impact of learning (15 indicators)<br>2. Financial and human resources invested in education (6 indicators)<br>3. Access to education, participation and progression (5 indicators)<br>4. Learning environment and organization of schools (8 indicators) |
| The benchmarking is primarily focused on OECD countries but many non-member countries participate with many indicators now covering almost two-thirds of the world's population. |
| **13. The Dynamics of Technology Based Economic Development: State Science and Technology Indicators—Office of Technology Policy, US Department of Commerce** |
| The purpose of this report is to enhance public policy decision-making by presenting a selection of comparable indicators and rankings related to the technology-based economic development conditions in all 50 states. |
| The framework consists of a total of 38 measures—25 input measures and 13 output measures. The S&T stimulating input measures fell into three main categories:<br>1. Funding In-Flows<br>2. Human Resources<br>3. Capital Investment and Business Assistance<br>The outcome data categories are focused on:<br>1. High-technology intensity of the State's Business Base<br>2. Other Outcome Measure (patents, fast-growing companies, earnings and workforce employment).<br>Each of the measures was converted to a metric by eliminating its scale sensitivity. The fourth edition of the report includes a new Time Series section. It displays longitudinal data covering periods of up to ten years and is intended to show data trends over time for ten metrics. |
| The benchmarking is primarily US national averages and rank ordering of states for each of the metrics. |

# *Recommendation 2*
# Building Innovation Skills for the Future
## Embedding Innovation Learning throughout our Education System and Beyond[8]

**SUMMARY**

**Innovation within all enterprises, both large and small, whether public or private, is key to the future wealth and stability of the United States. Yet, we are currently not providing our students and workforce with the up-to-date skills they need to contribute creatively every day in their workplace. Innovation can be learned, but only through experience. We propose a National Support Network with the long-term goal of providing every student in high school and college the opportunity to gain these vital skills. Based on the proven pedagogy of Problem-based Learning (PBL) the network will harness the power of the Internet to solve the major structural and resource barriers currently preventing this necessary major addition to the education of the nation. Up to ten regional universities, already committed to innovation education, will form the backbone through "innovation learning centers." These centers will support the educational jurisdictions in their region by:**

**1) agreeing on and acquiring an information infrastructure to support the network,**
**2) installing course management software and PBL course materials at each node,**
**3) creating Innovation Learning Centers at each node for "training the trainers",**
**4) establishing and supporting outreach at each node to the following communities of interest – departments of education, school districts, 2 and 4 year colleges, teachers and faculty,**
**5) documenting the institutional barriers to adoption of PBL at institutions of higher education with case studies of successful implementation while developing marketing and outreach on the success of PBL and the models that support its adoption,**
**6) offering assistance to States to review academic standards for high school graduation to incorporate and highlight the importance of PBL and innovation.**

**Open access to this supportive "train-the-trainer" model will spread innovation learning across the nation at all levels by significantly reducing the barriers to change and, through sharing of materials and best practices, minimize the investment needed to implement this vital addition to the nation's education. The centers will also support workforce retraining in innovation skills.**

[8] Prepared by: Dr. Anthony C. Warren. Director of the Farrell Center of Corporate Innovation and Entrepreneurship. Smeal College of Business, The Pennsylvania State University. September 2004

**Background**

The US is seriously challenged to grow domestic wealth by remaining competitive in a rapidly changing truly global economy. This is increasingly difficult in a world where barriers to trade in goods, services, resources, know-how and capital have disappeared. We must compete by maximizing the use of our intellectual capital through innovation.

Historically, of course, innovation has been a key national attribute underpinning our ability to identify and exploit new opportunities[9]. Much of the creative energy that spurred our historic growth came from immigrants following the "American Dream" within a supportive legal and financial infrastructure. Now, with the rules of competitive engagement fundamentally changed, the learning of relevant innovation skills is vital to our future success as a nation. No longer can we rely on *ad hoc* creativity and entrepreneurial drive. Innovation must now be applied to much more complex situations in all enterprises including businesses, both large and small, the public sector and our educational institutions. Yet we are not providing our students and workforce with the holistic skills to perform in this new environment.

Unfortunately, with few exceptions, innovation learning that has been introduced into our curricula either within higher education or at K12 levels has largely been based on a linear textbook driven pedagogy. This does does not encourage innovative thinking around complex multi-dimensional problems. If we are to include learning of newer innovation skills throughout our educational institutions, there are major cultural, regulatory and resource barriers to overcome. This white paper proposes a major national initiative to embed innovation skill acquisition learning for all students in a way that can overcome these barriers to change. Before describing the initiative in detail, we discuss the pedagogical model for innovation skill acquisition, and the barriers to incorporate this model throughout our educational infrastructure.

**The Current Situation.** A number of initiatives to provide entrepreneurship courses have appeared over the last decade or so. A review of the programs and curricula both within colleges[10] and K12 schools[11] as well as the regulations and standard requirements in certain states such as Pennsylvania[12], Utah,[13] and Virginia[14] immediately expose a number of shortcomings:

- To the extent that innovation is addressed at all, it is the focus within isolated courses on entrepreneurship rather than on the broader and more valuable subject of innovation, applicable to ALL enterprises.
- Entrepreneurial skills are related solely to start-up companies and hence severely restrict the applicability of the courses to future careers in established enterprises.

[9] "The Free Market Innovation Machine", William J. Baumol, Princeton University Press, 2002.
[10] Innovation in entrepreneurship education, P. Sandercock, 2001, www.colemanchairs.org/files/
[11] www.entre-ed.org/, and www.nfte.com,
[12] www.pde.state.pa.us/stateboard_ed/lib/stateboard_E-standards020802.pdf
[13] www.usoe.k12.ut.us/ate/skills/bus/entrepreneurship/entrepreneurshipstandards.pdf
[14] http://vvcrc.tec.va.us

- There are many different approaches and course structures proposed and used with little commonality or large scale sharing.
- Syllabi are structured in a linear format with text support materials in a more traditional pedagogy not conducive to developing innovation skills.
- Each curriculum, and standard are being developed largely in isolation with no structured sharing mechanism for resource saving and best practice implementation.
- There is little real-time experiential content or student involvement, vital for innovation learning.
- Little attention is given to re-training the teachers for innovation courses – a major barrier to widespread adoption.
- There are a range of institutional barriers to broad-based curricular change, that touch every aspect of higher education, e.g. credit/tuition calculations, professional and career incentives for faculty to participate in PBL, organizational sponsorship, access to technology, etc. In the K12 arena, there are even higher barriers. Not only do teachers lack the preparation and support to undertake new approaches, but current academic standards and high stakes assessment often constrain the use of PBL in favor of the transmittal of rote skills, facts and information. Entrepreneurship and innovation tend to be treated as ancillary subjects that are secondary to the core academic program, ignoring the realities and demands of the world that high school graduates will encounter. The public schools are developing a rather closely integrated system of standards, curriculum and assessment that preclude any new content or approaches without significant intervention.

These observations indicate that, if there is to a major change in innovation learning, we need to *support* rather than *mandate* standards and curricula. Each jurisdiction, state, and educational institution needs to create their own programs to fit local conditions. This individuality must be preserved to overcome resistance to change. However, the creative use of technology can provide a powerful method to reduce inherent barriers to innovation education at all levels *and* reduce the demand on limited resources. Before describing the proposed initiative in detail, it is pertinent to outline a proven pedagogy for innovation learning.

**Pedagogy for Learning Innovation Skills.** Contrary to a common view, successful innovators are not born with inherent skills, but can learn them. They can acquire social skills to work in diverse, multidisciplinary teams, to communicate their innovations, and garner the resources to see their innovations through to completion. They are comfortable with ambiguity, recognize new patterns within disparate data; they are inquisitive and analytical. They see challenges as opportunities and understand how complete solutions must be built from a range of resources. These skills are best acquired by actually experiencing innovation first-hand. This builds the confidence that underpins future success.

To quote Benjamin Franklin, "*You tell me, I forget; you teach me, I remember; you involve me, I learn*". Innovation, being a multi-dimensional, holistic skill set, is best learned through involvement in the process using a Problem Based Learning Pedagogy (PBL). This is not a novel approach to education. Initially pioneered at McMaster

University for medical education in the 1960's, PBL has been extended to many other fields of learning[15]

However, PBL has not entered the educational mainstream for several reasons:

- Until now, there has not been a nationally recognized need to include PBL as a mainstream pedagogy for all students. Of course, in certain areas, such as medicine, the metal and wood working trades etc. experiential learning has always played a major role. Now the national imperative requires PBL to be available to all students as the main vehicle for acquiring innovation skills.
- Because PBL has not been central to our education, we have not trained our teachers in the methods. Guiding PBL classes requires new skills. Teachers must be comfortable with a less structured environment where the student output is less definable and predictable. They have to move from a textbook supported "chalk and talk" format to a mentoring style in which the students largely determine the directions they take.
- PBL courses, by their very nature, being less definable, challenge the existing standards. New standards need to be developed by departments of education and educational institutes so that innovation output can be graded and compared. New valid and reliable assessments must be developed that can document, examine and evaluate complex thinking and problem-solving.
- There are, as yet, no adequate standard courseware or textbooks available to provide teachers with the support materials. Therefore teachers are often faced with developing their own materials, a major demand on their limited resources.
- Management of PBL courses can be more resource demanding than "conventional" teaching posing a further barrier to implementation.
- Students have grown up largely being taught in structured, linear, predictable environments. The transition to learning in an unstructured, non-linear class is challenging and requires gradual adaptation using structured PBL support.
- Our educational systems and their supporting organizations are built along subject lines such as math, English, science, etc. In higher education, these lines are even more rigid. Within business schools for example, the academic departments of finance, marketing, strategy, accounting etc. dominate, with little overlap between the design and implementation of courses. The same comments are true for engineering, science, and the humanities. Innovation on the other hand, requires a holistic approach incorporating disparate worldviews applied to a broad range of challenges and opportunities. Not surprisingly, innovation learning has fallen between these functional academic disciplines.

These challenges can be largely overcome using the Internet to support courseware and class management software. A successful pilot, funded by the Kauffman Foundation, has been implemented at The Pennsylvania State University[16]. These efforts can provide the starting point for a national scalable support network as described below.

[15] For a short summary see www.pbl.ist.psu.edu

[16] "A Scalable Problem-based Learning System for Innovation Education", R. Hanke, L. Kisenwether, A. Warren, to be presented at the NCEC Conference, Portland, OR, Sept. 2004

**Aim and Outline of the Proposal**. Every student in at two and four year colleges will have the opportunity to take at least one PBL course to learn innovation skills. Every student in high school should be required to undertake one PBL based project to learn innovation skills in senior years. In addition, the PBL courses will be accessible for in-company workforce re-education. To accomplish this bold initiative, we propose a national web-based PBL support system that will:

- Collect, create (where needed), host, and share innovation PBL materials including real-time cases.
- Train teachers in PBL pedagogy applied to innovation using on-line and other outreach means.
- Aid teachers in tailoring course materials for their specific student groups assembled from modules collected by the innovation network. When new materials are developed at any member of the network, they will be shared across the nation, insuring efficient course development and continually updated materials. This flexible use of shared materials on a standard course support software platform is not possible using text-book delivery.
- Develop and validate new assessment techniques for PBL.
- Identify institutional barriers to implementation and develop best practices for new procedures and policies.
- Host course management software to support PBL learning.

These functions will be dispersed into the national educational infrastructure through up to ten regional "outreach" nodes based in Universities which already have established recognized educational programs in innovation and entrepreneurship based on PBL methods.

**5. Implementation Plan.** The following steps are proposed.

**a)** Assemble core group of 10 Universities/Colleges (“nodes”) regionally dispersed
**b)** Agree and acquire information infrastructure to support the network
**c)** Install course management software at each node and initial course materials
**d)** Implement PBL courses if not already established
**e)** Create Innovation Learning Centers at each node for “training the trainers”
**f)** Establish and support outreach at each node to communities of interest – departments of education, school districts, 2/ 4 year colleges, teachers and faculty
**g)** Document the institutional barriers to adoption of PBL at institutions of higher education and case studies of successful implementation.
**h)** Develop model comprehensive policies for institutions of higher education.
**i)** Conduct marketing/outreach on success of PBL and models supporting adoption.
**k)** Develop/implement “train the trainer” courses based largely on-line in each region.
**l)** Offer assistance to States to review academic standards for high school graduation to incorporate and highlight the importance of PBL and innovation.
**m)** Acquire federal, state and private sector funding for implementation.

(Total start-up costs of $15MM per node is estimated, with an ongoing budget at each node of $5MM per year. (Additional funding is required to support teacher’s expenses in training and for computer infrastructure in schools where it does not already exist).

## *Recommendation 3*
## Government Policy Coordination for Innovation[17]

**SUMMARY**

**Innovation policy is the new pathway to building prosperity and national competitive advantage for advanced industrial nations. The 21st Century Innovation Working Group recommends an aggressive public policy strategy that energizes the environment for national innovation.**

**We believe that innovation is an issue that merits the time of the President. We recommend that the President establish a focal point within the Executive Office of the President to frame, assess, and coordinate strategically the future direction of the nation's innovation policies. This could be either a Cabinet level interagency group, or a new distinct mission assigned to the National Economic Council.**

**We recommend that the President give consideration to the following action items:**

- **Establish an explicit innovation agenda. Direct his Economic Advisors to analyze the impact of current economic policies on U.S. innovation capabilities and identify opportunities for immediate improvement.**

- **Direct his Cabinet Officers to undertake a review of Department programs and policies to determine their impact on the nation's innovation performance. Use this as an opportunity to break down "stovepipes" and foster closer collaboration among the agencies to meet clear national needs.**

- **Clarify and expand the role of existing mechanisms, such as the National Economic Council, the Office of Science and Technology Policy, the Domestic Policy Council and, the National Security Council to upgrade and strengthen the consideration of policy choices on innovation.**

**BACKGROUND**

Public policies impacting innovation are of critical importance to maintaining U.S. global economic leadership. These policies are distributed across numerous Federal agencies, legislative committees, international organizations, state and local governments. Innovation must be embedded as a leading policy issue and become an essential feature of the policy development process.

We have considered the combination of formal government policy mechanisms, informal information transfer processes and the engagement of nongovernmental groups to infuse innovation into the government decision-making process. We continue to return to a Presidential focus on innovation and an organization charged to implement this vision.

[17] Prepared by Kathleen Kingscott, IBM and Alice B. Gast, MIT v.2.8 September 2004

## Leadership and the National Innovation Agenda

Creating a national agenda explicitly based on innovation will require leadership, a solid commitment to making hard choices and a broad based dialogue among constituents. The outcome, however, will be a more effective policy agenda that removes barriers between agencies and constituents. Also, we must pay attention to the strategies other nations create, as many nations explicitly have chosen to use innovation as their engine for growth.

The United States must accept and act on the concept of innovation as a driver of economic growth. Fostering national innovation requires strategic thinking, scholarly research, education, systems integration and organization. It demands agility, adaptation, new tactics, new organizational constructs, and new means of communicating.

Our national policies create the environment in which innovation either thrives or wanes. Yet policymakers and the public generally do not balance decisions and make hard choices based on driving innovation. Most policy choices reflect pressures and needs viewed in a single dimension, with a focus on an individual problem set. Often, choices are made in one area without regard to the consequences they may have in another. For example, trade matters may be significantly affected by tax policy. Policy choices traditionally have not been viewed in an integrated way.

The 21st Century Work Group suggests that these choices be made with a clear focus on enhancing innovation and economic growth. Issues involved cover many areas, from research, to skills, to market access, to financing, to metrics, and more, spanning many agencies and disciplines.

**Integrated Innovation Policy Examples**

*We are encouraged by examples of initiatives currently underway at various government level which focus on strengthening the innovation ecosystem. Notable federal examples include newly created economic data on the service sector, the first new economic indicator from the U.S. Census Bureau in nearly forty years. The Networking and Information Technology R&D Program focuses on the multiple outcomes of Federal research across national security, scientific leadership, research and the 21st century society.*

*State and regional examples include new strategies to adapt regional economies to global challenges. In Texas, for instance, the biodefense industry is being created by the intersecting needs for research, product development, existing medical expertise and a partnership model with 32 institutions organized into a Center of Excellence.*

Our challenge as a nation is to look at the broad array of policies, across the board --- from taxes to market access -- from technology and research partnerships to innovation financing --and make that examination from the perspective of driving innovation. Then we must lay out clear, actionable, strategic policy choices for our society, with all the stakeholders at the table, with innovation at the core.

To illustrate the challenge of policy integration, Table 1 below demonstrates the extensive range of public policies impacting innovation and the diverse ways these policies can stimulate or inhibit innovation.

## Table 1 - Public Policy Impact on Innovation

| Public Policy | Examples of Innovation Impact |
|---|---|
| **R&D Funding** | Impacts scientific direction (e.g., life sciences, nanotechnology, advanced computing) and production of scientists and engineers. Supports innovation infrastructure of universities, research centers, federal labs, industry research. Specialized programs like ATP support pre-competitive collaboration. MEP supports small manufacturers and SBIR technology-based start-ups. Public R&D goals and administrative procedures can conflict and misalign with private sector goals, expectations and management requirements. |
| **Macro Fiscal and Monetary Policy** | Cost of capital for innovation and rate of national economic growth influence investment decisions, available earnings, stock market valuation of innovative enterprises, etc. Currency policy, foreign and domestic, impacts international competitiveness. |
| **Technology Transfer** | Bayh-Dole Act and Federal Tech Transfer Act impact the incentive for industry-university-lab collaboration and rate of knowledge flow to innovators |
| **Human Resource Policy** | Federal education and training programs, education subsidies and research funds to support universities are a determinant of the supply of qualified workers needed for scientific research, development, and commercialization of innovation. |
| **Tax Policy** | Provides R&D incentive. Rate of depreciation affects transfer of knowledge embedded in new capital. Provides level of incentives for consumers to adopt innovation. |
| **Standards** | Facilitates platform technologies, such as Internet, computing systems, software and interoperability. Standards can also function as a barrier to technical change and can restrict markets. |
| **Procurement** | Government can stimulate market and standards development through large-scale aggregation. Design specifications can restrict introduction of new technologies. |
| | |
| **Intellectual Property** | Acts as incentive for innovators. Can restrict entry of competitors. IP protection can be weak globally, reducing return to innovation. |
| **Market Access** | Choice and access to foreign markets, export conditions and foreign direct investment influence market potential, risk and growth. Export controls can inhibit competitiveness. |
| **Economic Regulation** | Impacts innovation investment through pricing control, rates of return, market share restrictions and entry of competitive alternatives. |
| **Social and Environmental Regulation** | Can act as stimulus to innovation and also impact performance parameters of innovation. Type of regulation also impacts industry costs, relationship to suppliers and employment conditions. |
| **Health Care Policy** | Major driver of business cost of operations. Demographics and growing demand for health care creates opportunity for new products, services and productivity-enhancing technology |
| **Privacy** | Public concern creates additional demand for protecting information flows and assets. |
| **Homeland Security** | Creates government market for innovation, and creates additional economic requirements for managing risks and vulnerabilities of most economic sectors, including information industry, financial industry, water, energy, transportation, manufacturing supply chains, etc. |
| **Employment & Manufacturing** | Current political pressures add to protectionist risks, constraints on global investment, "buy America" provisions, employment transition costs, and higher skill standards. |

**Innovation Defined More Broadly**

Traditionally, the essentials for national innovation have included research funding, an educated workforce, and skills development. More recently, the contributions of business models and business processes have been recognized as well. In either case, however, these are primarily "inputs" to the market.

A more contemporary, integrated approach will serve our commercial and national security needs more fully. Markets respond to customer value. As we deliver value, we must consider our choices from a variety of perspectives. For example, how do our decisions affect our national infrastructure? Do we have the right methods of bringing partnerships together? Are we investing in the physical sciences, as well as in the life sciences? We must examine whether we have the most effective public policy environment to deliver value to our society.

The delivery of value requires us to understand the complementary but unique roles public and private institutions have in national innovation. A useful description of this distinction is found in *Competing in the Global Economy - The Innovation Challenge*, November 2003, Department of Trade and Industry, the United Kingdom:

*"Innovation systems are a set of actors (e.g. firms), institutions, markets and networks which jointly and individually contribute to the development and diffusion of new technologies. And which provide the framework within which governments form and implement policies to influence the innovation process... But national Governments have an impact on system performance through national policies. The main role for Government is to improve the efficiency of innovation systems and facilitate their formation."*

## Table 2: Government Innovation Initiative Examples

**Hydrogen Fuel Initiative** significantly increases the Nation's investment in hydrogen energy R&D, with high-risk/high-payoff investments in innovative materials and processes for the production, storage, and use of hydrogen in fuel cells.

**Nanotechnology Initiative.** NIST, DOE and NSF are supporting the development of nanoscale R&D user centers nationwide, to provide access to the necessary infrastructure for researchers at small businesses and academic institutions.

**The Biomedical Informatics Research Network** allows sharing, analysis, visualization, and data comparisons across laboratories State-of-the-art computing, communications, and information technologies are radically empowering the Nation's research and education communities.

**Manufacturing Initiative** which has created a new Commerce Department Assistant Secretary for Manufacturing and Services. The Manufacturing Report on American (January 2004) lays out a national strategy including components dealing with R&D and innovation.

**National Biological Information Infrastructure (NBII)** is a broad, collaborative program to provide increased access to data and information on the nation's biological resources.

**NASA Quest** is a resource for educators, kids and space enthusiasts who are interested in meeting and learning about the national space program.

**International Bovine Genome Sequencing Project** brings together Federal agencies with industry and international partners to advance common research priorities.

**Homeland Security.** The Department of Homeland Security is now one of the largest R&D agencies in the Federal Government focused on technologies to detect and respond to terrorist threats in the US.

**Innovation recognition** such as the National Science and Technology Medals, Baldridge National Quality Award, Presidential Early Career Awards for Scientists and Engineers

**The Institute of Education Sciences** was created as part of the Education Reform Act of 2002 to address the need for rigorous research on learning that will lead to research-based education tools for improving education programs and practices.

**The Math-Science Partnership (MSP)** program strengthens K-12 science and Mathematics education by uniting local school districts with college and university faculty in mathematics, science, and engineering, enhancing education programs and improving teacher preparation.

**Innovation Workshops.** Department of Commerce organizes workshops on Innovation in America, focusing on Corporate, University, and Federal Laboratory Research and Development (R&D), Broadband technologies and advanced technology for education and training

The 21st Century Work Group has drawn a distinction between innovation at the firm, institution, or regional level and innovation as part of a national strategy. Both are critical to economic growth and the national strategy should create a climate to enhance innovation at all of these levels.

Finally, as a nation, we must consider our innovation process more globally; outreach to our global collaborators, competitors and consumers is important. The enhancement of a science and technology component of our diplomatic services may be one way to expand our innovation horizons and capture the best of the global community.

The decisions we make now have long-term implications for the future. They affect our leadership in scientific frontiers and emerging technologies, how we enhance human capabilities to learn, upgrade skills and adapt to global workforce dynamics, provide "innovation risk" capital for more rapid commercialization and diffusion, and shape our national infrastructure. We have the opportunity to position the United States as a leader in innovation and expand global markets, and growth and national prosperity. These are serious choices for a strategic moment.

## Implementation Factors and Stakeholders

We believe that the best approach to engaging the stakeholders is to send a message from the highest level of the government. The President through his advisors, cabinet members and Executive Office can improve policy setting and engage the agencies. We applaud examples of multidisciplinary, cross-functional initiatives such as those in Table 2.

## *Recommendation 4*
## Retooling Skills for Innovation
### Reform educational curriculum based on Problem-Based Learning[18]

**SUMMARY**

**Education, both at the college level and in K-12, needs significant changes to prepare students to be leaders and innovators in the coming years. The system needs to be re-aligned to promote a competitive, 21st century definition of student achievement. One essential target for reform is in the area of curriculum, where creative and integrative instruction based on Problem-Based Learning (PBL) should be developed and implemented within multi-disciplinary and diverse teams, including distributed teams where possible. Additionally, Standardized Technology Platform(s) to support PBL using interchangeable course modules should be developed and deployed to solve the scalability, and complex course management issues that PBL raises. New methods of teacher training, school organization, governance, incentives and accountability must also be addressed to support and sustain the newly-aligned system.**

**BACKGROUND**

The workforce of the future requires people who have the following types of skills: strong communication skills, ability to work collaboratively, ability to manage ambiguity, strong problem solving skills, and the ability to rapidly learn new skills. A system that is designed to support curriculum that focuses on acquiring discreet skills and memorizing information will not generate the leaders and innovators we need. Given our current education culture, vertically organized curricula, and accountability targets changes are required in all levels of education, i.e., K-12, College and Corporate. If we are to prepare the nation to compete we must nurture these skills that have a direct impact on our nation's role as a technical and innovative leader. Significant growth in US productivity over the last 5 years has occurred *despite* the fall in work-force educational skills. However, in the longer term, this lack of investment in the appropriate skills will be a threat to our economic stability and national security. [19] [20]

Problem based learning (PBL) is one methodology which appears to be able to help enhance the development of these badly needed skills. Viewed as an effective approach to developing scientific, mathematical and technological talent and creativity, PBL focuses on ill-structured problem solving, providing more meaning, applicability and relevancy to classroom materials and facilitating the development of critical analysis skills that are needed in the workplace. [8,9,10] According to Andrew Hargadon's hypothesis on driving technology innovation, "It is one thing to know about a technology; it's something different to know how to apply it, what else it can do, and how to adapt it to new settings. Those skills come only through use, if only just once or twice." This being the case,

[18] Prepared by: Valerie Taylor, Texas A&M, Anthony Warren, Penn State, Matthias Preschern, IBM.
[19] How to use problem-based learning in the classroom, Robert Delisle, 1997.
[20] Learning for the 21st Century, Partnership for 21st Century Skills Org, 2003
[8] Do as I say, not as I do? Student assessment in Problem Based Learning, Jeff Nowak and Jonathan Plucker, Indiana University, June 1999.
[9] Integrating the Core Business Curriculum: An Experienced-Based Solution, Larry Michaelsen, Selections, 2001, 9-17
[10] The Case against Teaching: Larry Spence. Change, New Rochelle Press, Nov/Dec 2001 1-1

problem-based learning helps foster an innovative environment by encouraging students to extrapolate learning from other experiences and applying them to solving a problem at hand.

Key characteristics of PBL include: Ill-structured, complex problems that provide the focal points and stimuli for the course or ideas originated by students that can be developed during the learning process; Learning is student-centered with teachers acting primarily in the role of facilitators; Faculty act as a coach or facilitator as students assume greater responsibility for their own learning; and students work in small groups to solve/provide multiple solutions to problems.

- PBL requires significant changes in culture, policy, and organization of schools for effective implementation – a re-alignment of the entire enterprise to focus on new goals.
- Curriculum reform can not proceed without significant changes in teacher preparation, professional development, incentives
- Education accountability must focus on metrics and use assessments that are aligned with PBL and the new skill set required for the new workplace

While PBL helps to foster key skills needed in the workplace it should be noted that the workplace is no longer a local environment but a global environment. Hence it is necessary that students be exposed to collaborative technologies that facilitate interactions among students at geographically different locations. Such technologies should be used with PBL, such that the teams are composed of students at different locations. The costs of having these technologies easily available at all sites must also be considered with the implementation of the proposed curriculum. Just as the workplace will, by definition, continue to evolve in the future, schools must become enterprises that support innovation and encourage the development and implementation of new curriculum and approaches.

**Benefits of the Recommendations**

Beneficial for all levels of education, PBL and similar methodologies will help enhance current curricula and build much needed skills in both incumbent workers and ensuing generations. In addition to fostering students' motivation to learn other disciplines, students will gain an appreciation for life-long learning. Further, the interactions result in better communication skills as students relate their specific knowledge to others to solve a common problem. Creative, integrative curricula will develop these critical skills, enabling the US to compete more effectively and become more innovative and will provide the population to leverage these skills to move up the economic value chain. Schools can become the place where students encounter an environment that supports, encourages and responds to innovation.

# *Recommendation 5*
# Catalyzing Collaborative Investments in Innovation[21]

**SUMMARY**

**Innovation requires research investment and collaboration between many parties, including large, medium and small companies, universities, and government. Collaborative arrangements can result in higher innovation productivity. Effective collaboration demands new mechanisms. The 21st Century Working Group's recommendations in this area include:**

9. **Strengthen knowledge networks between appropriate partners, both virtual and real by establishing a National Innovation Portal, an open-source forum for innovation that matches companies with appropriate partners.**
10. **Enhance federal and state funding for research and innovation, especially merit-based programs (cf. NSF, NIH, DOD, DOE, DOC, and state programs) that match or provide funding in all technology areas according to technological and commercial promise.**

## BACKGROUND

Each of these areas is discussed below with Working Group findings and more detailed recommendations.

### 1. Foster stronger collaboration of government, public, companies and universities for the creation of collaborative networks capable of spreading the risks of failure and enriching the sources of knowledge for innovation.

Collaborative arrangements, both on-line and in-person, can result in higher innovation productivity, economic growth and standards of living. Inter-organizational collaboration can allow corporations to reduce innovation and market risks, facilitate the movement of human capital across geographic boundaries, and mitigate the inevitable adjustments of currency and production capacity. The high risks of innovation used to mean that only very large corporations could afford to undertake large, multi-year projects. However, new communication technologies and a deeper understanding of how innovation can be managed across boundaries (interpersonal, interdepartmental, inter-organizational, and international) make it now desirable to innovate collaboratively.

Thus, the state-of-the-art in managing innovation is the creation of collaborative networks capable of spreading the risks of failure and enriching the sources of knowledge for innovation. These collaborative arrangements can range from dyadic partnership to virtual organizational networks, defined as clusters of organizations, bound by common objectives, broadly compatible technology platforms, and organizing principles such as language, dispute resolution processes, and information sharing protocols.

Industry Clusters are networks of enterprises, large and small and they may also encompass universities. Each member adds a distinct product or service value, which is

[21] Prepared by: Richard Seline, New Economy Strategies. Anthony Warren, Penn State University. Kenneth L. Simons, Rensselaer Polytechnic Institute.

then added to the value of the (local) network as a whole. Currently, funding for the development and encouragement of Industry Clusters is a jurisdictional effort, intended to culture local new businesses with resulting tax revenues. While individual jurisdictions allocate funds to the creation of clusters, they require an appropriate combination of resources and an impetus, a spark, to begin. Allocating funds does not ensure one will emerge, nor is a spark without resources sufficient. Once in motion, clusters can take years to build momentum, and once they do, they are subject to limitation by the very resources that spawned them.

To date the focus of the cluster innovation has been spatial proximity. Spatial proximity builds social capital, which is the primary source of trust. All collaboration and innovation rests on this trust. Telecommunications technology continually improves the ability of companies to collaborate with resources outside funded jurisdictions. If a level of trust can be established without the need for spatial proximity, through the use of communications technology, the speed of innovation can be further increased.

Companies need a new means of looking outward. This can be greatly accelerated by using emerging Virtual Knowledge Networks. Such endeavors are already underway in Europe, making use of centralized server and peer-to-peer models.[22] The creation of a Virtual Knowledge Network, leveraging communications technology to facilitate the matching of needs for innovation with those who can best provide it, will allow companies of all sizes and in Clusters to sustain their competitive strengths.

The features of such virtual networks would include: access limited to registered US enterprises; build virtual teams with security and established trust procedures; procedures for managing shared intellectual property; proven innovation management software; and, problem/opportunity driven rather than transaction focused. Because collaboration will occur across regional boundaries, offering opportunities to many jurisdictions, funding must be offered at the Federal level to ensure the maximum utility of the Network. Beneficiaries of continual innovation include companies and entrepreneurs who profit by it, employees who operate said companies, and the jurisdictions to which they pay taxes. Money generated and spent in a community improves the quality of life for all residents.

**Detailed Recommendation**

***Establish a National Innovation Portal, an open-source forum for innovation that matches companies with appropriate partners, initially for small and medium-sized enterprises. Going beyond a jurisdictional and local Industry Cluster focus (state, city, townships, and counties) on innovation investments would expand opportunities to engage more companies in other areas and encourage a broader range of innovation.***

**Benefits of Recommendations**

Collaborations increase the speed of innovation, provide access to innovation resources, especially for SMEs, and support cluster, regional and national competitiveness.

[22] Passiante, et al. Digital Innovation. Imperial College Press, London. 2003.

**2. Enhance federal and state funding for research and innovation, especially merit-based programs (cf. NSF, NIH, DOD, DOE, DOC, and state programs) that match or provide funding in all technology areas according to technological and commercial promise.**

Competition in products varies along a spectrum. At one end of the spectrum are products in which a few firms become dominant producers of a product, and late entrants rarely if ever capture substantial market share. In the middle of the spectrum, early and late entrants perform similarly; early and late entrants have similar rates of growth and similar rates of abandoning the market. At the other end of the spectrum are products (or time periods for specific products) in which late entrants have unusual opportunities to take over markets from incumbent firms and new firms are likely to become market leaders. The first two types of products have been shown to be common. The third type definitely occurs but its relative frequency is unknown and, from the little research available, appears to be modest.

These competitive processes matter for international competitiveness, because they affect US firms' ability to stay in, or enter successfully, the business of producing any given product. Being one of the relatively early firms to produce a new product, especially in the first type of industry, is (on average) a route to profit and employment. Late entry by US producers is most likely to succeed in the second and especially third type of industry. Loss of firms' competitive edge in the first type of industry is likely to be difficult or impossible to reverse.

Although it is tempting to target efforts to help industries that are ailing in the face of international competition, it is far from clear that such help has had any net benefit. R&D funds may be too little too late, so that US firms fail anyway as they cannot match the quality and efficiency of international competitors. For example, targeted R&D and small business funds may be awarded to the most promising projects, where part of what makes for promise is the ability to become and remain competitive with other firms in the industry. Trade restrictions, through tariffs, anti-dumping laws, and other means, are often assessed as having society-wide costs that exceed the benefits.

Another consideration for policy is that large firms appear to have the advantage for incremental, routine innovation. Small and large firms appear to be more similar in their ability to create new products, radically new technological approaches, and innovations for which marketable patent rights are unusually defensible. Although it is often argued that small firms have the advantage at creating novel innovative approaches, research has attained no definitive conclusion on this issue and any difference appears to be modest or perhaps nonexistent. Hence large firms are important to retain national competitiveness in many industries, and large firms operate roughly as effectively as small firms in other industries. Competition appears, from the (limited) existing evidence, to spur innovation in that the most innovation seems to occur when 2-3 firms operate in a market instead of a single monopolist (and instead of many small firms but that may depend on type of industry).

Innovation appears to be the major reason behind the above competitive outcomes. That is, if firms establish themselves as long-term market leaders in an industry it is likely that innovation was the cause of their success. Likewise, if firms take over the leading market share from incumbent firms in an industry it is likely that they gained this dominance through innovation. Innovation includes not just major new products or methods, but also vast numbers of minor improvements to the nature of a product or service or to how it is manufactured or provided. Large numbers of minor improvements appear to be crucial in the first type of industry, whereas more radical changes appear to be key in the third type of industry.

How do these characteristics of innovation relate to the appropriate kinds and amounts of corporate and government spending? The kind of innovation that is most useful is where the greatest opportunities lie, including service products. Since services now constitute the bulk of GDP, innovative development that promises broad-based improvement in services may be especially fruitful. Kinds of innovation in which government investment may be especially fruitful include more basic research and development, outside the often short-term planning horizons of businesses. Indeed businesses may need to consider longer time horizons in their budgeting of R&D and innovation given that their global competitors may do the same. The amount of R&D investment that should ideally be made, as a percentage of GDP, is difficult to assess. However innovation (and the subsequent transfer of innovative results and skills) is the primary driver of economic growth, and maintains the nation's economic viability in an age of international market competition. Assessments have indicated that the benefits of publicly subsidized R&D and innovation far outweigh the costs.

**Benefits of the Recommendations**

- Help the nation's companies to remain competitive
- Facilitate job retention or growth, instead of job loss to high-quality, high-efficiency foreign firms
- Retain strong value in US investments including retirement plans
- Retain one of the world's leading technology and innovation infrastructure
- Enhance development of new products, improve product quality and features, and enhance efficiency, yielding greater economic growth

# 9. Additional Reference Documents

**(Posted to NII Web Portal www.compete.org)**

- Issue Papers prepared by 21st Century Innovation Working Group Team Leaders.
- Measuring Innovation for National Prosperity: Innovation Framework Report, January 2004.
- Executive Briefing Report: Innovation Metrics, January 2004.
- Innovation Metrics: Measurement to Insight, presentation to 21st Century Working Group, April 28, 2004.
- Innovation Metrics Recommendation, Milbergs and Vonortas, June 1, 2004
- Innovation: The New Reality for National Prosperity, Interim Report of the 21st Century Innovation Working Group, June 1, 2004.
- Innovate America: Thriving in a World of Challenge and Change, National Innovation Initiative Interim Report July 23, 2004.
- National Innovation Initiative: Working Group Recommendations, A Resource Document, August 6, 2004.
- Recommendations for the 21st Century Innovation Working Group to the NII Advisory Committee, version 1.4, September 22, 2004.
- Extensive array of innovation reports and indicators by NSF, World Economic Forum, OECD, European Commission, etc...

# National Innovation Initiative

## Valuing Long-Term Innovation Strategies

**October 2004**

**Version 1.32**

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# Valuing Long Term Innovation Strategies

## (v.1.32)

## EXECUTIVE SUMMARY

**A central objective of the *National Innovation Initiative* is increasing the incentive for the private sector to pursue long term innovation strategies and investment. An important determinant is how markets evaluate such strategies. While markets are considered efficient they rely on information. Markets do, when they can see it, value innovation. However, if this information is "asymmetric" markets are likely to overestimate or underestimate the intrinsic value of innovation. Even managers often do not understand their own innovation assets. We currently lack adequate and well accepted methods for measuring innovation assets and the value of long term innovation strategies. The challenge, then, is to help markets more clearly see and assess long-term innovation strategies without giving away trade secrets and compromising company competitiveness. Cautious disclosure of rearward looking financial performance and a limited discussion of near-term performance guidance characterize today's communications between companies and financial markets. Clear disclosures of innovation strategies are simply not central to the current dialog. By making the innovation strategies of a company more clearly visible to the markets, a virtuous cycle can be created where companies with strong internal innovation performance systems and robust innovation strategies are rewarded while those without are not.**

***To meet this objective it is recommended that the private sector undertake a major information campaign to better understand their own innovation assets and use that understanding to educate investors, financial analysts and markets on the historic contribution and future growth potential of longer term innovation. An effective way to do this would be through voluntary disclosures of intellectual capital, integrated performance measures and indicators of future value. The specific recommendations are:***

***1. Industry should initiate voluntary and supplemental disclosure of intellectual capital, innovation performance and indicators of expected future value.***

***2. Government should enhance the legal and regulatory framework and "safe harbor" provisions to encourage the disclosure of longer term innovation strategies in a way that enhances investor trust and provides for better disclosure.***

***3. Industry, associations and universities should partner to educate themselves and financial analysts and consultants on emerging technological trends, innovation performance and management practices and support research on comprehensive valuation methodologies for assessing longer term innovation strategies and risks.***

***4. Corporate boards of directors should consider management incentive structures that encourage long-term intrinsic value creation rather than short-term objectives.***

***5. Established enterprises should develop and pursue new approaches for their innovation investments including portfolio-based risk taking and look to entrepreneur/venture capital dynamics for insights and lessons.***

## BACKGROUND FOR THE RECOMMENDATIONS

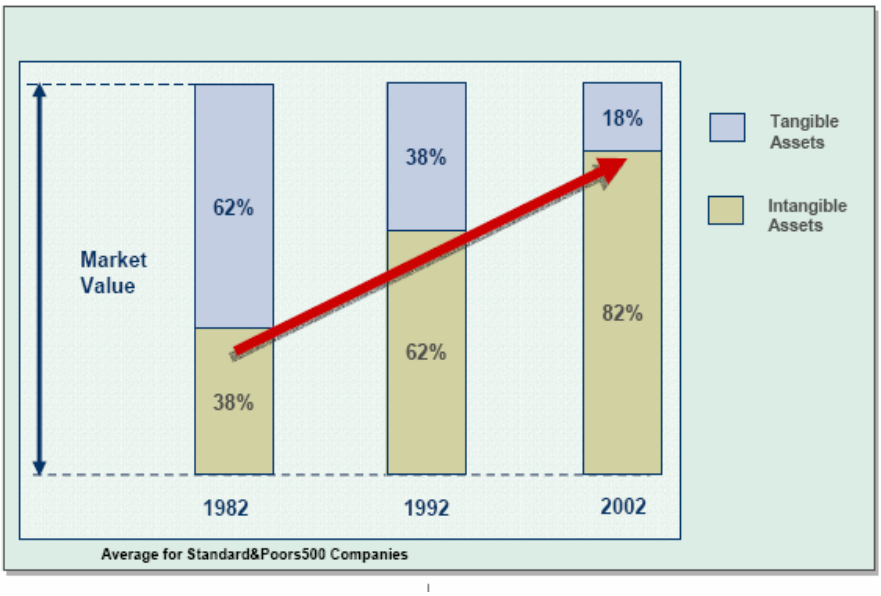
Innovation is the engine of the 21st century economy. Successful companies will be those that continually invest in innovation—creating, developing and deploying new technologies, products, services and processes. This is a fundamentally different kind of economy which in the past was driven by investments and management of "tangible assets" such as land, plant and equipment, and physical resources. Today, firms are increasingly relying on *intellectual and intangible assets* to sustain their competitive advantage and the market value of their firms.

The bursting of the Internet bubble caused many to question the notion of efficient markets and the link between market value and innovation. Nevertheless there is widespread recognition that market valuations in the future will be based on new technology, innovation and other intangibles as the predominant drivers of future value.

> ***"Wealth and growth in today's economy are driven primarily by intangible (intellectual) assets"***
>
> **Baruch Lev**

In the late 1990s the annual US investment in intangible assets (R&D, business processes and software, brand enhancement, employee training) was roughly $1 trillion, almost equal to the total manufacturing investment in physical assets ($1.1 trillion). Furthermore, according to some analysts intangible capital currently constitutes well over half of corporate market value. Accenture by comparing book value to market values in 2002 approximated that intangible assets accounted for 82% of market valuation. See Chart 1.

**Chart 1: Growing Importance of Intangible Assets in Market Valuation**




This is testimony to investor confidence in the future growth and global power of the US innovation system. It also reflects a level of market risk if our innovation ecosystem of business, universities, government and skilled management were to falter.

### *New Dynamics of Value Creation*

The knowledge based global economy is changing the dynamics of value creation yet the methodologies and information typically available to market analysts and investors are deficient for assessing the core innovation capabilities of firms. When American management faced the competitive challenges from Japan in the 1980s managements focused on creating more efficient

production processes and upgrading quality control. The focus was on cost reduction, elimination of waste and return on capital. However for the 21st century innovation economy this model for managing the performance of organizations ends up falling short. Organizations must now compete more on continuous innovation, creation of new markets, introduction of new products and services, differentiation and satisfying more complex customer needs. Cost, financial efficiency and quality are still important but no longer fully encompass what is required to successfully create value and compete in global markets. Competitive advantage today is how effectively the firm can create customer value through innovation. We need new generation performance measurement systems that capture the dynamics of longer term innovation.

**Longer Term Innovation Creates Value**

***In a study of business launches in 108 companies, we found that 86% of those new ventures were line extensions—incremental improvements to existing industry offerings—and a mere 14% were aimed at creating new markets or industries. While line extensions did account for 62% of the total revenues, they delivered only 39% of the total profits. By contrast, the 14% invested in creating new markets and industries delivered 38% of total revenues and a startling 61% of total profits…Competing in overcrowded industries is no way to sustain high performance. The real opportunity is to create blue oceans of uncontested market space…In blue oceans, demand is created rather than fought over. There is ample opportunity for growth that is both profitable and rapid.***

**Kim and Mauborgne, Harvard Business Review, October 2004**

***Expert Views on the Inadequacy of Innovation Measures***

The immediate challenge is how to realize better information and transparency innovation investments that may have longer term revenue and earnings potential (future value). A new measurement and disclosure approach is needed to provide management, investors, and financial markets with a more complete understanding of value creation.

An SEC inspired task force, chaired by Jeffrey Garten *(Yale School of Management)* looked into whether company disclosure requirements provide investors with the information they need to assess company value. The report concluded that, "The current reporting system, comprised of Generally Accepted Accounting Principles (GAAP) and SEC mandated disclosures, focuses primarily on historical financial measures. The system provides limited guidance about other information investors need."

***Companies that measure key non-financial strategic performance areas are more likely than their non-measurement counterparts to be perceived as industry leaders (74 % versus 44 %) and to exhibit superior performance on three year return on investment (80% versus 44%).***

**Metrus Group Study (1996)**

Peter Wallison *(American Enterprise Institute)* and Robert Litan *(Brookings Institution)* in a new book call for a totally new system that would provide ways to account for the growing importance of intangible assets such as intellectual capital, information or knowledge used in production of goods and services, research and development, trademarks, brand names, patents and even alliances with suppliers and distributors. With intangible assets accounting for up to 80 percent of the value of S&P 500 companies the authors say that market value cannot be measured using GAAP accounting. *(The GAAP Gap: Corporate Disclosure in the Internet Age)*

Baruch Lev *(New York University's Stern School)* observes that the old financial model is broken and urges investor relations officers and CFOs to create a new model for communicating non-financial factors to the investment community.

***Intangibles: The Key Driver of Long Term Performance***

Innovation measurements are useful not only for external reporting but also for management strategy and control. "As the importance of intangible assets increases in terms of its impact on the valuation of companies, organizations must become more effective and efficient in the management of these assets in order to remain competitive and maximize shareholder value."

**Table 1: Examples of the types of capital, categorizing them as tangible and intangible**

| *Type of Capital* | *Type of Asset* | *Examples* |
|---|---|---|
| Financial | Tangible | Monetary Investment; Land and Buildings; Equipment |
| Human | Tangible | Manual Labor; Repetitive Tasks; Low-Tech Skills; Process Execution |
| Intellectual | Intangible | Process Generation; Best Practices; Experience; Intuition; Wisdom |
| Social | Intangible | Internal Networks; External Relationships; Communities of Practice; Goodwill; Shared Values; Internalized Standards |

*Source: Carayannis, E.G. "Measuring intangibles: managing intangibles for tangible outcomes in research and innovation" Int. J. Nuclear Knowledge Management*

***Gaps in Innovation Data***

Data on intangible assets is not systematically collected. Most innovation related information available from firms is highly qualitative and anecdotal. Therefore it has limited value for management or investor decisions. There are enormous data voids. R&D investments are the only intellectual capital factor required to be publicly reported by companies; there is access to company level patent data but little more. Intangible assets that are increasingly important to longer term innovation include: customer satisfaction and relationships, IT investment, education of employees, recruitment practices, new product development processes, external research and technology alliances, services innovation and participation in alliances and regional networks. Information on how firms cross functionally integrate intangible assets is also limited. Large R&D spending may mean little if a company does not have well conceived business process for transforming research results into the market place. A well trained sales force will not generate maximum value without customer feedback to the research, product development, manufacturing and supply chain function. Highly qualified scientists and engineers if not compensated and recognized appropriately might leave for better opportunities. Table 2 is partial list of longer term innovation issues which could be resolved through improved measurements.

**Table 2: Key Issues that Effect Long Term Innovation Performance**

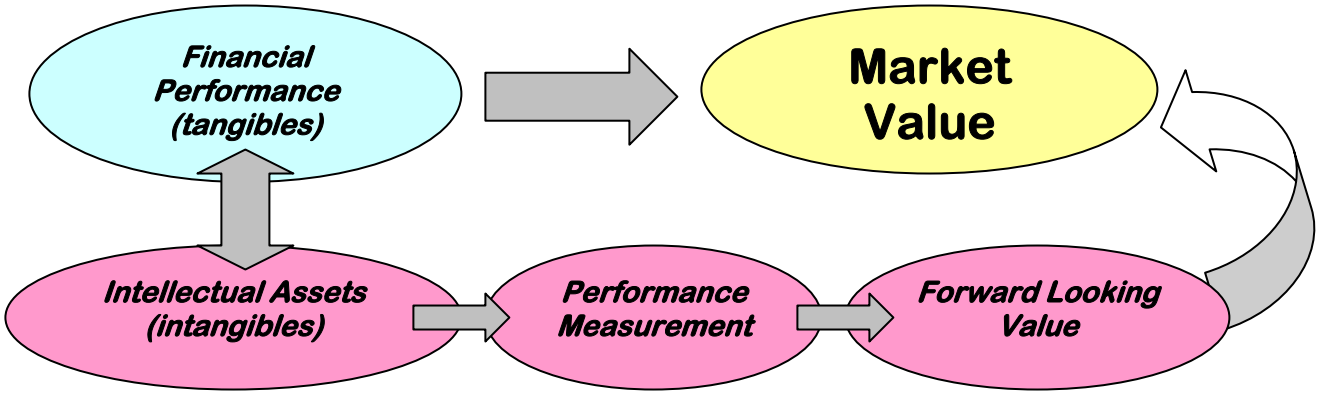
- What organizations structures are most conducive to R&D, multidisciplinary breakthroughs and innovation success?
- What project management methods lead to higher rates of commercialization?
- What is the contribution of industry-university collaborations and corporate networking alliances, partnerships and joint ventures on company performance? What is the optimal way to structure these arrangements?
- What is the rate of return on investments in intangibles (R&D, training, branding, customer relationship building)?
- What compensation and incentive systems positively impact individual, team and enterprise performance?
- How are new knowledge and technologies captured, adopted and diffused within the organization?
- When are failing products and services and business processes abandoned? How does the enterprise know when to abandon?
- What value are new products, services and processes creating for customers?
- How does the public policy, legal and regulatory environment impact innovation and value creation?

***How Longer Term Innovation Drives Market Valuation***

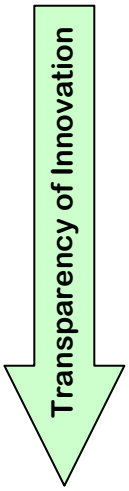
Chart 2 is a highly simplified model of the drivers of value. When markets are efficient, this translates into increases in market value. Markets take into account perceptions of future growth potential which are driven by firm's intellectual assets and measures of business performance such as management competence to transform intellectual assets into future revenue streams and profits. A number of factors external to the firm also influence market valuations, including the uncertainties as to future economic conditions, market demand, competitive rivalry and alternate technological trajectories. Improving the transparency of intellectual assets, performance measures and expected innovation outcomes will help investors and markets put a value on long term innovation strategies.

## Chart 2: Value Creation Framework

**(Shorter term financial drivers and longer term innovation drivers)**




| Market Driver | Measurement (examples) |
|---|---|
| Financial Performance | GAAP Income and Balance Sheet Statements. Quarterly earnings guidance. |
| Intellectual Assets | Intangible capital, R&D, patents, technology alliances, skills of workforce, innovation strategy, management competency. |
| Performance Measurement | # of new products introduced, customer satisfaction and retention, recruitment rate, market share, adaptability. |
| Forward Looking Value | Market demand, expected revenues, rate of return, profits on innovation projects, economic and technical risks. |




***Markets Positively Value Innovation—if they know about it***

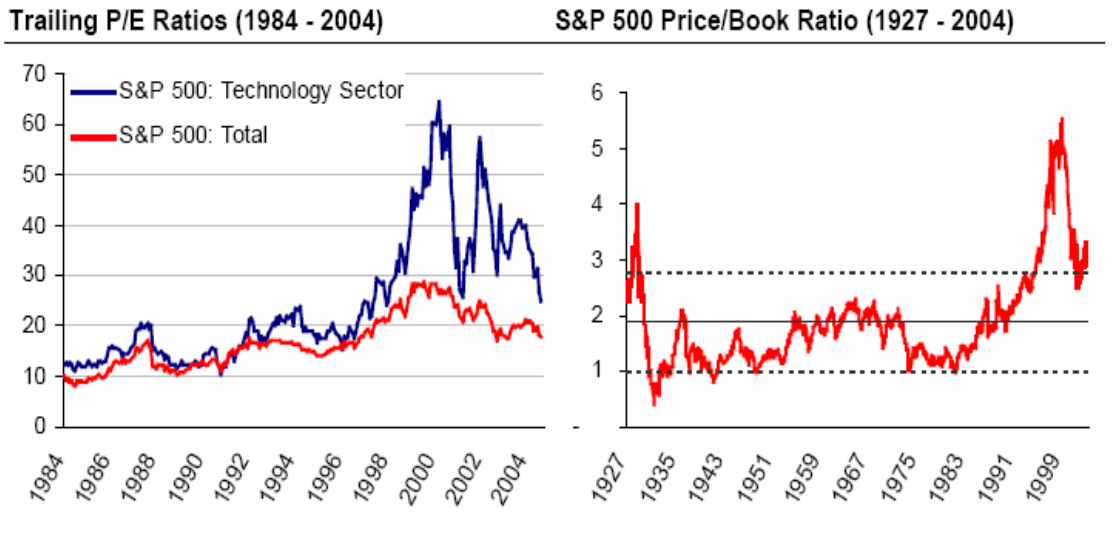
Evidence suggests that capital market participants do respond to intellectual asset information. Knowledge-intensive companies, identified via their expenditures on R&D, have a market value that is significantly higher than their book value (Hansson 1997; Lev 1997). Intellectual capital is a lead indicator of future performance of organizations. Financial analysts recommend higher amounts be invested for long term holding when the intellectual asset measures as well as the financial measures are above the industry average. Based on a content analysis of 284 corporate annual reports over the years 1993-1997, there is evidence of a highly significant and positive correlation between intellectual capital disclosure and market capitalization. This is consistent with research indicating positive correlation between voluntary disclosure and stock market valuation.

The NII Innovation Finance Working Group points out in their report that the marketplace continues to evolve in its recognition of the value of intangible assets to the external valuation of modern companies. Simply comparing the 10 highest market cap companies today vs. 10 years ago shows the relative ascendancy of companies focused on human, intellectual and technology capital as compared with those focused on commodity processing and/or manufacturing.

| Company name | 2004 Market Cap ($ Billions) | Company Name | 1994 Market Cap ($ Billions) |
|---|---|---|---|
| General Electric | 356 | General Electric | 85 |
| Exxon Mobil | 309 | Toyota | 79 |
| Microsoft | 296 | Exxon Mobil | 73 |
| Citigroup | 243 | Mitsubishi | 71 |
| Pfizer | 243 | Royal Dutch Petroleum | 60 |
| Wal-Mart | 226 | Wal-Mart | 60 |
| AIG | 185 | Coca-Cola | 59 |
| Bank of America | 181 | Altria Group Inc. | 52 |
| Johnson & Johnson | 173 | Merck | 42 |
| IBM | 145 | IBM | 41 |

Source: Morgan Stanley

The long-term rise in the stock market vs. alternative investments has been accompanied by a stair step rise in P/E ratios, and more interestingly, Price-to-Book ratios.

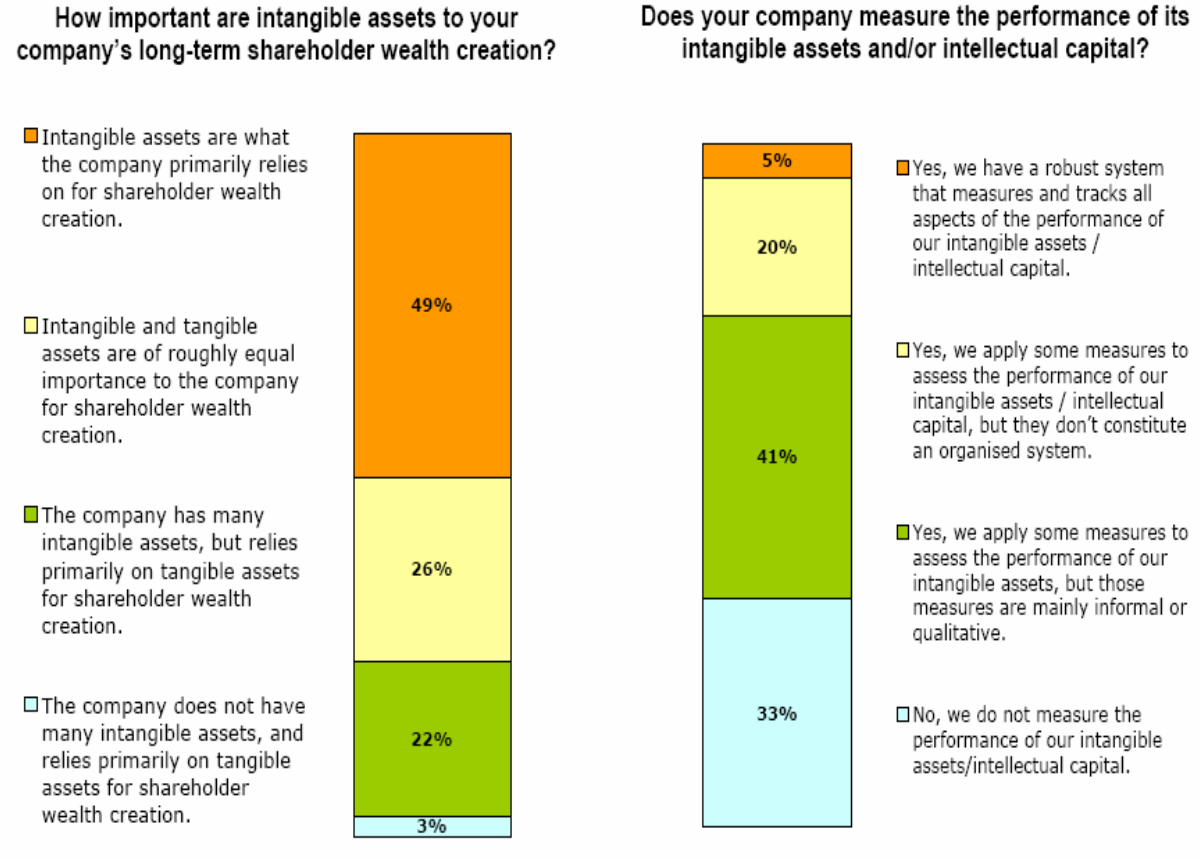



Source: Morgan Stanley

***Executive Perceptions on the Importance of Intangibles and Measurement***

Accenture conducted a global survey of senior executives in conjunction with the Economist Intelligence Unit on the value management of strategic assets both tangible and intangible *(September 2003)*. Overall, executives believe intangible assets are of high importance to their company's long term shareholder wealth creation. Nearly half consider intangibles to be the primary source of shareholder wealth creation for their company, while another 26 percent see intangible and tangible assets being of roughly equal importance. While the importance of intangible assets and intellectual capital is largely recognized, measurement of their performance,

according to the vast majority is lagging or even nonexistent. Only 5 percent of executives claim their company has a robust system that measures and tracks all aspects of the performance of intangible assets and intellectual capital.




***What do we do about it?***

There is general agreement that traditional accounting based information systems do not provide adequate information on intellectual capital, innovation performance and their economic impact. Lack of this information results in mis-estimates of the value of innovation which can increase the cost of capital to intellectually intensive enterprises, hindering their investment and growth. Some suggest leaving the issue to the free market to sort out. Others argue for a significant overhaul of corporate accounting and financial reporting practices. In between are various proposals for encouraging voluntary corporate disclosure of intellectual capital.

There is growing interest in voluntary disclosure. Much of the leading work for voluntary supplemental disclosure is underway in the UK, Canada, Denmark, Australia, Sweden, Netherlands, OECD, and European Union. *See Attachment 1: Selected Innovation Disclosure Initiatives.*

# DETAILED RECOMMENDATIONS

**1. Industry should initiate voluntary and supplemental disclosure of intellectual capital, innovation performance and expected returns and risks.**

Firms with strong intellectual assets and well conceived innovation strategies and management procedures could enhance market valuations and stability through greater disclosure of intellectual capital and innovation performance measures. What is necessary to encourage this process is a developing corpus of best practices. We recommend that industry associations in concert with various reporting and disclosure experts and practitioners from industry, academia, and the investment community develop guidelines, methodologies and best practices for companies interested in adopting enhanced disclosures.

In order to better inform markets of the value of long term innovation strategies firms would undertake sectoral specific initiatives to disclose:

- Non financial information and performance metrics.
- Forward looking indicators related to projected innovation investment and outcomes
- More information about the firm's intellectual and intangible assets.

Improved supplemental and voluntary disclosures of intellectual assets and performance would provide significant benefits to investors as well as the businesses providing such disclosures. Many of the biases against longer term innovation strategies could be overcome. Longer term innovation strategies can be encouraged and help ensure market valuations that support this objective.

**2. Government should enhance the legal and regulatory framework and "safe harbor" provisions to encourage the disclosure of longer term innovation strategies in a way that enhances investor trust and provides for better disclosure.**

It is in public interest to have more information about firm innovation capabilities. However, business reporting is subject to complicated certifications and inspection processes, possible litigious action and serious regulatory challenges from government. This concern has been heightened by recent examples of managements abusing investors by providing false and misleading accounting reports. The existing safe harbor provisions may not be sufficiently strong to overcome potential negative consequences of supplemental disclosures. The trick is to give management the ability to present information on intellectual capital, performance and future values without leaving too many degrees of freedom for managerial manipulation. Government should pursue development of a legal and regulatory framework that protects voluntary disclosures. Public intervention should be catalytic—not controlling through regulation. Government regulatory agencies such as the SEC could provide valuable analytic support and expertise by working with industry associations and networks.

**3. Industry and universities should partner to educate themselves and financial analysts and consultants on emerging technological trends, innovation management practices and more comprehensive methodologies for assessing long term innovation strategies, risks and potential returns.**

Management and analysts benefit from better information on innovation trends, innovation performance and methodologies for assessing the link between innovation activity and future financial outcomes. Industry and universities should partner with the financial analyst community to proactively generate such information as well as support research to improve valuation

methodologies. Such research and education program would accelerate more disclosure and improve the credibility of market analysis.

The NASD, SEC and private non-profit and for-profit organizations and media organizations currently provide investment related training and training materials to investors and financial planners. To enhance long-term valuations, our recommendations should encourage all educational entities (governmental, non-profit and for-profit) to provide focus to the long-term and away from short-term evaluations.[1]

Such education should provide a focus on value creation and innovation rather than simply the basics of financial reporting: net income and cash flow.

The corporate sector should also be encouraged to provide this kind of education, specifically financial services firms selling 401(k) and other retirement and investment services. In addition, all corporations should be encouraged to provide this kind of training to their own staff in order to reinforce, within their own company, the commitment to long term outcomes that support innovation. Many firms today embrace open book management. This kind of training should be extended, expanded and modified to focus on long-term outcomes including innovation that drive real value.

**4. Corporate boards of directors should consider new management incentive structures that encourage long-term intrinsic value creation rather than short-term objectives.**

To promote longer cycle innovations, corporate boards of directors should implement CEO and management incentive structures that encourage long-term intrinsic value creation rather than short-term objectives (such as annual net income targets). In addition, boards should not focus on market valuation because market valuations are subject to the laws of supply and demand and other extrinsic issues outside the control of managers. Such focus can muddy the laser like focus that boards, CEOs and their managers should have in creating long-term value through innovation. Incentive structures should reflect the realities of business structures which today are reliant on intellectual capital and innovation. This means incentive structures that reflect multi-year outcomes, and payouts that are based on long-term results. Boards should be consistent in their approach and encourage managers to use similar long-term views when evaluating the performance of their employees.

The incentive structures of professional money managers should likewise be based on longer-term outcomes. A recent report has shown the negative consequences to investors of short-term thinking by portfolio managers. [2] Financial services firms should be encouraged to lengthen the time horizon for bonus structures so that when their employees make investments on behalf of their clients, longer time horizons are encouraged. The SEC and others should create investor awareness

[1] For example, Mary L. Schapiro, Vice Chairman, President, Regulatory Policy and Oversight, National Association of Securities Dealers wrote: "Educated investors are essential to successfully functioning capital markets. At this critical time in our financial history, restoring the confidence in our financial system lost over the past year will depend upon financial advisers and investors truly understanding the companies they invest in. As *Economic Value Management* shows, being educated means more than understanding the unique language of the stock market, it is more than reading a prospectus or an annual report, it is more than listening to an analyst's opinions. Being educated requires a genuine understanding of the value of a company."

[2] Buy and hold, the strategy most commonly recommended to stock investors, is being increasingly abandoned by the professionals, with US mutual funds holding stocks for an average of just 10 months, a record low. At the same time the average annual turnover of a fund's portfolio has risen to a record high of 118 per cent, according to figures from the Bogle Financial Markets Research Center.

around this issue and encourage full disclosure of portfolio manager bonus/incentive arrangements. (See disclosure and communications for more on this topic.)

***Management Systems.*** Imbedded management structures must also be changed. To encourage innovation and long-term intrinsic value creation, managements must redesign the way in which numbers are reviewed and analyzed. While many corporations have extensive processes in place to respond to monthly and annual results and their forecasts, the processes and conversations around innovation and longer-term value are often less imbedded in the management process, if they are present at all. So in support of these efforts, managements must make a concerted effort to create the structures for this review and analysis so that the focus is clear and present in the organization's day to day interactions. Examples of this lack of focus abound. And studies show that the effects are wide reaching.[3] These management approaches harm innovation and the ability of organizations to realize value from creativity and innovation.

***Metrics.*** The metrics organizations use to describe their results must shift from short term measures (i.e. short time horizon/duration) to long term ones and from net income or cash flow to long term intrinsic value creation. To do this, corporations must educate themselves on metrics that describe long-term intrinsic value and implement them in their management systems. Management systems (as described above) must use these longer-term measures of performance not only to assess whether to undertake a project (NPV) but also to judge the organization's performance and improve it over time. Such actions will not only encourage innovation but also a learning process focused on realizing the value of those investments. These broader metrics of intrinsic long-term value creation provide the context necessary to promote reduced usage by corporations of short-term yardsticks while placing the measurements of intangibles in the broader context. This will help prevent corporations and investors from treating intangibles disclosures as a sideshow. With these metrics in place, corporations will have real measures of whether or not their innovations created value; if not, what to do about it; and if so, how to duplicate it.

***Disclosure and Communications.*** Consistent with first recommendation corporate communications to the street and to employees should be re-focused to the longer-term, to innovation and long-term intrinsic value creation. Over reliance on quarterly earnings projections concentrates the focus on meeting forecasts (as well as the shorter term) rather than on investment, innovation and the operations of corporations. The media should also be encouraged to report on longer time horizons and on performance from a broader perspective than earnings results, recognizing the longer term cycles involved in innovation and the deployment of intellectual capital.

**5. Established enterprises should develop and pursue new approaches to improving the productiveness of their innovation investments including looking to the portfolio-based risk taking and creative destruction dynamics of the entrepreneur/venture-capital ecosystem for insights and lessons.**

Given the large amount of talent and capital within established enterprises, enterprises must join entrepreneurs as central figures in the nation’s innovation engine if we are to leverage the full resources of our economy. There is, however, an intrinsic challenge to fueling innovation within

[3] According to a survey of 401 financial executives and in-depth interviews of an additional 20, conducted through the joint efforts of Duke University, the National Bureau of Economic Research, and the University of Washington, 55% would avoid initiating a very positive NPV project if it meant falling short of the current quarter's consensus and 78% would give up economic value in exchange for smooth earnings. The implications are that potentially even demonstrable value-creating innovations will not be funded if they interfere with the production of short-term results. Citation for the study: Graham, John Robert, Harvey, Campbell R. and Rajgopal, Shivaram, "The Economic Implications of Corporate Financial Reporting" (January 20, 2004). http://ssrn.com/abstract=491627

an on-going concern: the capital and talent deployed in established companies are largely engaged in, and tailored to, delivering the current business. Innovation, then, which requires different skills, risk-taking decision making, patient capital, etc., is often found competing for resources that are not well suited to its purpose. Companies should be considering why it is that entrepreneurs and open markets are more effective at developing breakthrough innovations and how they can translate some of those lessons to their own management system.

Attachment 1: Selected Intellectual Capital Disclosure Initiatives

| Initiatives | Description |
|---|---|
| **Denmark—Intellectual Capital Statements** | This 2003 guideline for intellectual capital statements is the result of an extensive cooperative project between researchers, companies, industry organizations, consultants and civil servants and coordinated by the Danish Ministry of Science, Technology and Innovation. The report presents elements of the intellectual capital statement, how to prepare a statement and content of external statements. |
| **Australia—Invisible Value: the case for measuring and reporting intellectual value** | The identification, measurement and reporting of intellectual capital emerged as an important issue at the Australian National Innovation Summit in February 2000. The Governments innovation initiative, *Backing Australia's Ability* is based on the recognition that intangible assets are outstripping traditional assets as drivers of growth. The papers reviews internal and external measures of intellectual capital and the accounting treatment of intangible assets and also consider international experiences. |
| **Sweden-- Skandia** | Skandia, a financial services company, was the first in the world to develop an integrated intellectual capital model which defined and classified intangibles not shown in the balance sheet. |
| **Canada—Canadian Performance Reporting Initiative** | This initiative was designed by the Ontario Premier's Council in partnership with the Canadian Institute of Chartered Accountants to increase the effectiveness investment innovation capacity in Ontario in the early 1990s. The main perceived barrier to increasing investment in innovation was the lack of clear measures of the returns these investments could generate. The work is aimed to develop a set of standards to account for the cost of ideas and the productivity of knowledge workers. |
| **United Kingdom—Creating Value from Your Intangibles** | This is a self-assessment tool designed to be complementary to financial accounting by focusing on the non-financial aspects of a business which influence future cash flows and the value of the business to its shareholders and stakeholders. The guidelines build on the first intangibles report "Creating Value from Your Intangible Assets". |
| **European Union—(HLEG)** ***European High Level Expert Group on the Intangible Economy*** **and (MERITUM)** ***Measuring Intangibles to Understand and Improve Innovation Management*** | The HLEG report discusses economic transformation, evidence on the links between intangible investment and economic performance and implications for official statistical and accounting systems. The aim of MERITUM project is to provide insight into the process of transforming intangibles into increased wealth. An objective is to develop guidelines for the measurement and disclosure of intangibles based on comparison s between findings in six European countries (Denmark, Finland, France, Norway, Spain and Sweden). |
| **OECD—several projects intangibles** | Work on intangible investments within OECD is according to two main theories: human capital theory and the theory of innovation and technical change. A number of OECD directorates work on this issue and numerous publications are available. |
| **United States -- Financial Accounting Standards Board (FASB) –** | Disclosures about Intangible Assets project. The objective of this project was to establish standards that will improve disclosure of information about intangible assets that are not recognized in financial statements. A comprehensive special report was completed in 2001: *Business and Financial Reporting, Challenges from the New Economy* authored by Wayne Upton. In January 2004 the Board removed this project from its research agenda. |

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# National Innovation Initiative

## The Extended Production Enterprise and Innovation

**November 2004**
**Version 3.0**

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**21st Century Innovation Working Group**
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# The Extended Production Enterprise and Innovation v.3.0

## SUMMARY

The 21st Century Innovation Working Group recognizes manufacturing as an important driver of present and future prosperity. The manufacturing sector plays a large role in investing in R&D, introducing new products and generating economic output, productivity, employment and exports. Structural shifts in the global manufacturing environment now require a change in perspective and strategy if we are to maintain a strong and competitive US manufacturing base.

The change in strategic perspective is focused on expanding innovation opportunities at the intersection of manufacturing and services. Business processes that comprise the manufacturing process do not need to take place in a single firm or location. In fact they are increasingly a part of a distributed and ***extended production enterprise.*** The creation of value by US manufacturers now requires complementary innovations in non-factory processes and novel integration of supply chains, small manufacturers, services, logistics systems and customer support functions. The value being provided by manufacturing is shifting from a ***production to a solutions model.***

**The 21st Century Innovation Working Group recommends:**

**1. Establish world class centers for production excellence to accelerate knowledge sharing, the speed of innovation and jumpstart commercialization of new technology based products.**

**2. Refocus DOD research and procurement technology programs to support breakthrough technologies and speed up the deployment process.**

**3. Encourage and support the development of voluntary, open and interoperable software standards to drive innovative applications for the extended production enterprise.**

**4. Expand use of industry led technology roadmapping projects to define the next generation of innovation opportunities for the extended production enterprise and advise on federal R&D priorities.**

**5. Establish prototype Innovation Extension Centers for Small Manufacturers**

**6. Consider strategies for reducing the burden of external overhead costs on innovation and productivity improvement.**

# The Extended Production Enterprise and Innovation v.3.0

***Prepared by: Egils Milbergs with major contributions from William Bonvillian, Rick Jarman, Anthony Warren, Ned Ellington, Rebecca Taylor, Chad Evans and Taffy Kingscott***

Although the dominate feature of the US economy is the service sector, the 21st Century Innovation Working Group recognizes manufacturing as an important driver of present and future prosperity. The manufacturing sector plays a large role in investing in R&D, introducing new products and generating economic output, productivity, employment and exports. However, the recent economic recession has surfaced new challenges and problems:

- Employment declines in manufacturing
- Loss of export competitiveness
- Change in the pattern of foreign investment trends toward developing economies
- Shortages of critical skills
- Rise in non-controllable costs such as health care and regulatory compliance

We must put aside the growing perception that manufacturing is in decline and instead begin designing and implementing a new foundation for high performance production. With the right innovation strategies, investments and changes in policy the US has an opportunity to accelerate the deployment of new production processes and strengthen the contribution of manufacturing *and* the service sector. In fact, the integration of services with manufacturing is central to the evolution of the extended production enterprise. The value being provided by manufacturing is shifting from a *production* to a *solutions* model.[1]

***Structural Changes in Manufacturing***

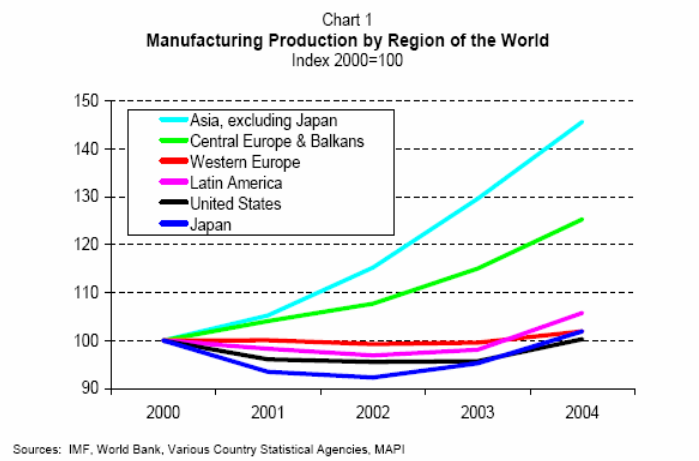
We have met challenges to the US manufacturing base before. Manufacturers showed amazing resilience when they faced up to the mid-80s competitiveness challenge, primarily from Japan. Manufacturers responded and fought back impressively by giving extraordinary attention to the fundamentals of cost, quality control and productivity improvement. By the late 1990s the US emerged as the manufacturing productivity leader of the world.

**Today the situation is different and more complex. The challenge is more than waiting for a business cycle recovery; the challenge is profoundly structural.** Driving this structural shift are the transformation of formerly centrally planned economies toward market oriented economies, less reliance by developing economies on import substitution toward export oriented development, increased adoption of global business strategies, reduction of global trade barriers that accelerate the transnational flow of goods, services, personnel and capital, and, worldwide diffusion of IT and communication applications. Manufacturers also must deal with terrorist and political risks that can cause major disruption of just-in-time supply networks. These factors are having a particularly large impact on US based high technology manufacturing industries. The traditional manufacturing strategies of cost control, lean, six sigma, continuous productivity improvement and quality are the minimum requirements to compete in today's global marketplace. **In the future, the winning strategy will depend on innovation, adaptiveness, collaboration and speed within the extended production enterprise.**

[1] Duesterbuerg, T. and Preeg, E. (editors). *US Manufacturing: The Engine for Growth in a Global Economy.* Praeger. 2003.

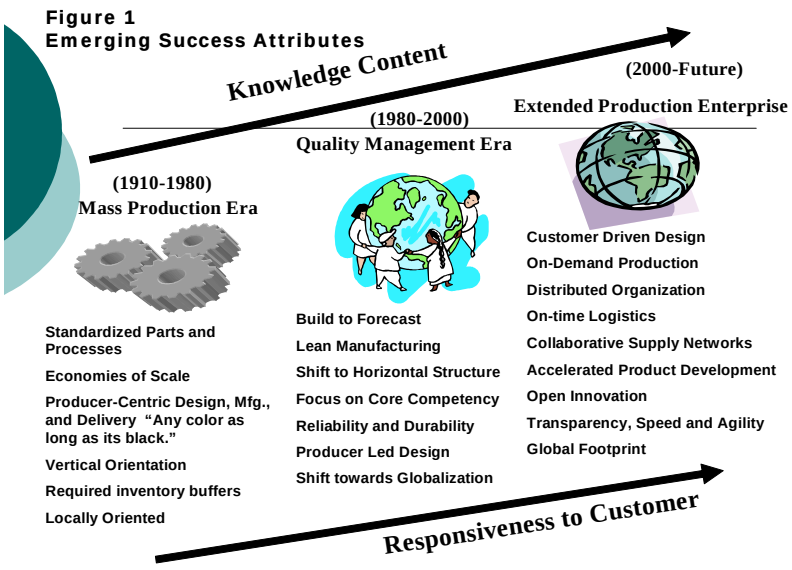
### *Global Position of US Manufacturing*

Although the United States remains the world's leading producer of manufactured goods, it now trails among major regions of the world in manufacturing growth. Chart 1 shows that the United States is last among the six major geographic regions of the world in terms of manufacturing growth since the beginning of the decade. [2] Not only did manufacturing in the United States decline more than other regions in the global recession in 2001, it has been slower to recover from the industrial downturn. The fastest regions for manufacturing growth in the world have been in Asia (outside of Japan) and in Central Europe and the Balkans. These areas are low-cost manufacturing centers that are now well positioned to export manufactured goods to developed countries like the United States, Japan, and Western Europe.




### *Requirements for Success*

To overcome our cost and wage disadvantages, we need to lead the world in deploying new production technologies and integrate the manufacturing function into the larger innovation ecosystem with a focus on creating value. We must maximize the growing intersection of manufacturing and services and find innovative ways to manage supply networks, small manufacturers, services, logistics, and customer relationship functions. *"Dazzling prototypes are not sources of profit. Reliable and cost-competitive products must be manufactured to reap the final reward of innovation."* [3] Innovation across the extended production enterprise will create a strong productivity *and* value creation advantage for U.S. based industry. The fundamental requirement for success is how to incorporate higher levels of knowledge content and customer responsiveness into manufacturing operations. Figure 1 shows some of the emerging attributes of the successful 21st century enterprise. Those manufacturers that make innovation the centerpiece of their competitive strategy will be the global winners.




[2] Meckstroth, D., *The United States Trails the Global Manufacturing Expansion of the Early 2000s*. e-Alert. Manufacturers Alliance/MAPI. November 4, 2004. p. 1

[3] Bonvillian, W. *Meeting the New Challenge to U.S. Economic Competitiveness.* Issues in Science and Technology. Fall 2004. p. 80

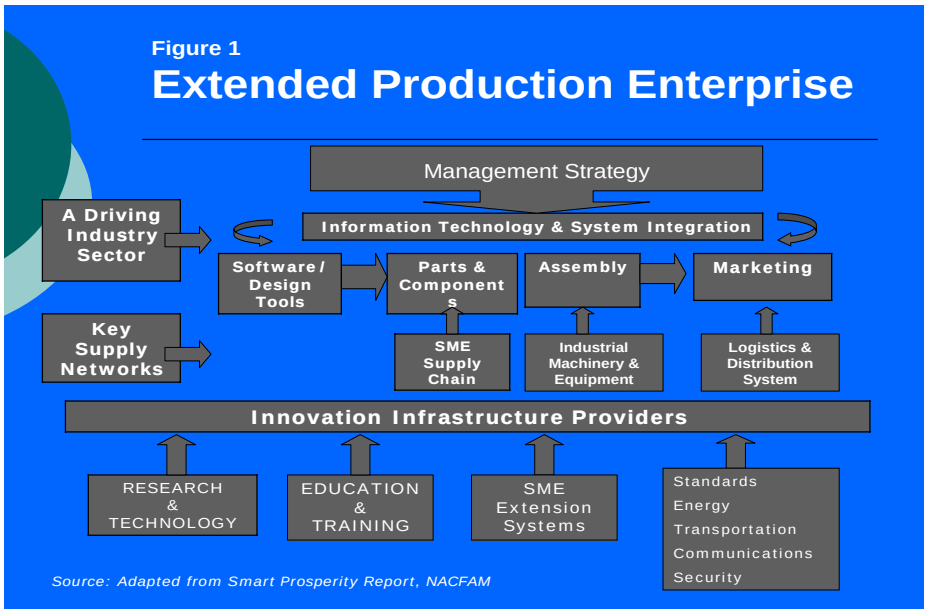
***From Factory-Centric View to the Extended Production Enterprise***

A new strategic perspective on manufacturing is needed to focus innovation on these new requirements. Business processes do not need to take place in a single enterprise or location. In fact they are increasingly a part of a distributed and *extended production enterprise.* The successful 21st century manufacturer will be more like a system integrator, managing a supply chain or virtual network that consists of various combinations of business process suppliers whether or not provided by the manufacturer itself.

> ***"Globalization is causing a shift in the source of competitive pressure, and of competitive advantage, from excellence at the point of production— now more or less assumed— toward excellence in governing spatially dispersed networks of plants, affiliates, and suppliers."*** *(Electronic Industry Alliance, 2004).*

**Consequently, the creation of value by manufacturers now requires complementary innovations in non-factory processes and novel integration of supply chains, services, logistics systems and customer support functions.**

Figure 1 illustrates the emerging 21st Century production enterprise as an extended, networked and distributed system. As the figure makes clear, component fabrication and assembly are only a part of value chain from raw material to the customer and include software and design tools, supply chains, advanced industrial machinery and equipment, distribution and logistics systems and the overall management strategy that integrates the whole system toward customer value.




These components in turn rest on a common infrastructure of research, technology development, standards, education and training and technical assistance organizations to small and medium sized suppliers. If we want to ensure that successive waves of innovation begin in the US and that US workers are the first to benefit from the next big things we have to optimize collaboration, innovation, efficiency, dynamism and effectiveness of the entire extended production enterprise. **Industry must lead, but government can be a critical partner, enabler and facilitator.**

## Trends and Challenges for the Extended Production Enterprise

**Technology Opportunities**. A number of significant trends in manufacturing technologies hold potential for creating a US competitive advantage. We see it in the elements of flexible automation progress, complex numerically controlled tooling and advanced CAD/CAM, precision engineering and design, dual use systems for commercial and military products and in contract distributed manufacturing to gain the advantages of volume, e-commerce that connects supply chains, materials databases and shared use facilities for R&D and prototyping. These technologies if leveraged appropriately offer major productivity improvements to help offset the wage and cost advantages of foreign competitors.

**Collaborative Approach is Key.** A key ingredient for success will be collaboration between industry, customers, suppliers, research and government to share the risk, cost and time of development of new technologies. This means integrating new designs, processes and materials in a modular fashion. We will need to invest in new human, organizational, and financial models. The U.S. could dominate nano-technology if we are the first to build nanofabrication capabilities to make cost competitive products for the global market.

**DOD has a Critical Stake.** If US production capabilities continue to shift to overseas locations, and our innovative design and R&D stages follow it offshore, the Department of Defense will face a major national security problem with maintaining a technology edge and its transformation strategy. DOD is a huge beneficiary of productivity gains in manufacturing which helps DOD afford its vast acquisition and procurement program as it transforms its infrastructure to deal with the changing threat environment. The DOD can play a vital role by collaborating with industry on breakthrough manufacturing processes such as distributed and desktop manufacturing, quality inspection that is built into the production process, use of revolutionary materials and methods of fabrication, and devices and machines built at the nano-scale.

**New Business Models.** The next generation of manufacturing will entail new business models that integrate services, design, and manufacturing stages throughout the *extended production enterprise* creating value *"on-demand."* Business processes increasingly rely on software, communication technologies and an expanding array of computing devices and sensors to work effectively. Open computing platforms—both hardware and software—are an essential feature of a more networked world. Software research and standards for interoperability enable enterprises to have the freedom to share information, collaborate and upgrade applications without tremendous legacy costs or time delays. The lack of software interoperability adds to production inefficiencies and poses a major barrier to shortening the design to manufacturing execution cycle. More interoperability will enable a "network effect" and more efficient manufacturing/service integration. The pervasive and exponential economic impact of the Internet owes its success to the application of open computing principles and standards.

**Adaptive Capacity of Small and Mid-size Manufacturers.** There is perhaps no greater need for innovation than in the small and mid-size manufacturing sector (SMEs). The 350,000 SMEs that employ over 7 million people and comprise nearly half the US manufacturing base are confronting enormous challenges to remain viable in today's global economy. Issues facing small manufacturers include disproportionate regulatory burdens; unfamiliarity with changing technology, production techniques and business management practices; lack of interaction with other companies in similar situations; difficulty in finding high quality assistance; access to qualified workers; high health insurance costs; and, the problems in obtaining capital to modernize. These trends in combination raise serious economic survival issues for small manufacturers.

**Technology Roadmapping and Federal Research Priorities.** Technology roadmaps represent a consensus regarding industry direction and research needs, innovation trajectories, alternative scenarios and the possibility of disruptive technologies and surprises. Industry associations and sector based collaborations are making greater use of technology roadmapping methodologies as an input to the federal R&D priority setting process as well as inputs to their own innovation planning. Roadmapping exercises can provide the basis for public and private investments in radically new production systems.

# RECOMMENDATIONS

### 1. Establish world class centers for production excellence to accelerate knowledge sharing, the speed of innovation and jumpstart commercialization of new technology based products.

Industry led collaborations focused on innovation, knowledge and flexibility in production will help accelerate deployment of new technologies as fast as they become available. Shared R&D and production facilities, knowledge exchanges, and on-demand training and education in high tech sectors of manufacturing can be leveraged across many industries in both the commercial and government sectors. World class centers of production excellence provide an infrastructure that attracts, develops and retains top technical talent, reduces costs through shared facilities, accelerates new product development and time to market, educates students from the technician to the PHD level and potentially generates start-up companies in new high growth markets.

For example the creation of SEMATECH in the 1980s played a vital technology development role for maintaining the global market position of the US semiconductor industry. The National Center for Manufacturing Sciences (NCMS) is another large scale industry collaboration devoted exclusively to manufacturing technologies, process, and practices. The Infotonics Technology Center is showing promise as a partnership of industry, universities, New York State and the federal government aimed at creating a state-of-the-art prototype and pilot fabrication facility to accelerate the commercialization of new products in the field of photonics and micro-systems. [4]

Federal funding for centers for production excellence should be catalytic. Long term sustainability requires leadership from industry and a combination of private sector and state and local government financing.

### 2. Refocus DOD research and procurement technology programs to support breakthrough technologies and speed up the deployment process.

DOD should work collaboratively with industry to reestablish its historic role as a sponsor of breakthrough technologies in 21st century manufacturing processes. These could include distributed and desktop manufacturing, quality inspection that is built into the production process, use of revolutionary materials and methods of fabrication, supply chain collaboration and devices and machines built at the nano scale. [5]A particular need is in breakthroughs in small-lot manufacturing, with the goal of becoming as efficient and cost competitive as mass production. DOD could help transition those manufacturing technology and process advances into the prototype and testing phases at DOD contractors. This would enable new approaches to be evaluated and later transitioned into a broad base of U.S. industry.

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[4] Allen, G. and Jarman R. *Collaborative R&D: Manufacturing's New Tool.* Wiley. 1999

[5] NACFAM Reports. *Defense Supply Chain Policy: Roundtable Discussion, September 2002* and *Contributions of and Issues Concerning Small and Medium Sized Manufacturers in the Defense Industrial Base.* June 2002

## 3. Encourage and support the development of voluntary, open and interoperable software standards to drive innovative applications for the extended production enterprise.

Greater interoperability of computing devices and software through open standards will benefit US trade, competitiveness, GDP growth and employment. Interoperability is no longer just a technical issue. Its real value is in meeting rising user expectations regarding the exchange and use of information and applications. [6] For example within the supply chain process, businesses are attempting to apply advanced software systems and algorithms to manage interactions transparently with information to reduce the "bull-whip" effect on inventory due to changes in supply and demand. The software industry which supports the extended production enterprises is moving from packaged software products to software as a service on the network. This transformation will profoundly affect the software industry itself and the industries which use such software to manage their business processes. Substantial productivity improvements can be gained as computing becomes more pervasive and interoperable in the extended production enterprise.

*"It is estimated that the adoption of computing into everyday objects such as consumer and industrial products will create a total savings of $70 billion in the United States and $155 billion internationally. The cost savings will come from areas such as improved visibility into the supply chain, theft reduction, and improved operations… The next phase of the software and Internet evolution will start to merge bits with atoms… The physical world and the virtual world will become increasingly connected as computing devices and physical objects of all kinds gain intelligence and the ability to communicate with the network via wired and wireless technologies and intelligent identification techniques."* Nicolas Evans, Business Innovation and Disruptive Technology: Harnessing the Power of Breakthrough Technology for Competitive Advantage

*Enterprise Integration Act of 2002*

In 2002 Congress took an important step in passing legislation authorizing the National Institute of Standards and Technology (NIST) to work with major manufacturing industries on standards development for electronic enterprise integration. The legislation was based on the finding that over 90 percent of United States companies engaged in manufacturing are small- and medium-sized businesses. Most of these manufacturers produce goods for assembly into products of large companies. The emergence of the Internet and the promulgation of international standards for product data exchange have greatly accelerated the movement toward electronically integrated supply chains. European and Asian countries are investing heavily in electronic enterprise standards development, and in preparing their smaller manufacturers to do business in new environment. Their efforts are well advanced in the aerospace, automotive, and shipbuilding industries and are beginning in other industries including home building, furniture manufacturing, textiles, and apparel.

***Open standards** are specifications that are openly documented and available, evolved collaboratively through standards organizations or by consensus in the commercial marketplace. The characteristics of openness when applied to standards are:*

- ***Published without restriction***
- ***Made feely available for adoption by industry***
- ***Controlled by an open industry organizations with a well-defined inclusive process for evolution of the standard***
- ***Implemented by offerings in the marketplace***

[6] Milbergs E., Kueter J. *Exploiting E-Manufacturing: Interoperability of Software Systems Used by US Manufacturers.* Prepared by National Coalition for Advanced Manufacturing. February 2001.

The 21st Century Innovation Working Group strongly endorses the objective of developing a common reporting format for sharing usability data with consumer organizations; determining software quality using automated and knowledge-based methods with industry partners; planning a shared manufacturing business to business interoperability test bed; improving software engineering processes and cooperating internationally in this field of knowledge.

No one set of standards will meet all legitimate needs. At the same time, a proliferation of incompatible software programs and on-line services is also a possibility with damaging consequences to the freedom to collaborate, productivity and competitiveness of small manufacturing enterprises. This would create severe operational problems for small to medium sized suppliers who do business with multiple customers. Lacking systems that are interoperable they frequently find themselves having to support several different proprietary software and hardware platforms. The lack of software interoperability adds substantial costs, operationally inefficiencies and lengthens the design to manufacturing development cycle.

The excess carrying cost of the lack of software interoperability in the auto supply chain is more than $1 billion. [7]The annual cost to U.S. industry of weakness in software testing is in the range of $60 billion per year. [8] Industry-led commitment and solutions are needed, but government can play an essential facilitating role in producing those solutions.

This issue needs to be addressed with some urgency to take advantage of a huge innovation opportunity. It is recommended that industry and government collaborate to:

- Create a neutral test-bed for open standards software and web based services designed for interoperability.
- Allocate increased R&D support for design of next generation interoperable computing and software platforms.
- Incorporate software interoperability standards into government and corporate procurement and e-commerce activities
- Promote adoption of open standards software through such mechanisms as the NIST Manufacturing Extension Partnership program and proposed pilot Innovation Extension Centers. *(See Recommendation below)*

## 4. Establish Prototype Innovation Extension Centers for Small Manufacturers

Innovation is a strategic imperative for small manufacturers if they are to avoid major disruption of their business as foreign competitors enter their market space and their larger business customers consider shifting production activity to overseas locations.

The time is right for establishing innovation as a new mission and focus for the NIST Manufacturing Extension Partnership network of 350 centers that has traditionally focused on providing technical assistance services in manufacturing operational efficiency and

[7] Brunnermeier, S., Martin, S. *Interoperability Cost Analysis of the US Automotive Supply Chain.* Prepared by Research Triangle Institute for National Institute of Standards and Technology. March 1999. p. ES-6.
[8] Research Triangle Institute report prepared for NIST. *The Economic Impacts of Inadequate Infrastructure for Software Testing.* May 2002

quality.[9] SMEs must become "adaptive" and capable of finding new competitive advantages by looking ahead for market changes, dominating niche markets and rapidly exploiting new technologies and service advantages. [10] Many resources available to SMEs are in regional colleges and universities, federal labs, small business development programs and financial communities. However, there is no common framework or process for integrating these resources at the right time and in the right quantity.

Department of Commerce should consider pilot testing the creation of prototype innovation extension centers to assist small manufacturers develop new innovation capabilities including how to identify emerging innovation opportunities working jointly with customers, new product design processes and tools, collaboration with larger enterprises on optimizing supply chains and logistics, application of advanced information technology tools and services, and financing of innovation strategies. Such innovation centers could assist small manufacturers navigate and integrate the resources of the federal government such as the SBIR programs and facilitate small business partnerships with federal laboratories, universities and venture capital community. If the prototype centers prove successful they could be scaled up to a nation wide network funded by federal, state, local and private sector. Such centers will enhance regional innovation clusters and expand opportunities for investments in R&D and commercial innovation.

## 5. Expand use of industry led technology roadmapping projects to define the next generation of innovation opportunities for the extended production enterprise and advise on federal R&D priorities.

Another section of the NII report makes the case for bolstering federal basic research support, encouraging high risk multidisciplinary research and providing more balanced investment across various disciplines including the physical sciences, engineering, mathematics, computer science, non-medical life sciences, environment sciences and the social sciences.

This shift is critically important to the future vitality of the extended production enterprise. We recommend that industry associations and sector based collaborations make greater use of ***technology roadmapping methodologies*** as an input to the federal R&D priority setting process. Technology roadmaps represent a consensus on where industries are likely to be heading and help identify the innovation trajectories, research needs, alternative scenarios and the possibility of disruptive technologies and surprises.

An exemplary roadmapping project, the biannual National Electronics Manufacturing Initiative (NEMI), identifies the 10 year outlook for key technology developments impacting the global electronics industry. This widely utilized roadmap helps OEMs, EMS providers and suppliers prioritize R&D and technology deployment investments, influence the focus university-based research and provide guidance for government R&D investment in emerging technologies.[11]

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[9] Reeder, F., et.al. *The Manufacturing Extension Partnership Program*. National Academy of Public Administration. May 2004. p. viii.-x

[10] Warren, A., Susman G. *Review of Innovation Practices in Small Manufacturing Companies.* Prepared by The Pennsylvania State University. 2004. See also: *Competing Against Manufacturing in Low Cost Regions: Focus on China.* Prepared by Stone & Associates, Inc. for NIST-MEP, Final Report. March 2004.

[11] http://www.nemi.org/roadmapping/index.html

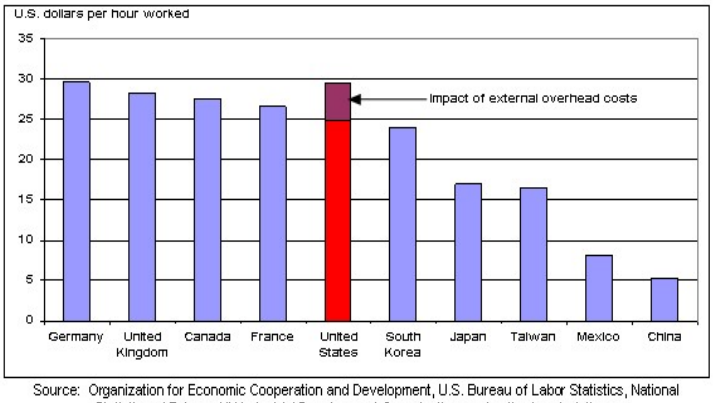
In the case of the nation's defense infrastructure such roadmaps can have a significant influence on the development and speed by which we deploy new intelligence gathering systems, weapons and technologies for homeland security. For manufacturers in the commercial marketplace properly focused federal research investment can provide the foundation for entirely new kinds of production processes, products and market opportunities. Research areas of high potential for manufacturers include nanotechnology, meson-scale manufacturing, engineered materials, pervasive computing, knowledge management, alternative energy systems and web based enterprise integration.

Collaborative road mapping exercises have significant advantages over individual company efforts. Companies can collaborate with customers and potential customers as well as suppliers and potential suppliers. It leverages the collective capabilities and expertise of industry without compromising confidential competitive information. By identifying where industry is going and what technologies, business practices and products it needs to get there, businesses can more effectively focus their investments in innovation toward customer needs and avoid costly mistakes. Through collaboration industry can better surface the range of strategic uncertainty and formulate innovation investments with less risk. Technology road mapping which is not narrowly formulistic can also reveal important intersections with complementary service sector technologies and provide forward looking insights on societal, environmental and public policy issues needing attention in the innovation and deployment process.

## 6. Consider strategies for reducing the burden of external overhead costs on manufacturing innovation and productivity improvement.

Rising external costs, not directly controllable by manufacturing firms, largely offset the US manufacturing advantage in innovation and productivity. External overhead costs from taxes, health and pension benefits, tort litigation, regulation and rising energy prices add approximately 22 percent to U.S. manufacturers' unit labor costs (nearly $5 per hour worked) relative to their major foreign competitors. The absolute value of the excess cost burden on U.S. manufacturers (nearly $5 per hour) is almost as large as the total cost index for China. [12] Taken together, external overhead costs offset a large part of the 54 percent increase in productivity realized since 1990. The study goes on to point out that all four of the top U.S. developing country trading partners (China, Mexico, South Korea and Taiwan) have dramatically increased their U.S. trade share since 1990 and are orienting themselves toward high-end manufactured goods such as industrial machinery, telecom equipment and office machines, and transportation equipment. A reduction in these external costs

**Raw Cost Position of the United States And Its Nine Largest Trading Partners, 2002**




Source: Organization for Economic Cooperation and Development, U.S. Bureau of Labor Statistics, National Statistics of Taiwan, UN Industrial Development Organization, and author's calculations.

[12] Leonard, J. *How Structural Costs Imposed on US Manufacturers Harm Workers and Threaten Competitiveness*. Prepared for the Manufacturing Institute of the National Association of Manufacturers. December 2003. p. 11.

would enhance US manufacturing global competitiveness and reduce the costs and future risks of innovation.

NAM makes the following recommendations:

- Reduce the corporate tax burden and reform the treatment of foreign-source income.
- Reduce the burden of rising health coverage costs and encourage greater consumer responsibility for health status and coverage costs.
- Reform rules for funding pension plans to avoid devastating cyclical swings in funding requirements.
- Undertake serious legal reform by curtailing frivolous lawsuits, placing large, nationwide class-action lawsuits in federal court, and negotiating fair and equitable compensation to legitimate asbestos claims.
- Establish a more objective cost-benefit review process for proposed and existing regulations that takes full account of adverse business impacts.
- Adopt changes in land-use regulations to allow access to undeveloped domestic natural gas reserves.

# NATIONAL INNOVATION INITIATIVE

## *A Guide to Implementing the Agenda*

***(version 1.1)***



**Strategies and Actions for:**

*Business*
*Universities and Colleges*
*State and Local Government*
*Federal Government*

**Prepared for:**
**PARTICIPANTS AT THE NATIONAL INNOVATION SUMMIT**
**Washington, DC**

# National Innovation Initiative

## A Guide for Implementing the Agenda

On December 15, 2004 the National Innovation Initiative (NII) released its final report **"INNOVATE AMERICA".** The report calls on all sectors of society to make a commitment to innovation as the single most important factor in determining America's prosperity through the 21st century. The challenge is to unleash the creativity, inventiveness and resources of business, government, workers and universities for the purpose of driving our future productivity, standard of living and leadership in global markets. A traditional response to the dynamic forces of global economic integration and technological acceleration will not be the best way forward. We must be more innovative and collaborative. The expertise and leadership of all sectors must become more engaged as interdependent participants in the innovation ecosystem. Implementation is a shared responsibility.

The NII recommendations are organized into three broad categories:

***Talent*** – the human dimension of innovation, including knowledge creation, education, training and workforce support. Recommendations support a culture of collaboration, a symbiotic relationship between research and commercialization, and lifelong skill development.

***Investment*** – the financial dimension of innovation, including R&D investment, support for risk-taking and entrepreneurship, and encouragement of long-term innovation strategies. Recommendations seek to give innovators the resources and incentives to succeed.

***Infrastructure*** – the physical and policy structures that support innovators, including networks for information, transportation, health care and energy; intellectual property protection; business regulation; and structures for collaboration among innovation stakeholders. Recommendations support an innovation infrastructure for the 21st century, a flexible intellectual property regime, strategies to bolster the nation's manufacturing enterprises, and a national innovation leadership network.



The following charts provide an innovation roadmap for leadership and action by Business, Universities and Colleges, State and Local Government and the Federal Government.

| INNOVATION CHALLENGES | Business Sector Leadership and Actions |
|---|---|
| ***TALENT Challenge***<br><br>Build a **National Innovation Education Strategy** for a diverse, innovative and technically-trained workforce<br><br>Catalyze the **Next Generation of America Innovators**<br><br>Empower **Workers to Succeed in the Global Economy** | Fund internships, fellowships and traineeship experiences exposing students to real-world business environments<br><br>Expand investment in employee lifelong learning opportunities to continuously upgrade work competencies.<br><br>Collaborate with universities and community colleges to develop curricula designed to teach innovation skills and provide problem-based experiential learning.<br><br>Enhance the portability of employee benefits including retirement, annuities, investment funds such as 401(k) plans, education and health savings accounts.<br><br>Promote an innovative organizational culture through recognition programs, incentives, collaborative learning, teamwork, interdisciplinary problem-solving and commercialization skills. |
| ***INVESTMENT Challenge***<br><br>Revitalize **Frontier and Multidisciplinary Research**<br><br>Energize the **Entrepreneurial Economy**<br><br>Reinforce **Risk-Taking and Long Term Investment** | Support long-term federal multidisciplinary research in the physical, engineering and services sciences.<br><br>Collaborate with business peers and government entities to create regional Innovation Hotspots.<br><br>Invest in qualified angel funds to support entrepreneurial ventures.<br><br>Consider incentive and compensation structures that encourage long term value creation and innovation.<br><br>Initiate standards for the voluntary disclosure of intellectual capital and innovation performance.<br><br>Educate financial analysts on technology trends, innovation performance and management practices.<br><br>Assess impact of new regulations on innovation through a public-private Financial Market intermediary Committee. |
| ***INFRASTRUCTURE Challenge***<br><br>Create **National Consensus for Innovation Growth Strategies**<br><br>Create a **21st Century Intellectual Property Regime**<br><br>Strengthen **America's Manufacturing Capacity**<br><br>Build **21st Century Innovation Infrastructures – the health care test bed** | Establish public-private partnerships to foster the growth goals and innovation needs of each business sector.<br><br>Partner with the public sector to develop a National Innovation Scorecard.<br><br>Support development of a private sector-led National Innovation Prize.<br><br>Participate in pilot projects to highlight techniques for leveraging patent data for discovery.<br><br>Identify best practices and processes for standards-setting bodies.<br><br>Establish privately-led Centers of Production Excellence, including shared facilities.<br><br>Foster open and interoperable standards for manufacturing and logistics systems.<br><br>Expand use of technology roadmapping to define innovation opportunities for the extended production enterprise.<br><br>Partner with government to build an integrated healthcare capability, interoperability standards, and pilot programs for international electronic exchanges for public health, research and health-care delivery. |

| INNOVATION CHALLENGES | University and College Leadership and Actions |
|---|---|
| ***TALENT Challenge***<br><br>Build a **National Innovation Education Strategy** for a diverse, innovative and technically-trained workforce<br><br>Catalyze the **Next Generation of America Innovators**<br><br>Empower **Workers to Succeed in the Global Economy** | Create innovative approaches to S&E education, fellowships, foreign student retention aimed at the scientific and technical skills needed in the US workforce.<br><br>Promote innovation culture through exposure to creative thinking and commercialization methods and give more weight in promotion policies for teaching creativity, inventiveness and innovation.<br><br>Develop curricula specifically designed to teach innovation skills and provide problem-based experiential learning.<br><br>Create Innovation Partnerships to bridge the traditional gap between the long-term discovery process and commercialization.<br><br>Fund internships for innovation –oriented student interested in local start-up and business environments.<br><br>Establish curricula to teach innovation management skills to managers from small business. |
| ***INVESTMENT Challenge***<br><br>Revitalize **Frontier and Multidisciplinary Research**<br><br>Energize the **Entrepreneurial Economy**<br><br>Reinforce **Risk-Taking and Long Term Investment** | Support long-term federal research investment, particularly, in physical, engineering and innovation related sciences and increase the proportion of future research to multi- and interdisciplinary research.<br><br>Recognize "services science" as a new academic discipline and partner with industry in developing curricula and training focused on services and enterprise transformation.<br><br>Collaborate with industry and government entities to create regional Innovation Hotspots.<br><br>Initiate research on methodologies for assessing the value of longer-term innovation strategies and risks. |
| ***INFRASTRUCTURE Challenge***<br><br>Create **National Consensus for Innovation Growth Strategies**<br><br>Create a **21st Century Intellectual Property Regime**<br><br>Strengthen **America's Manufacturing Capacity**<br><br>Build **21st Century Innovation Infrastructures – the health care test bed** | Conduct research on improving innovation metrics including definitions, data quality, surveys and models on an international basis.<br><br>Participate in pilot projects to highlight techniques for leveraging patent data for discovery.<br><br>Provide research and educational support to privately-led Centers of Production Excellence, including shared research facilities.<br><br>Conduct software research in support of open and interoperable standards for the extended production enterprise.<br><br>Improve technology roadmapping methodologies to help industry and government identify the next generation of innovation opportunities.<br><br>For Universities with health care facilities, partner with industry and government to create an integrated healthcare capability and undertake research on applying industrial engineering to healthcare delivery. |

| INNOVATION CHALLENGES | State and Local Government Leadership and Actions |
|---|---|
| ***TALENT Challenge***<br><br>Build a **National Innovation Education Strategy** for a diverse, innovative and technically-trained workforce<br><br>Catalyze the **Next Generation of America Innovators**<br><br>Empower **Workers to Succeed in the Global Economy** | Catalyze Innovation Partnerships to bridge the traditional gap between the long-term discovery process and commercialization and tailor resources to capture regional interests and economic clusters.<br><br>Fund internships for innovation –oriented student interested in local start-up and business environments.<br><br>Create Local and regional innovation synergies through incentives for interaction between small business and educational resources.<br><br>Clarify regulations affecting annuities and offer tax incentives to make annuity options more attractive to employees and employers.<br><br>Encourage the widespread availability of Health Savings Accounts, including affordable options for low-income workers. Define a role for government reinsurance to reduce the cost of employer-provided coverage.<br><br>Champion more flexibility under federal state employment and training programs to direct resource toward high performance programs, high-growth skills and skills in demand by local firms. |
| ***INVESTMENT Challenge***<br><br>Revitalize **Frontier and Multidisciplinary Research**<br><br>Energize the **Entrepreneurial Economy**<br><br>Reinforce **Risk-Taking and Long Term Investment** | Collaborate with industry and government entities to create regional Innovation Hotspots and raise funds and develop proposals to operate pilot national innovation centers.<br><br>Develop a promotional effort to educate local foundations about the beneficial impact of asset investments in entrepreneurial ventures. .<br><br>Enhance the legal and regulatory framework and "safe harbor" provisions to encourage the disclosure of longer-term innovation strategies.<br><br>Develop state and local explicit innovation agendas to complement federal innovation initiatives.<br><br>Systematically collect real time data on state and regional innovation performance. |
| ***INFRASTRUCTURE Challenge***<br><br>Create **National Consensus for Innovation Growth Strategies**<br><br>Create a **21st Century Intellectual Property Regime**<br><br>Strengthen **America's Manufacturing Capacity**<br><br>Build **21st Century Innovation Infrastructures – the health care test bed** | Support formation of privately-led Centers of Production Excellence to accelerate commercialization.<br><br>Establish prototype innovation extension centers to help SMEs become first tier partners in the extended production enterprise.<br><br>Lead in the early adoption of new health care technology, electronic reporting and exchanges.<br><br>Expand the use of performance-based purchasing agreements to reduce medical errors and achieve better health outcomes.<br><br>Conduct software research in support of open and interoperable standards for the extended production enterprise.<br><br>Improve technology roadmapping methodologies to help industry and government identify the next generation of innovation opportunities.<br><br>For Universities with health care facilities, partner with industry and government to create an integrated healthcare capability and undertake research on applying industrial engineering to healthcare delivery. |

| INNOVATION CHALLENGES | Federal Government Leadership and Actions |
|---|---|
| ***TALENT Challenge***<br><br>Build a **National Innovation Education Strategy** for a diverse, innovative and technically-trained workforce<br><br>Catalyze the **Next Generation of America Innovators**<br><br>Empower **Workers to Succeed in the Global Economy** | Establish tax-deductible "Invest in the Future" scholarships for American S&E undergraduates (Treasury).<br><br>Create 5,000 new portable graduate fellowships funded by federal R&D agencies (NSF and other agencies).<br><br>Expand university-based Professional Science Masters and traineeships to all state university systems (NSF).<br><br>Fund pilot efforts to create innovation-oriented learning environments in K-12 and higher ed (NSF).<br><br>Reform immigration to attract the best and brightest S&E students from around the world (Homeland Security).<br><br>Stimulate workforce flexibility and skills through lifelong learning opportunities (Labor).<br><br>Accelerate portability of health care and pension benefits (Labor, HHS)<br><br>Align skills needs more tightly to training resources and expand assistance to dislocated workers. (Labor) |
| ***INVESTMENT Challenge***<br><br>Revitalize **Frontier and Multidisciplinary Research**<br><br>Energize the **Entrepreneurial Economy**<br><br>Reinforce **Risk-Taking and Long Term Investment** | Establish "Innovation Acceleration" grants that re-allocate 3 percent of agency R&D budgets. (R&D Agencies).<br><br>Direct 20 percent of the Defense Department S&T budget to long-term research (DOD).<br><br>Intensify support for physical sciences and engineering (Federal R&D agencies).<br><br>Enact a permanent, restructured R&E tax credit and extend the credit to university-industry consortia (Treasury).<br><br>Designate lead agency and inter-agency council to coordinate economic development policies (Commerce).<br><br>Increase the availability of early-stage risk capital with tax incentives and expand angel networks (Treasury). .<br><br>Create safe-harbor provisions to promote voluntary disclosure of intangible assets (SEC).<br><br>Reduce the cost of tort litigation from 2 percent to 1 percent of GDP.<br><br>Convene a Financial Markets Intermediary Committee to evaluate the impact of new regulations on risk-taking. |
| ***INFRASTRUCTURE Challenge***<br>Create **National Consensus for Innovation Growth Strategies**<br><br>Create a **21st Century Intellectual Property Regime**<br><br>Strengthen **America's Manufacturing Capacity**<br><br>Build **21st Century Innovation Infrastructures – the health care test bed** | Enact a federal innovation strategy through the Executive Office of the President (White House).<br><br>Build quality in all phases of the patent process (Commerce).<br><br>Leverage patent databases into innovation tools (Commerce).<br><br>Conduct research and create a test bed for open and interoperable software standards (Commerce).<br><br>Create Innovation Extension Centers to enable SMEs to become first-tier manufacturing partners (Commerce).<br><br>Expand electronic health reporting (HHS).<br><br>Establish pilot programs for international electronic exchanges on healthcare research and delivery (HHS). |

# The National Innovation Agenda by Lead Action Responsibility

| Federal Government | State/Local Government | Universities and Colleges | Business |
|---|---|---|---|
| · Establish tax-deductible private-sector "Invest in the Future" scholarships for American S&E undergraduates | · Build 10 Innovation Hot Spots over the next 5 years to capitalize on regional assets and leverage public-private investments | · Establish innovation curricula for entrepreneurs and small business managers | · Develop new metrics to understand and manage innovation more effectively |
| · Empower young American innovators by creating 5,000 new portable graduate fellowships funded by federal R&D agencies | · Expand use of performance-based purchasing agreements | · Stimulate creative thinking and innovation skills through problem-based learning in K-12, community colleges and universities | · Create centers for production excellence including shared facilities and consortia |
| · Expand university-based Professional Science Masters and traineeships to all state university systems | | · Create innovation learning opportunities for students to bridge the gap between research and application | · Catalyze national and regional alliances to implement innovation policies and innovation-led growth |
| · Reform immigration to attract the best and brightest S&E students from around the world and provide work permits to foreign S&E graduates of U.S. institutions | | | · Foster development of industry-led standards for interoperable manufacturing and logistics |
| · Stimulate workforce flexibility and skills through lifelong learning opportunities | | | · Expand industry-led roadmaps for R&D priorities |
| · Accelerate portability of health care and pension benefits | | | · Create best practices for collaborative standards setting |
| · Align federal and state skills needs more tightly to training resources | | | · Align private-sector incentives and compensation structures to reward long-term value creation |
| · Expand assistance to those dislocated by technology and trade | | | · Establish National Innovation prizes to recognize excellence in innovation performance |
| · Stimulate high-risk research through "Innovation Acceleration" grants that re-allocate 3 percent of agency R&D budgets | | | |
| · Restore DoD's historic commitment to basic research by directing 20 percent of the S&T budget to long-term research | | | |
| · Intensify support for physical sciences and engineering to achieve a robust national R&D portfolio | | | |
| · Enact a permanent, restructured R&E tax credit and extend the credit to research conducted in university-industry consortia | | | |

| | | | |
|---|---|---|---|
| · Designate a lead agency and an inter-agency council to coordinate federal economic development policies and programs to accelerate innovation-based growth<br>· Increase the availability of early-stage risk capital with tax incentives, expanded angel networks, and state and private seed capital funds<br>· Create safe-harbor provisions to promote voluntary disclosure of intangible assets<br>· Reduce the cost of tort litigation from 2 percent to 1 percent of GDP<br>· Convene a Financial Markets Intermediary Committee to evaluate the impact of new regulations on risk-taking<br>· Enact a federal innovation strategy through the Executive Office of the President<br>· Build quality in all phases of the patent process<br>· Leverage patent databases into innovation tools<br>· Create Innovation Extension Centers to enable SMEs to become first-tier manufacturing partners<br>· Expand electronic health reporting<br>· Establish pilot programs for international electronic exchanges on healthcare research and delivery | | | |