Innovation Vital Signs Project

Final Report

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Executive Summary

This report, prepared by the IVS project team assembled by ASTRA, is a synthesis of work that was performed in pursuit of the objective of identifying what we termed the Innovation Vital Signs of the US economy. The activities performed in pursuit of this goal were:

1) the development of an innovation framework that provides a foundation for understanding the processes and interrelationships of the innovation ecosystem,
2) performance of a comprehensive survey of public and private sector innovation indicator sources,
3) development of a systematic database of innovation indicators including an analysis of the utility and quality of available indicators, and
4) conduct an Innovation Vital Signs Workshop in which parties with an interest in innovation and innovation measurement were invited to a day-long session focused on reviewing the work done by the IVS team and providing their expertise in identifying strengths and gaps in the current system of innovation measures that they were familiar with. .

The deliverables provided by the project are:

- the IVS innovation framework
- the results of the survey of publicly available reports and databases
- the results of the survey of privately-developed available reports and databases that are potentially available to use as components of the Innovation Vital Signs
- a classification of indicators/databases according to the elements of the innovation framework
- a structured and working set of criteria for assessing the utility and quality of innovation indicators for potential inclusion into the potential series of ranked innovation vital signs
- a scoring of both the public and private indicators against the criteria and summarizing and analyzing the results of the scoring exercise
- a summary of the results into a provisional set of IVS indicator candidates for future analysis and review
- a detailed summary of the activities and conclusions of the Innovation Vital Signs workshop that was conducted as part of the project
- a review of approaches that might prove useful in presenting the Innovation Vital Signs in an innovative visualization format in order to provide observers and analysts with a mechanism to more easily understand the trends and drivers that are captured in the innovation vital signs data.

Based on our compilation of a sample of 52 public indicator sources and 95 private indicator sources, our analysis provides evidence of patterns, commonality, and variability in how innovation environments are being measured. Over 3200 indicators were reviewed as potential candidates for inclusion as innovation vital signs.

Our survey did not seek to identify a single, all-purpose innovation indicator. Instead, it is clear from the analysis that there is not a commonly accepted framework for innovation indicators based on a widely accepted innovation theory. Rather, the lack of such a widely accepted theory is just another milepost indicating that the interest in innovation has not yet reached a state where there is a single unifying theory. Instead, the survey reveals that innovation is a very complex activity with many dimensions, a fact that makes the need to develop a better understanding of innovation that much more important.

One of the abiding conclusions reached as a result of this work is that any potential innovation indicator is a statistic and, at best, provides only a partial and limited view of the innovation process. Our work has reinforced the notion that, like human health, there is no single indicator that properly captures the complexity of the process of innovation. This is hardly a surprise. What was surprising is that of the literally thousands of indicators that have been sorted through in the pursuit of this project, there are indeed only a very limited number for which there can be said to be a strong connection to the measurement of innovation.

While there are many that can be dragooned into service as indicators of innovation, the fact that these data series were not compiled with the measurement of innovation in mind is problematic. Using such indicators for the purposes of qualifying and quantifying innovation is a bit like having only a flat head screwdriver in one's toolkit. While it works well for the purposes for which it was created, a flat head screwdriver is problematic when faced with a Phillip head screw. What is needed is a full tool kit with the right tools for all the jobs that are going to need to be done.

A partial answer to this problem is the growing interest in combining innovation indicators to form aggregate and composite measures. Such combinations of indicators are frequently presented as rank order benchmarking devices, seeking to compare one country, region, or other organization against other comparable organizational units. However, to arrive at such rankings it is necessary to make choices as to which indictors to include, how to introduce weighting factors, etc. to create and utilize an algorithm for calculating specific result for a family of indicators.

The focus of this project was not in that direction. Rather, this project aimed to identify and categorize existing indicators into a framework that would serve as the foundation for establishing a structure of benchmarks and trend data that would enable an understanding of the health and vitality of the nation's innovation ecosystem. Having performed the analysis, it is our conclusion that, while not ideal, the underlying thesis of the work has been proven. There are currently-available indicators that can be compiled into a 'vital signs' structure that can serve as the foundation for:

1) understanding the factors that drive innovation
2) determining whether our national innovation performance is improving or declining
3) establishing the relative position of the US versus our global competitors in terms of the health of the innovation ecosystem that is understood to be a key component of the nation's economic future.

The ability to do this is underscored by the work performed in this project. Finding the time and devoting the required resources are the next issue. From an informed public policy perspective, it would be desirable to fill the gap in understanding that currently exists. The work in this project points to several activities that might be pursued as first steps in moving toward that objective.

Introduction

This report introduces a framework for describing the "national innovation ecosystem" and for guiding the development of a structured system for capturing data, and routinely reporting, on what we call **Innovation Vital Signs (IVS)**. The purpose of such a system is to provide policymakers a tool to evaluate the nation's innovation capabilities and performance, and better assess policy choices and potential impacts.

The framework takes a multi-dimensional and comprehensive view of innovation and recognizes the importance of:

- both technology push (inputs), the innovation practices of enterprises and outputs of the innovation process and ultimate national impacts.
- the context in which innovation takes place including the macroeconomic conditions, the public policy environment, infrastructure, and the national mindset for innovation.
- changes in the nature of innovation including globalization of innovative activity, business models for managing innovation, new types of innovation, service sector innovation, entrepreneurial activity and variations in the diffusion/adoption rates for innovation.

The report also stresses that the current inventory of indicators and measurement methods does not adequately describe, in a timely manner, the dynamics of innovation today. Innovation policy for the coming century will require new indicators, new data collection and integration methods, and sophisticated visualization tools, to enable understanding the more subtle, qualitative and interactive elements of innovation, a greater recognition of service sector innovation, and coming to terms with how the demand for innovation is created.

> **Innovation is a process by which value is created for customers through public and private organizations that transform new knowledge and technologies into profitable products and services for national and global markets. A high rate of innovation in turn contributes to more intellectual capital, market creation, economic growth, job creation, wealth, and higher standard of living.**

A dramatic change in the approach to innovation is required if we wish to sustain our competitive advantage. Doing so will require a transition to a globally integrated economy, and an innovation-driven economy capable of routinely developing and commercializing "new-to-the-world" technologies. This new growth opportunity cannot be realized with traditional methods such as increasing R&D inputs. It has to be broadened to include new business models and value creation as main drivers, and a new basis for describing the contextual conditions in which innovation operates and flourishes. The framework offered in this report integrates the fundamental change in innovation practices from the previous closed, static, linear and individualistic perspective into a multidimensional, dynamic approach that is capable of staying abreast of the demands of a global economy.

1) Defining Innovation

Innovation is a key contributor to achieving our national goals—economic growth, competitiveness, comparative advantage, national security, and a higher standard of living. According to leading economists, nearly half of US total factor productivity growth is accounted for by technological progress, investment in innovation and the skills and experience of the workforce (Solow, Kendrick, Denison, Romer, Kuznets and Jorgenson). Cross-country 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 results in new products and services, gives rise to new markets, generates growth for enterprises, and creates customer value. 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 productivity growth, long-term wealth creation and higher living standards.

Prominent study groups and experts (e.g. PCAST, National Academies, National Innovation Initiative) have recommended improving innovation indicators, models and policy frameworks to better reflect the global, knowledge based, networked economy.

Like human health, no single measure captures innovation's multiplicity of features. We need to know more about knowledge production and utilization, technology transfer, standards, entrepreneurship, services innovation, general purpose technologies, public policy impact, innovation infrastructure and relating these factors to economic growth, standard of living, productivity and global competitiveness.

The Innovation Vital Signs project will generate a bounded set of input, process and output indicators to track national innovation and competitive performance and to better inform policy implications and impact.

Policymakers will have more insight on how to ensure that the US remains the most fertile and attractive environment for innovation in the world.

Innovation as an Ecosystem

Innovation is not a singular and independent activity but is more appropriately described as a multi-dimensional system of interacting factors, processes and agents. This paper aims to build a consensus framework to help assess and organize the vast array of innovation indicators and to better understand the dynamics of our "national innovation ecosystem." The framework serves as a mapping tool for guiding the development of a system for compiling and reporting on the multiple data series that we expect to identify as Innovation Vital Signs.[1]

[1] The framework builds on the work of the National Innovation Initiative, Council on Competitiveness, *Innovate America*, December 2004

Entrepreneurs and innovating enterprises are the prime agents for transforming knowledge and commercializing products, services and processes. Our new understanding of innovation, however, rejects the idea that innovation simply flows from some earlier process of scientific discovery. Innovation is not just a linear process that unidirectionally proceeds from science to the enterprise and then the marketplace. The framework here goes beyond knowledge creation (invention) and emphasizes the many additional factors that drive the transformation of knowledge into useful products and services and value for society.

In fact innovation is non-linear and increasingly a global, multidisciplinary, distributed, and interactive activity. Successful innovation draws on many non-technical activities such as organizational design, training, financial engineering, marketing, customer relationships, etc. When today's modern enterprise innovates it rarely does it with only its own internal resources. Innovation is process in which enterprises interact with the external environment. They may draw on universities for intellectual property and talent, on the financial resources of venture capitalists, on the skills of other firms, consultants and suppliers and even source product development from customers. Said another way innovation occurs in the context of an innovation ecosystem, a system made of many players, connections and linkages between customers, suppliers government, education, research, and other economic actors.

Therefore for a framework to be useful for monitoring innovation performance it needs to be balanced across a variety of domains and recognize that more than innovation inputs come into play. We note that no framework can be definitive and final. The framework will always be a work in progress. Innovation and how we describe and measure it is inherently dynamic and constantly evolving.

Defining Innovation

No standard definition of innovation exists. Earlier definitions tended to have narrow focus on the specific characteristics of an innovative product or service. Over time these definitions have broadened to include how organizations innovate. Today's definitions describe innovation as a system and the context in which an innovation operates. Some examples of definitions are below.

Innovation Definitions
Innovation is "the commercial or industrial application of something new—a new product, process or method of production; a new market or sources of supply; a new form of commercial business or financial organization." Schumpeter, Theory of Economic Development
Innovation is the intersection of invention and insight, leading to the creation of social and economic value. Innovate America, National Innovation Initiative Report, Council on Competitiveness, 2004)
Innovation covers a wide range of activities to improve firm performance, including the implementation of a new or significantly improved product, service, distribution process, manufacturing process, marketing method or organizational method. European Commission, Innobarometer 2004, November 2004
Innovation—the blend of invention, insight and entrepreneurship that launches growth industries, generates new value and creates high value jobs. Ahead of the Curve, The Business Council of New York State, Inc. 2006
The design, invention, development and/or implementation of new or altered products, services, processes, systems, organizational models for the purpose of creating new value for customers and financial returns for the firm. *Measuring Innovation in the 21st Century Economy Advisory Committee, Department of Commerce. Federal Register Notice, April 13, 2007,*

Innovation Definitions (continued)
An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations. Innovation activities are all scientific, technological, organizational, financial and commercial steps which actually, or are intended to, lead to the implementation of innovations. Oslo Manual, 3rd Edition, OECD
Innovation success is the degree to which value is created for customers through enterprises that transform new knowledge and technologies into profitable products and services for national and global markets. A high rate of innovation in turn contributes to more market creation, economic growth, job creation, wealth and a higher standard of living. 21st Century Working Group, National Innovation Initiative, 2004

The definitions above update our perspective on innovation. To generate real economic benefits, the nation must not only generate fresh ideas and intellectual property, but also innovate across many technical and non-technical dimensions to be globally competitive and commercially successful.

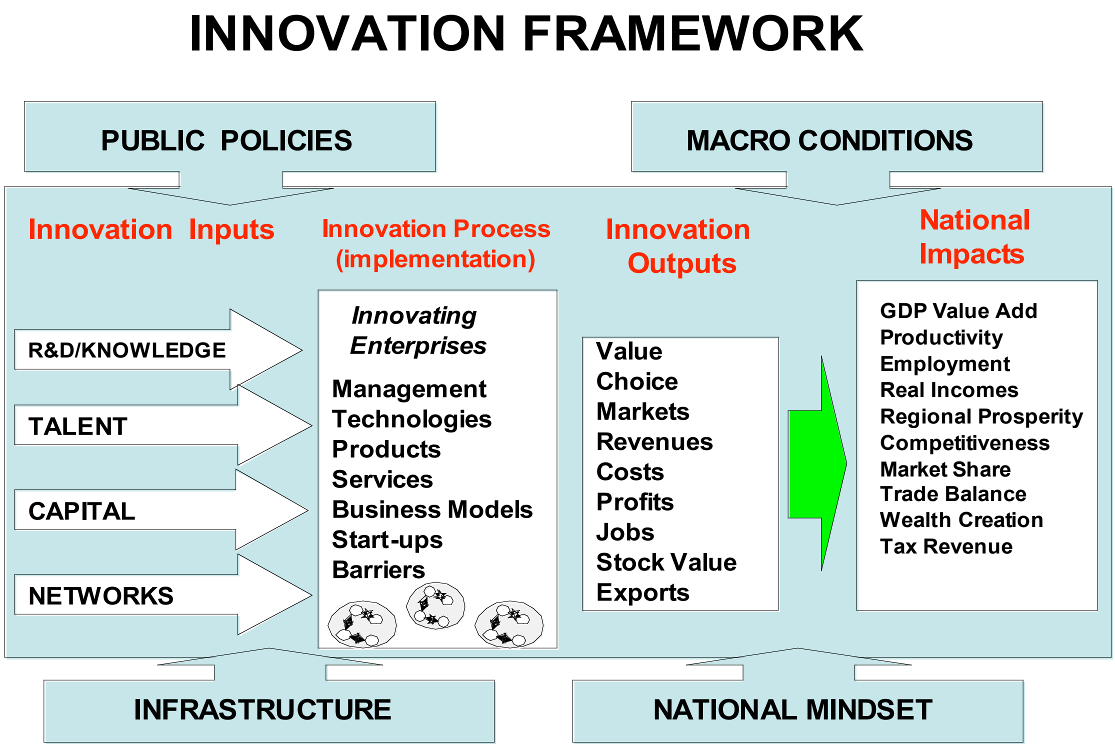
Designing the Innovation Framewwork

The *"function of a framework is to help guide data collection and analysis of the fundamental determinants of innovation and performance"* (Mowry 1997)

An innovation framework can be constructed at a number of levels of abstraction and detail—from an individual technology project, to the enterprise, to the industry sector, to the national and even global level. The following framework extends the traditional linear chain model to the innovation process and enlarges it to incorporate all aspects of society, thus creating a comprehensive "national innovation ecosystem". Despite a national outlook, it retains its focus on the enterprise level, and clusters the most important innovation factors into the following dimensions.

- Innovation input factors such as R&D, talent, capital, patents, and scientific publications.
- Innovation process (implementation) factors such as number of innovation based start-ups, ideas in the pipeline, product development cycle time, management strategy/practices, type of business model, alliances/collaborations, internationalization of innovative activity, and barriers to commercialization.
- Innovation output factors such as new products commercialized, market penetration and growth, cost reduction, profits, revenues and value to customers.
- Economic impact factors such as growth, employment, productivity, standard of living, competitiveness and global market share.
- In addition to factors directly related to innovation four contextual domains are identified. These contextual factors influence the rate and direction of innovative activity.
- Macro-economic conditions such as fiscal/monetary environment, interest rates, global economic growth rates, demographics.
- Public policy conditions such as R&D funding policy, taxes, intellectual property, regulations, standards and market access policies.
- Innovation infrastructure conditions such as university research infrastructure, federal labs, capital markets, power and transportation systems, regional clusters.
- National Mindset -- This domain includes public attitudes to science, cultural factors, and political issues related innovation.

These dimensions, individually and as an ecological system, make up the context in which the nation's enterprises innovate. The Figure below is a graphical representation of this ecosystem. A detailed discussion of its key elements appears below the diagram.



Innovation Inputs

The range, scope and effectiveness of innovation strategies will depend on the type, quantity and quality of key innovation resources (inputs), the most important of which are:

Research and development: funding, intellectual property, patents, scientific publications.

Talent: human capital, education, competencies, experience. Mobility and flexibility of the workforce are an important innovation input.

Capital: access to financing, particularly risk and entrepreneurial capital.

Networks: knowledge communities, linkages, collaborations, public/private relationships, social capital.

Such innovation inputs can differ across various disciplines, regions and types of innovation —incremental, disruptive, system integration and platform technologies.

Innovation Processes (Implementation)

This dimension focuses on innovating enterprises whether established or entrepreneurial start-ups. Innovation implementation is the capability to fuse customer requirements (presently and in the future) with the innovation resources it can access, develop, and exploit. Innovation can be of a non-technological nature involving business process reengineering, training, cultural change, reorganized information systems, and redeployment of assets. Management practices, organizational factors, and barriers in technology development and commercialization are among a series of other important considerations. The general implementation process consists of market definition, design, engineering, production, marketing, distribution, and support phases. These activities can be viewed as linear steps, but the reality in most cases is much more complex. For each phase of the process there are numerous sub-processes, both internal and external to the enterprise, involving feedback loops and the coupling of each activity to downstream and upstream phases. Technical and economic problems that are uncovered in the development process often generate demand for additional research in engineering and even fundamental science.

Innovation Outputs

This dimension of the framework addresses the outputs of innovative activity. This domain also surfaces some of the more complicated and elusive measurement issues.

> ***Private enterprise innovation outputs*** Innovation's contribution to enterprise output can be measured by sales and profits contributed by new products/services, change in market share, and intellectual property licensing revenues. Intangible outputs, such as an increase in a firm's knowledge stock and acquired competencies in managing innovation, organizational learning and adaptiveness is more subjective and difficult to quantify. Yet these subjective factors are strategically significant to long-term competitive performance.
>
> ***Customer value outputs*** The diffusion and adoption of new products and services by customers (business and consumers) is the centerpiece of innovation policy and strategy—where the supply of innovation meets the demand for innovation. The rate of customer adoption (diffusion) is what ultimately determines the impact of innovation on the national economy. Customers adopt innovation not just because of the inherent characteristics of a product or service innovation, but rather by the value expected when innovations are acquired and utilized. People do not buy products; they buy expectations of future benefits (Leavitt 1969).
>
> ***Product impact*** relates to the functionality, range and performance of the innovation in terms of improving customer utility and performance. Product impact could deal with the range of goods or service, creation of new markets and revenues and improvements in quality. Process impact relates to reduced costs, improved production flexibility, and increased productivity and capacity. Service impact relates to more intangible factors such as timing and scheduling of delivery, convenience, technical support, training, brand image, safety, environmental impacts and compliance with regulations.

The intersection of "innovation producers" with "innovating customers" is an important driver of economic growth and productivity. In this relationship the innovation output of one enterprise becomes part of the innovation input to another enterprise, creating a virtuous cycle with a powerful multiplier effect. An example of this powerful dynamic is the high rate of innovation in semiconductors (Moore's Law), which in turn helped drive the innovativeness of the PC business, which in turn became an important driver of the software business, which fed back as a driver of the PC business and so on.

Gauging the value of innovation to customers, including 'intangible' variables (e.g., convenience, service support, training, testing, and observability as well as product performance) is an important consideration for accelerating the rate of innovation diffusion, creating market growth, and generating downstream (spillover) economic benefits.

National Innovation Impact

Growth in real GDP and GDP per capita are the conventional measure for the overall contribution and impact of innovation. Some other measures that are useful include labor and total factor productivity, employment growth, income per capita, sectoral trade balances, corporate earnings associated with innovation, stock market valuations, global market share, and penetration of markets.

Innovation Contextual Factors

Four additional factors are considered below. The innovation activities and outputs discussed above require, and are influenced by, important contextual factors. These factors are outside the domain of private sector control and often require public policy action of a long-term nature.

Macroeconomic Conditions The innovative activities of enterprises depend in large part on perceptions of the overall national and global economy and expectations for the future. The risk profile for innovation and expected benefits are linked to macro-economic conditions in domestic and foreign markets, cost of capital (interest rates), currency valuation, and access to markets. How these macroeconomic conditions are perceived by enterprises and influence innovative behavior may vary considerably depending on the industrial, regional and technological sector.

Innovation Infrastructure The nation's innovation infrastructure helps supply inputs to private enterprises. This infrastructure that can be substantially shaped by public policies and investment includes:

- Information infrastructure
- Regional innovation clusters
- Scientific and research institutions
- Capital providers and markets
- Education institutions

Additional discussion of the specific characteristics of each of these factors appears in the discussion of contextual factors presented in Section 2 of this report.

National Mindset Public attitudes to science, technology and innovation and how the media circulates and amplifies innovation-related information can affect political debate, influence public policy choices, stimulate career choices in science and engineering and foster public/private investment in innovative activity.

Public Policy Environment The public sector is linked to the innovation process in powerful and deep ways. R&D funding from the public sector accounts for a substantial portion of national R&D investment. The choices of government in supporting a field of science (e.g., life science, nanotechnology, advanced computing) influence the direction of innovative activity. However, R&D is only one area of public policy that bears on innovation. Table 1.1 below illustrates the extensive range of public policies impacting innovation and the diverse ways these policies can stimulate or inhibit innovation.

Table 1.1 - 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 Policy	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. Standards can also function as a barrier to technical change and can restrict markets. Governmental and other bodies are becoming increasingly aware of the power of standards and their critical role in the development of new technologies and new markets. Failing to pay appropriate attention to the need to stay up to date on standards, or adopting standards that are not in synch with global markets, can be extremely costly to a nation's welfare
Procurement	Government can stimulate market and standards development through large-scale aggregation. Design specifications can restrict the introduction of new technologies.
Antitrust	Can encourage industry innovation collaboration. Encourages new market entrants. Significant to this effort is the need to update policies with a focus on emerging global market and the fact that national antitrust policies may be moot in an environment that is increasingly fragmented in terms of points of value add, and increasingly distributed in terms of supply chains and the opportunity to impact economic outcomes without regard for national boundaries.
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 technologies that have the potential for significant impacts in care and treatment of disease, but equally as large an impact in the prevention and avoidance of disease.

Table 1.1 - Public Policy Impact on Innovation (continued)

Public Policy	Examples of Innovation Impact
Privacy	Public concern creates additional demand for protecting information flows and assets. There is a confluence of needs (both commercial and public sector issues) and enabling technologies that provide answers to these needs, but there are continuing concerns about the potential to have new enablers be abused. Such abuse includes public sector appropriation of private records, private sector misuse of the data, and the ever present threat of criminal access to data and the fraudulent use of individuals' private/confidential records.
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 & Trade Policy	Globalization trends can create political pressures and add to protectionist risks, constraints on global investment, "buy America" provisions. Labor, environmental and health standards can disrupt employment and investment patterns.

2) Process of Compilation of Public Sector Indicators

Public Sources of Innovation Indicators

To develop our inventory of innovation indicators we conducted a comprehensive survey of public reports. As reports where identified we categorized them as to their perspective or point of view—whether the perspective was primarily of a global, national regional or enterprise level. See *Table 1* below. Appendix 1 is a complete list of reports in the public indicator survey. [2]

Perspective	Brief Description	Reports in Survey	Examples of Sources
Global	This compilation refers to indicators of global innovation activity and indicators that are compiled at the global level for purpose of making consistent international comparisons.	18	**OECD** **World Bank** **IMD**
National	Typically in-depth indicators collected within national boundaries spanning research spending to education to productivity to employment to international trade competitiveness. These statistics are frequently gathered as an extensive time series and can be used to correlate activities from one dimension to another. Many indicators were originally designed to track economic performance, but can be adapted to better understanding innovation performance.	10	**NSF** **BEA** **BLS**
Regional	The regional indicators are those related to what some term as economic clusters. Typically these indicators are designed at the sub-national level (e.g. state, regional, metropolitan and city level) In some cases regional indicators can also be defined as being multi-state and multi-national data structures, take for example the Baltic states as an area of interest. These indicators are being collected and compiled in a way that differentiates the region innovation activity from averaged national indicators	15	**ASTRA** **Silicon Valley** **Massachusetts**
Enterprise	These are typically indicators related to the activities of a given business or industry. Indicators of enterprise activity are a key determinant of overall innovative capacity and capability. While sounding relatively simplistic it gives rise to the question, what it is an enterprise? More innovation activity is now occurring outside the enterprise than internally. In general, there is little hard data that is consistent over time and comparable across industries and the size of an enterprise — whether the enterprise is a multinational corporation or a single entrepreneur operating out of the proverbial garage.	9	**Canada** **Denmark** **New Zealand**

[2] Advocacy reports that used indicators specifically directed to policy change were excluded from the sample. (The relationship of indicators to support policy change is a subject of separate inquiry)

Sources of Private Sector Indicators

The other category of indicators that we surveyed for this analysis are the so-called *private sector indicators. These indicators* consist primarily of industry or occupational statistics compiled by organizations with a particular interest in a narrow slice of overall economic activity.

These sources of this private-sector data can be broken out into two primary categories. The first of these are the trade and professional associations and societies that compile a wide variety of information on trends and events on behalf of their membership. Much of the data compiled by these types of organizations is in the realm of *market information* based on production or sales or orders for goods and/or services within a given economic sector.

Consulting companies and market research firms compile the other primary source of information produced by the private sector. The data compiled by these organizations tends to be equally, if not more, specialized than the data collected by the trade and professional organizations. Much of what is collected and examined relates to specific slices within the industry sectors that are identified, and product groupings that are very narrowly defined. These groups also frequently compile benchmark data within the industries that they examine. Such data is useful in making year to year and intra-industry comparisons based on the size of organizations and the types of specific product sub-sectors they operate in. This is base information that generally is not available from government sources. As such, those who compile and publish the data have a greater degree of freedom and latitude in what they choose to report, and what they consider to be important to their industry and/or constituents. And because the information is also frequently end market oriented, the data collected by these organizations tends to be far more timely overall than that which is collected by government sources.

Also worth mentioning is the fact that the data is frequently considered highly valuable to the organizations receiving it because it tends to be used for determining things such as the condition of specific markets, the state of the economy within the industry sub sector, and the individual reporting firms' share of the markets in which they compete. Because of this perceived and real strategic value, the organizations compiling the data tend to be responsive to contributors' new ideas and suggestions, much more so than is the case for most government data programs.

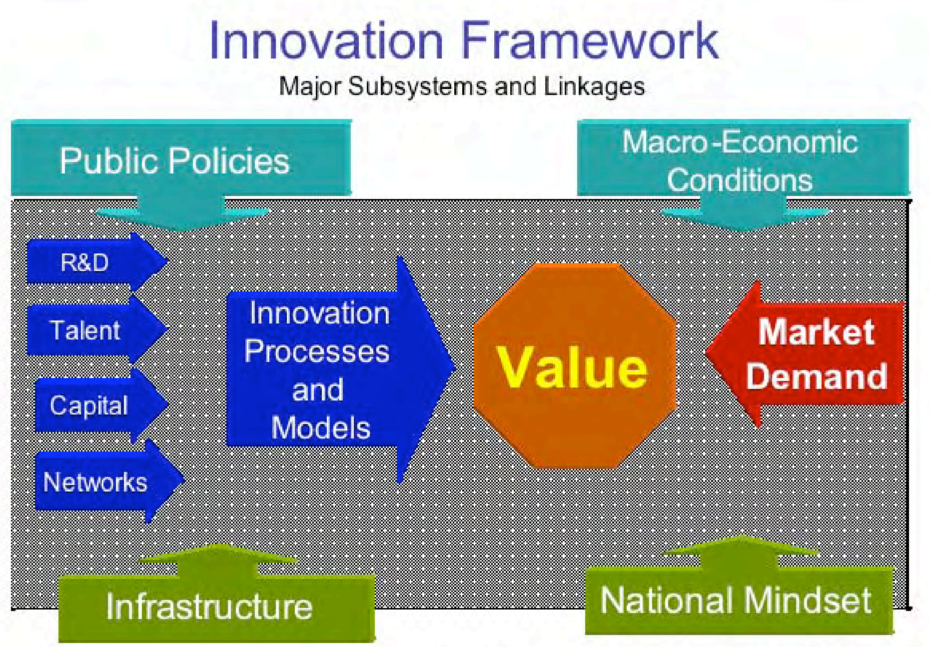
Innovation Ecosystem Framework for Further Categorizing Innovation Indicators

Our review of reports made clear there is little consensus on a common reporting framework, or for that matter, an underlying model of innovation. Accordingly, it was necessary to generate a working framework for categorizing in a consistent way the indicators identified in our survey. In constructing our innovation framework we considered a number of levels of abstraction and detail -- from an individual technology project, to the enterprise, to the industry sector, to the national and even global level. We also were mindful that innovation should not be viewed as a singular linear and independent activity. It is more appropriately described as a multi-dimensional system of interacting factors, processes, and collaborating agents -- or a national innovation ecosystem. We adopted a framework that was comprehensive and capable of integrating a broader range of indicators from the traditional to the R&D linear chain model.

The framework we developed provided:

- An end-to-end view of innovation that recognizes the entire ideation-to-market cycle, including inputs, the processes of innovating enterprises, the outputs of innovation, and factors that drive or inhibit the demand for innovation
- The context in which innovation takes - place including the macroeconomic conditions, the public policy environment, infrastructure, and the national mindset for innovation
- The changing attributes of innovation including globalization of innovative activity, collaborative activity, new business models, types of innovation, service sector innovation, entrepreneurial activity, and the diffusion rates of innovation.

The framework we eventually adopted is graphically illustrated below.



Source: Innovation Framework Report, November 2006.

We defined 14 factors that comprise this framework and used these as our landscape for mapping indicators. Working through these 14 factors proved useful and illuminating. It enabled us to logically "cluster" indicators from heterogeneous data sources, and then cross walk a variety of innovation taxonomies into a common basis for comparison and assessment. It also enabled us to better understand some of the complex relationships between the factors and the processes of innovation by examining the indicators that are available. It helped us identify strengths and weaknesses of the available indicators, and also enabled us to identify areas in which there are obvious data gaps.

The 14 factors analysis also demonstrated that the relative strengths and weaknesses are not the same for the five major groupings of indicators -- national through private sector. What it also revealed is that the areas with the greatest challenges in terms of available indicators tend to be those around which there is the most curiosity and also the highest level of vagueness due to the lack of quantifiability of some of the new indicators developed to capture such data. The 14 factors analysis also surfaced insights as to priorities, directions, and opportunities for future work and research.

The following is a discussion and brief exposition of the 14 factors that were employed

INPUT FACTORS

The range, scope and effectiveness of innovation are influenced on the *type, quantity and quality* of key innovation inputs, the most important of which are:

> Research & Development - This innovation factor consists of knowledge creation activity. The primary indicators for this factor are well established and include sources of R&D expenditures in the public and private sector and R&D expenditures by performing organizations such as universities, federal laboratories and private research facilities. This domain also includes related indicators such as scientific publications and intellectual property (patents). Extensive databases such as those prepared by the National Science Foundation are available in these areas. Over 17% of the 3126 indicators identified in our sample of indicator reports were categorized in this domain. These indicators are frequently overused as proxies of a nation's innovation capabilities. While R&D spending is an important driver of innovative activity it does not operate independently

of other innovation factors. Intellectual property can also arise as a by-product of developing new products and services. Innovative business models, processes, and marketing methods are generally of a non-R&D based nature.

Talent: The demand for creativity and innovative talent is increasing and this is probably the most important set of indicators in our framework. It is the individual scientist, engineer, entrepreneur or team innovator that does the real innovative work and value creation. The traditional way talent is measured is through tracking educational attainment of the labor force and graduates in universities and colleges in scientific, mathematics, and engineering disciplines. It is generally acknowledged that the more significant and revealing measures of labor force quality and operational competencies are lacking. All countries striving to be at the leading edge of technology debate the issue of brain drain and brain gain increasing the interest in measuring the ebb and flow of talent across borders whether it be for education, finding work, starting a business or permanently residing in a country. This "brain circulation" can reflect the relative attractiveness of national innovation systems and other considerations such as lifestyle, quality of life, immigration laws, freedom of association etc. With the baby boomers facing the retirement years there is concern over the production of skilled personnel and availability of talented immigrants. These trends underscore the need for relevant and timely innovation indicators to meet these policy concerns.

Capital - A key to developing and diffusing innovation into the economy and generating productivity growth is the size, characteristics, and rate of investment in the nation's capital stock (e.g., machines, equipment). Much credit is given specifically to ICT investment as contributing to higher productivity growth rates after 1995. Access to venture capital and initial public offerings (IPOs), while relatively small to total capital investment, plays a critical role in financing technology based start-ups and the early growth stage of companies. Venture backed companies have contributed enormously to employment and rising stock market valuations particularly during the 1990s. The federal government's Small Business Innovation Research (SBIR) program is a major source of seed capital

Networks - More innovation is of a collaborative nature spurred on by the exponential growth and pervasiveness of computer and communication technologies such as the internet, e-mail, collaboration software applications, search engines, social networks and mobile devices. The number of people and business firms having access to computers and high-speed data/voice/video connections can increase innovation capabilities, the speed and efficiency of innovation and create enormous new markets for on-line services ranging from financial services, education, e-commerce, health care and public services. Federal policy changes such as the Stevenson-Wydler Act and the Federal Technology Transfer Act have stimulated technology partnerships between universities and federal labs and increased the commercialization rate of publicly funded R&D. Such innovation inputs can differ across various disciplines, regions and types of innovation—incremental, disruptive, system integration and platform technologies.

PROCESS FACTORS

Innovating enterprises have the primary role in the US economy to fuse customer demand (current and those in the future) with the innovation resources it can access, develop, manage and exploit. This domain focuses on innovating enterprises whether established or entrepreneurial start-ups. From a firm level perspective innovation is typically defined as bringing of an invention or insight into a significantly new or improved product, service or production technology to market. Innovation can also be of a non-technological nature involving business models, training, cultural change, reorganized information systems, marketing strategies and redeployment of assets.

Despite the large number of innovation reports and databases, they provide limited insight into how innovation is sourced, managed, and measured by private sector organizations. This is somewhat surprising given the central role the private sector plays in the innovation process. There are few systematically collected indicators on private sector innovation activities and practices across different size businesses, sectors and geography. Many business firm surveys are done as ad hoc, one-time research projects. The most systematic, longitudinal and comprehensive effort currently is the Community Innovation Surveys done by the OECD in European Union member states.[3]

Measuring innovative activity of enterprises, large and small, is of critical value in order to understand which industries and firms are the innovation leaders and what attributes characterize that leadership. What are the sector/firm specific drivers of innovation and what is the impact on firm performance? What internal processes are used to manage the innovation including top leadership commitment, sources of ideas, organizational culture, project management tools/metrics, collaboration with customers, investment levels, intellectual property protection, IT support and marketing strategy?

For the more radical innovations and general-purpose technologies, the process may involve numerous recursive activities. Among these are items such as managing linkages with customers, partners, suppliers and knowledge providers, and integrating complementary innovations in services, public policy, distribution models, and customer relationship management.

Poor project execution and unanticipated technical problems can slow implementation (driving up costs, risk/uncertainty and time to market) and pose a significant barrier to revenue growth, generating profits, and long-term success in the marketplace. These barriers can also be of a non-technical nature. Examples include organizational resistance, changes in market conditions, competitor response, and regulatory and legal barriers. Identification of these barriers, and identifying methods for overcoming them, is a rich area for speeding up innovation cycle times and reducing the risks of innovation.

Management – refers to the role management plays in setting innovation strategy and fostering, and rewarding innovative activity at the firm level. Management sets the organizational and cultural tone of the firm. Management practices, organizational factors, and internal barriers to technology development and commercialization are important indicators. These indicators are a combination of both quantitative and qualitative indicators. Variables in the mix here include demographic characteristics such as age and education, but also attempt to include items whose intent is to capture experience, as well as other elements that would speak to the ability and intent of an organization's management to innovate.

Product Development - refers to the process of taking an idea through the entire range of activities from inception to where it becomes a marketable product. While many firms keep regular and rigorous track of their internal product development activities, measuring such activities across an entire economy, or across an industry, is a much more difficult endeavor. The general activities consist of market definition, design, engineering, production, marketing, distribution, and support phases. These activities can be viewed as linear steps, but the reality in most cases is much more complex. For each phase of the process there are numerous sub-processes, both internal and external to the enterprise, involving feedback loops and the coupling of each activity to downstream and upstream phases. Technical and economic problems that are uncovered in the development process often generate demand for additional research in

3) The guidelines for developing enterprise level indicators have been codified by the OSLO Manual, most recently in its third edition 2006. The latest OSLO manual gives greater recognition to non-technological innovation such as organizational structures (business models), management practices and marketing innovation. The indicators that are comparable across the European Community are derived from the European Community Innovation Survey. The US has no comparable innovation survey. The EC survey focuses on firm propensity to innovate and indicators related to sources of information, outcomes use of intellectual property and barriers to innovation. The most recently completed fourth survey (CIS-4) is a cross-sectional survey of all firms with over 10 employees in all 27 EU member states. It was conducted in 2005 with over 60,000 respondents. The survey includes all manufacturing sectors and many service sectors. Data are available from the Eurostat New Cronos website. http://epp.eurostat.cec.eu.int/portal/page?_pageid=1090,30070682,1090_30298591&_dad=portal&_schema=PORTAL or http://www.esds.ac.uk/international/access/access.asp The Flash Barometer Survey (FBS) is a cross sectional survey of 4534 innovative small to medium sized businesses with between 20 and 499 employees in 25 EU countries.

engineering and even fundamental science. For the more radical innovations and general purpose technologies, the process may involve numerous recursive activities. Among these are items such as managing networks and collaborations with customers, partners, suppliers and knowledge providers, and integrating complementary innovations in services, public policy, and distribution models. Private enterprise can also face various types of innovation barriers such as funding uncertainty for innovation, lack of qualified talent, organizational resistance, shareholder pressures for results, fear of failure and regulatory and legal barriers.

Efficiency - the efficiency indicators, those we have evaluated in our research for this report, have to do with the ability of the economy to find innovative ways of reducing costs, improving productivity and rapidly move ideas and/or products from one stage of development and market presence to another. Efficiency can also refer to the economy's ability to absorb new ideas, such as patent technology. It can also refer to the economy's ability to smoothly support all of the steps that are required to create new businesses. Clearly, efficiency is desirable in all manner of business and organizational practices. However, methodologies for spurring innovation are much more variegated and less subject to rigorous management practice and measurement.

Other Process - process indicators, as we employ the term here, and include other enterprise indicators not easily classified in the other areas. Such indicators might include alternative business models and internal-to-an-organization changes that have an ability to impact innovation. The spectrum covered here spans a range of options that is virtually limitless; including items such as outsourcing practices, customer service models, collaborative relationships, and the entire field that is comprised of has become known as business process reengineering.

OUTCOME FACTORS

The commercialization and adoption of new products and services by customers (business and consumers) is the centerpiece of innovation value—where the supply of innovation meets the demand for innovation. This domain also surfaces some of the more complicated and elusive measurement issues. At one level, indicators can measure the direct outputs of enterprises or industry. These private sector outputs when aggregated impact overall national conditions, competitiveness, standard of living and quality of life. The rate of end-user adoption (diffusion) ultimately determines the long-term impact of innovation on national productivity and economic growth. Customers adopt innovation not just for the functional characteristics of a new product or service, but rather by the value expected when innovations are acquired and utilized. People do not buy products; they buy expectations of future benefits (Leavitt 1969).

The value of innovation to customers, including ‘intangible’ variables (e.g., convenience, service support, training, testing, and observability as well as product performance) are important considerations in understanding innovation demand and how it propagates throughout the economy (spillover effects). This intersection of “innovation producers” with “innovating customers” is an important determinate of innovation demand. In this relationship the innovation output of one enterprise becomes part of the innovation input to another enterprise, creating a virtuous cycle with a powerful multiplier effect. An example of this powerful dynamic is the high rate of innovation (price and performance) in semiconductors (Moore’s Law), which helped drive innovation in the PC and software business, which in turn helped boost productivity performance in other business sectors and fed back as a driver of the PC business and so on.

Integrating indicators at the macro level with those at the micro level is another challenge. Some macro outcomes can be linked to indicators such as R&D expenditures, capital investment, educational attainment, and experience of the workforce. More problematical is connecting enterprise level indicators to macro economic performance. There continues to be large scope for creative research, development of new indicators, and the application of existing data to statistical fields and economic analysis.

This dimension of the framework addresses the outputs of innovative activity. This domain also surfaces some of the more complicated and elusive measurement issues.

Output – The output of innovation may be new to firm, new to the world or new to the customer. Clearly the most important consideration by private sector organizations is measuring the expected and real return of innovative effort. Among the most important indicators are contribution of innovation to revenue, profits, return on investment, change in market share, cost reduction and intellectual property licensing revenues. Intangible outputs, such as an increase in a firm's knowledge stock and acquired competencies in managing innovation, organizational learning, reputation, branding and adaptiveness is more subjective and difficult to quantify. These intangibles may be strategically significant to long-term competitive performance. From an end-user demand perspective there are many value indicators of potential relevance such as price reductions, more choice in goods or services, improvements in quality, convenience and overall satisfaction. .

Impact – Growth in real GDP, GDP per capita, and increases in total factor productivity are the conventional measure for the overall contribution and impact of innovation. Some other measures that are useful include employment growth, consumer price/quality trends, sectoral trade balances, corporate earnings associated with innovation, wealth creation, global market share, and penetration of markets. There are also impact measures for the overall economy such as GDP, employment, consumer prices, exports, consumer choice, value added, wages and wealth creation. These impacts are cumulative from innovation outputs such as new company formation, new product introductions, the portion of product portfolios comprised by innovative products, the component of total research endeavors dedicated to innovative activities, and many others. Impact measures can also be defined in terms of geography, such as innovative industry clusters, or the development of regional innovation networks.

CONTEXTUAL FACTORS

The intersection of "innovation producers" with "innovating customers" is an important driver of economic growth and productivity. In this relationship the innovation output of one enterprise becomes part of the innovation input to another enterprise, creating a virtuous cycle with a powerful multiplier effect. An example of this powerful dynamic is the high rate of innovation in semiconductors (Moore's Law), which in turn helped drive the innovativeness of the PC business, which in turn became an important driver of the software business, which fed back as a driver of the PC business and so on.

Gauging the value of innovation to customers, including 'intangible' variables (e.g., convenience, service support, training, testing, and observability as well as product performance) is an important consideration for accelerating the rate of innovation diffusion, creating market growth, and generating downstream (spillover) economic benefits.

Macroeconomic conditions – The innovative activities of enterprises depend in large part on perceptions of the overall national and global economy and expectations for the future. Most of the macroeconomic indicators connected with innovation tend to focus on investment spending and the impact of such investment on innovation in the broadly defined workforce. The risk profile for innovation and expected benefits are also linked to specific industry sector conditions in domestic and foreign markets, cost of capital (interest rates), currency valuation, and access to markets. How these macroeconomic conditions are perceived by enterprises and influence innovative behavior may vary considerably depending on the industrial, regional and technological sector.

Public Policy Environment – The public sector is linked to the innovation process in powerful and deep ways. R&D funding from the public sector accounts for a substantial portion of national R&D investment. The choices of government in supporting a field of science (e.g., life science, nanotechnology, advanced computing) influence the direction of innovative activity. However, R&D is only one area of public policy that bears on innovation. Table 2 below illustrates the extensive range of public policies impacting innovation and the diverse ways these policies can stimulate or inhibit innovation.

Innovation Infrastructure – The nation's innovation infrastructure helps supply inputs to private enterprises. This infrastructure can be substantially shaped by public policies and investment includes:

Information infrastructure provides enterprises with many of the important tools and communication platforms necessary for innovation. Global collaboration and open innovation systems rely on advances in computing, software applications, and information networks.

Regional innovation clusters are geographic groupings of similar tech-based enterprises and related support industries and services that share a common knowledge base, labor pools, markets or distribution channels (e.g., Silicon Valley—microelectronics, Detroit—automobiles, Maryland—270 Corridor-biotechnology). Participation in such clusters can enhance enterprise access to innovation inputs and speed up implementation.

Scientific and research institutions that serve as a major source of knowledge and include research universities, federal laboratories, non-profit research centers, R&D consortia, technology transfer centers and technological centers of excellence. Industry is utilizing a wide variety of coupling mechanisms to increase its access (e.g., personnel exchange, patent disclosure and licensing, university-industry partnerships).

Capital providers and markets that finance innovation and the acquisition of new products and services. Venture capital and government research programs have played a particularly important role in supporting technology-based entrepreneurs, start-ups and small business firms. Equity markets provide an important incentive for innovation, reward innovators and determine the value of enterprises.

Education institutions comprising grade schools and high schools, community colleges, universities and colleges, along with private sector training organizations, provide the pool of leading-edge scientists, engineers, managers and the technical workforce.

Mindset – Public attitudes about science, technology and innovation and how the media circulates and amplifies innovation-related information can affect political debate, influence public policy choices, stimulate career choices in science and engineering and foster public/private investment in innovative activity. Maximizing the value of the national innovation ecosystem involves more than individual players or nodes in the ecosystem. It involves embracing value from the whole and the power of collaborative advantage-- more openness between functions, sectors, industries, and cultures to build social capital of trust, reciprocity, complementary competencies, the striving for learning and excellence. A central challenge for the future is creating a mindset and culture that accepts and recognizes this new paradigm.

SUMMARY: INNOVATION VITAL SIGNS

A dramatic change in the approach to innovation is required if we wish to sustain our competitive advantage. Doing so will require a transition to a globally integrated economy and an innovation-driven economy capable of routinely developing and commercializing "new-to-the-world" technologies. This new growth opportunity cannot be realized with traditional methods such as increasing innovation inputs. It has to be broadened to include new business models and value creation as main drivers, and the contextual conditions in which innovation operates. The framework offered in this report integrates the fundamental change in innovation practices from the previous closed, static, linear, and individualistic perspective into a multidimensional, dynamic approach that is capable of staying abreast of the demands of a global economy.

To the degree that indicators are currently defined and available, the provisional framework establishes a baseline for a more comprehensive and textured view of the national innovation system. It also points us in directions to identify gap areas in which we need improved and new measures. As the framework and criteria for selecting Innovation Vital Signs evolves we anticipate the following uses

As the indicators and criteria for selecting Innovation Vital Signs are developed, they will help policymakers understand the nature of the US Innovation Ecosystem and be useful in the following ways:

- Awareness—provides information to policymakers, public and media for more comprehensively understanding the performance of the national innovation system.
- Performance—monitors progress and results against public policy objectives.
- Signaling and Monitoring—calls attention to significant innovation issues, trends and growth opportunities
- Accountability and Evaluation—supports formulation of government R&D budgets and innovation policies, and compliance with GPRA.
- Consensus Building—informs policy process on the potential impact of alternative innovation funding, policies, and strategies.

3) Methodology for Aggregation of Public Sector Indicators According to the Innovation Framework

The process used to derive the initial set of candidate indicators was quite simple – we compiled a comprehensive, though by no means exhaustive, listing of publicly-available innovation reports and studies from around the world. We then examined them to see what sorts of statistics and indicators they employed in their attempt to define and quantify the status of innovation within the sector, or the economy, or the industry -- or within whatever aggregative unit was being employed. Provided that the data series were consistent and reasonably representative of the types of indicators that we sought as relevant to innovation, we then added that set of indicators to our candidate list for scoring and subsequent analysis and review for inclusion among the set of innovation vital signs that we were seeking to ultimately ferret out of the global compilation.

The characteristics of the population of reports that we compiled and elicited data from is as follows:

Overall total - 52 Public Reports that included in excess of 3100 indicators of all kinds

Within this total the breakdown of subcategories was:

18 Global Reports – those being reports doing global comparisons of data

10 National Reports – these were reports focusing on statistics for only a single country and its own innovation performance

15 Regional Reports – the regional reports were mostly for state level data, though the also include the perspective of some non-US regional breakouts,

9 Enterprise Reports – these reports came from a diversity of geographies but have in common the fact that they are focusing on innovation at the firm level.

A detailed list of the individual public-sector innovation indicator reports has been prepared and is contained in Appendix A.

It must be noted that this is not a comprehensive list of indicators that might be available from all sources within the US and from around the globe. Nor is it necessarily a listing that has been sorted to exclude all duplication that might exist in the indicators being compiled at the various levels defined above. Instead, the effort here focused on what we might term the low-hanging fruit in the indicator world. Given that the charter of this work is to identify and aggregate innovation vital signs and determine their usefulness to evaluating the state of innovation in the US, we thought it more than adequate to gather and filter according to the methodology above.

Clearly, there are many ways in which the process might be improved and refined, but this can be left to future work. The focus of the work here was to, first and foremost, do the pioneering work of finding out what sorts of indicators are available and analyze these for their value as part of a compilation of first-cut innovation vital signs.

Immediately below is a table that summarizes the results of our breakdown of indicators by the categories described above, and further subdivides them into categories, or factors, that have to do with where the individual indicators reside within the concept of innovation. There are a total of over 3100 innovation indicators that were employed in the analysis to determine which of these are the most likely candidates to serve as innovation vital signs for the US economy.

Quantitative Detail on the indicators compiled and examined for the IVS Project

Table 3.1 Public Sector Innovation Indicators Summary					
Indicator	Global	National	Regional	Enterprise	Total
R&D	253	187	80	2	**522**
Talent	227	169	147	7	**550**
Capital	250	32	54	17	**353**
Networks	50	27	47	8	**132**
Management	13	1	0	21	**35**
Product Development	1	1	1	33	**36**
Efficiency	10	4	0	4	**18**
Process	64	3	11	176	**253**
Output	50	9	23	162	**244**
Impact	126	58	120	11	**315**
Macroeconomic	91	56	0	2	**149**
Policy	119	3	2	17	**141**
Infrastructure	145	63	59	25	**292**
Mindset	16	22	41	7	**86**
Total	**1415**	**634**	**585**	**492**	**3126**

Additional detail on the composition of the indicators we examined - by different types of classification and organizing structures - follows in Tables 2.2. and 2.3. These provide perspective on what the spectrum of indicators looks like when broken out according to the fourteen factors. They also provide an alternate type of quantification of the data that supplements the summary data appearing in the chart above.

Detailed Breakout of the Public Sector Indicators Compiled and Examined for the IVS Project

Table 2.2	INPUTS				PROCESS				OUTCOMES		CONTEXT				
Indicators Count by Report and Framework	R&D	Talent	Capital	Networks	Managemen	Prod Dev	Efficiency	Other	Output	Impact	Macro-Econ	Policy	Infrastructu	Mindset	Totals
GLOBAL INDICATORS															
OCED Science, Technology & Industry Scoreboard 2006	26	11	2	7	0	0	0	0	0	30	0	0	0	0	76
European Innovation Scoreboard 2005 Database	10	4	2	3	0	0	0	2	2	3	0	0	0	0	26
OECD Main Science and Technology Indicators (elec)	108	56	0	0	0	0	0	0	0	0	0	0	0	0	164
Main Science and Technology Indicators 2006/1 OECD	52	18	0	0	0	0	0	0	6	4	8	0	0	0	88
Oslo Innovation Scorecard 2004	6	4	0	0	0	0	0	0	1	2	0	0	0	0	13
IMD World Competitiveness Yearbook 2006	11	40	32	14	11	0	0	0	14	34	48	28	68	13	313
Global Competitiveness Index 2006	4	16	5	5	2	1	0	7	0	1	9	12	26	1	89
World Bank Knowledge Assessment Methodology (KAM)	6	23	6	10	0	0	2	0	4	3	8	9	12	0	83
Economic Freedom World Index 2006	0	0	5	0	0	0	0	0	0	1	7	23	5	0	41
Science and Technology Priorities of OECD Countries	18	0	0	0	0	0	0	0	0	0	0	0	0	0	18
World Bank Doing Business Indicators 2006	0	0	8	0	0	0	0	31	0	0	2	0	0	0	41
Global Entrepreneurship Monitor 2004-5	0	6	5	0	0	0	0	3	1	5	0	0	0	0	20
Capital Access Index 2005 -- Milken Institute	0	0	33	0	0	0	0	0	0	1	6	3	14	0	57
OECD Education at a Glance 2005	0	27	0	0	0	0	0	0	0	2	0	0	0	0	29
Industrial Development Report	3	5	3	3	0	0	0	1	0	2	0	0	19	2	38
Trend Chart report: Innovation in Services?	1	3	1	7	0	0	0	11	2	0	0	0	0	0	25
UN World Investment Report	4	9	146	1	0	0	0	7	20	38	2	40	0	0	267
Benchmarking Innovation & Framework Conditions 2004	4	5	2	0	0	0	8	2	0	0	1	4	1	0	27
Global Innovation Indicators Sub-Total	**253**	**227**	**250**	**50**	**13**	**1**	**10**	**64**	**50**	**126**	**91**	**119**	**145**	**16**	**1415**
NATIONAL INDICATORS	INPUTS				PROCESS				OUTCOMES		CONTEXT				
NSF Science and Engineering Indicators 2006	114	115	3	0	0	0	0	0	0	11	0	0	2	21	266
CEA Economic Indicators	0	5	6	0	0	0	0	0	0	9	17	0	0	0	37
BLS National Productivity	0	0	0	0	0	0	0	0	0	13	0	0	0	0	13
BEA/NSF R&D Satellite Account	13	0	0	0	0	0	0	0	1	0	4	0	0	0	18
UK Productivity and Competitiveness Indicators 2006	5	2	3	1	1	0	0	1	4	6	2	0	3	0	28
Norway Science and Technology Indicators 2005	9	5	0	3	0	0	0	0	0	1	0	0	0	0	18
EU Regional Benchmarking	5	7	0	3	0	0	0	1	0	2	5	0	1	0	24
New Zealand Economic Development Indicators 2005	6	12	15	0	0	1	4	0	2	13	19	2	2	0	76
Australia Public Science and Technology Report 2006	28	4	0	17	0	0	0	0	2	0	0	0	0	0	51
Canada Performance and Potential 2005-06	7	19	5	3	0	0	0	0	0	3	9	1	55	1	103
National Innovation Indicators Sub-Total	**187**	**169**	**32**	**27**	**1**	**1**	**4**	**2**	**9**	**58**	**56**	**3**	**63**	**22**	**634**
REGIONAL INDICATORS	INPUTS				PROCESS				OUTCOMES		CONTEXT				
ASTRA State Level S&T Indicators 2005	9	9	5	1	0	0	0	1	0	8	0	0	0	0	33
Washington State Index of Innovation & Technology 2006	2	4	5	0	0	0	0	0	4	10	0	1	3	0	29
Index of Silicon Valley 2006	1	12	1	0	0	0	0	0	2	7	0	0	15	0	38
Philadelphia Life Sciences Cluster 2005	14	25	9	0	0	0	0	5	1	1	0	0	0	0	55
Arkansasin the Knowledge Based Economy 2005	13	18	12	3	0	0	0	0	1	28	0	0	0	0	75
State New Economy Index	2	4	2	5	0	0	0	0	1	6	0	0	1	0	21
State Science and Technology Index 2004 Milken	13	18	12	3	0	0	0	0	1	28	0	0	0	0	75
Index Massachusetts Innovation Economy 2006-5	3	4	3	0	0	1	0	0	4	4	0	0	1	0	20
Southern Innovation Index	5	34	4	4	0	0	0	0	0	5	0	0	0	0	52
Region Lazio Innovation Scorecard 2005	5	4	1	5	0	0	0	2	2	6	0	0	1	0	26
State Based Assessment of Australian Research	7	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Southern Community Index	0	2	0	0	0	0	0	0	0	6	0	0	2	4	14
Hong Kong Creativity Index	6	13	0	21	0	0	0	3	6	3	0	1	33	35	121
Toronto Cultural Index and Plan	0	0	0	0	0	0	0	0	0	8	0	0	3	0	11
Wired Top Ten Geek Cities	0	0	0	5	0	0	0	0	1	0	0	0	0	2	8
Regional Innovation Indicators Sub-Total	**80**	**147**	**54**	**47**	**0**	**1**	**0**	**11**	**23**	**120**	**0**	**2**	**59**	**41**	**585**
ENTERPRISE INDICATORS	INPUTS				PROCESS				OUTCOMES		CONTEXT				
Index of Corporate Innovation -- Canada	0	0	0	0	9	1	0	6	6	0	0	0	0	0	22
Fujitsu Innovation Index 2006	0	0	0	0	11	1	4	16	9	0	0	0	0	0	41
Balanced Scorecard	0	0	0	0	1	10	0	18	22	6	0	0	0	0	57
Danish Intellectual Capital Statement	0	0	0	0	0	0	0	24	0	0	0	0	0	0	24
EU Benchmarking Enterprise	2	4	3	7	0	0	0	1	0	4	2	4	4	0	31
Intangibles to Tangibles Kaplan & Norton	0	0	0	0	0	15	0	0	92	0	0	0	0	0	107
Entrepreneurial Indicators FORA Denmark	0	3	14	1	0	0	0	0	0	0	0	13	21	7	59
European Community Intangible Assets Repository	0	0	0	0	0	6	0	36	17	1	0	0	0	0	60
Innovation in New Zealand	0	0	0	0	0	0	0	75	16	0	0	0	0	0	91
Enterprise Innovation Indicators Sub-Total	**2**	**7**	**17**	**8**	**21**	**33**	**4**	**176**	**162**	**11**	**2**	**17**	**25**	**7**	**492**
Innovation Indicator Inventory Grand Total	**522**	**550**	**353**	**132**	**35**	**36**	**18**	**253**	**244**	**315**	**149**	**141**	**292**	**86**	**3126**

Detailed Breakout of the Public Sector Indicators Compiled and Examined for the IVS Project

Table 2.3

Most Commonly Cited Indicators By Report Frequency	Global	National	Regional	Enterprise	SUM for ALL
Total Number of Reports by Type	**18**	**10**	**15**	**9**	**52**
R&D Expenditures	12	8	10	1	31
All Employment Indicators*	10	7	11	0	28
Venture Capital	8	3	11	2	24
Labor Force Characteristics	8	6	8	1	23
Intellectual Property	9	4	8	1	22
Scientists and Engineers	9	4	7	1	21
Higher Education	7	2	8	0	17
Process Factors	4	3	5	5	17
Internet	5	4	6	1	16
Collaborative Activity	5	6	5	0	16
Employment Impact	5	3	8	0	16
Trade Impact	8	4	3	1	16
Talent Factors	6	4	3	2	15
Organizational Factors	6	2	1	6	15
Revenues	5	3	1	6	15
Kindergarten through Secondary Education	6	2	6	0	14
Equity	3	2	5	2	12
Communication Infrastructure	6	1	4	1	12
Output Measures	1	3	3	5	12
Cluster Development, New Enterprise Growth	0	0	11	1	12
Scientific Publications	3	7	1	0	11
Foreign Direct Investment	6	2	2	1	11
Other Impact Indicators	4	3	4	0	11
Gross Domestic Product Indicators	5	6	0	0	11
Financial Assets and Infrastructure	6	2	0	1	9
Business Investment	4	4	0	1	9
Computer Ownership Activity	4	1	4	0	9
Legal System, Effectiveness and Integrity	7	0	1	1	9
Education Expenditures	1	2	5	0	8
New Enterprises	0	1	7	0	8
Interest rates	4	4	0	0	8
Tax Policy	4	2	1	1	8
Other R&D	3	3	1	0	7
Mobility of Students and Labor Force	3	2	2	0	7
Supply Factors including sources of innovation	4	1	0	2	7
Customer Relationship	2	0	1	4	7
New Products Introduced	1	1	1	4	7
Inflation, cost of living, producer prices	5	2	0	0	7
Quality of Life	2	1	4	0	7
Political Stability	2	3	2	0	7
Management and Organizational Values	2	1	0	3	6
Exports	2	1	2	1	6
Employment (firm output)	2	1	3	0	6
Productivity	1	5	0	0	6
Employment Indicators (Macro)	3	3	0	0	6
Exchange Rates	5	1	0	0	6
Regulatory System	5	1	0	0	6
Trade Policy	5	0	1	0	6

Most Commonly Cited Indicators By Report Frequency	Global	National	Regional	Enterprise	SUM for ALL
Total Number of Reports by Type	**18**	**10**	**15**	**9**	**52**
Physical Infrastructure, Air, Rail, Energy etc	3	0	3	0	6
Interest Rates	3	1	0	1	5
Product Development Activity	1	0	0	4	5
Customer Satisfaction	0	0	0	5	5
GDP and Value Add	1	1	3	0	5
Income	0	0	5	0	5
Fiscal Position of Government	2	3	0	0	5
Trade Indicators	4	1	0	0	5
Other Policy Indicators	5	0	0	0	5
Other Infrastructure	2	0	3	0	5
Other Mindset Indicators	2	1	1	1	5
Other Capital Factor	0	1	2	1	4
Employee Skills and Competencies	0	0	0	4	4
Productivity	1	1	2	0	4
Other Macroeconomic Factors	0	3	0	1	4
Environmental Conditions	1	1	1	1	4
Health Indicators	3	1	0	0	4
Confidence in government	1	1	2	0	4
Sources of Information	0	2	2	0	4
Tolerance to race, gender, immigrants etc	2	0	2	0	4
Tax Policy	1	0	0	2	3
Production Factors	2	0	0	1	3
Foreign Direct Investment	2	0	1	0	3
Stock Market Capitalization and Listings	1	0	1	1	3
Demography, Age Distribution	2	1	0	0	3
Human Rights	2	0	1	0	3
Public understanding of science technology	1	1	1	0	3
Social Networking Intensity	0	0	2	0	2
Efficiency Factors	0	1	0	1	2
Market Share	0	0	0	2	2
Electronic Commerce	1	0	1	0	2
Purchasing Power Parity	1	0	0	1	2
Entrepreneurial Attitudes	0	0	1	1	2
Capital Regulations	1	0	0	0	1
Merger and Acquisition	0	0	0	1	1
Media Activity	1	0	0	0	1
Profits	1	0	0	0	1
Stock Market Valuation and Measures	1	0	0	0	1
Cost Reduction	0	0	0	1	1
Intellectual Property Laws, Enforcement	1	0	0	0	1
Philanthropic Attitudes and Behavior	0	0	1	0	1
***Consolidation of Employment Indicators**					
Employment Indicators (Macro-Economic)	3	3	0	0	6
Employment Impact	5	3	8	0	16
Employment (Firm Output)	2	1	3	0	6
All Employment Indicators	10	7	11	0	28

4) Process for Assessing Innovation Indicators from Private Sector Sources

This section discusses and summarizes the potential to use private sector sources of information – as provided and maintained by industry associations and other sources, primarily market research firms – as a source of innovation indicators that might serve as contributors to the development of the select set of indicators that are found to be innovation vital signs for the US economy.

While innovation is not confined to occurring within the bounds of how analysts structure and view the world, in order to map the impacts of innovation on a systematic basis, it is necessary to establish a framework or guidelines within which the overview is contained. For the purposed of this research, we followed the steps and procedures listed below to develop results that are robust and transparent.

1) Organizing Principle – we chose to use the economic/industry framework that is mapped by the US Census Bureau and the Bureau of Economic Analysis in the NAICS system as the basis for this examination of the sources and uses of innovation within the private sector of the US economy. This decision provided an established foundation upon which to build the research and analysis.

2) Prioritization of Industries Examined – the search for innovation indicators was limited to private industry and was further narrowed to include a prioritization of industries to examine based on their relative contribution to GPD in 2004, the last year for which the data is available. This prioritization was relatively simplistic, narrowing its prioritization paradigm to two digit NAICS industry groupings. These industries and their contribution to GDP are listed on the following page.

3) Identifying Leading Organizations – under the assumption that statistical information programs are usually maintained by the larger, more established industry associations, a quick survey of industry sources was conducted to find a) the organizations who are the leaders in their industry, and b) industry groups who are leaders in the development and maintenance of industry statistics. Having these characteristics combined in a single organization was not a unique occurrence. What did prove problematic was the discovery that in non-manufacturing organizations and industries there is not a great deal of statistical information available, much less information that either directly, or by proxy, tracks innovation.

4) Identifying alternate (non-industry) sources of information – while industry and trade groups are obvious candidates to be sources of industry data that might serve as innovation indicators, there is also an industry of firms who research industries, their evolution, and events in them. Some of these are repositories for time series data and other information on the industries in which they specialize, which range from manufacturing to health care, but are heavily represented in the information technology sector, as well as other emerging industries where changes are rapid as they mature and evolve. A sampling of such organizations was contacted and findings about their ability to become sources of innovation data are summarized.

5) Summary of findings by industry – a summary analysis of available indicators and their applicability to serve as innovation indicators was prepared. This was accompanied by a review of the industries potential to be able to provide information on a list of indicators that were defined as part of the innovation framework discussed in Section1.

6) Conclusions – this is an overall perspective of the usefulness of industry organizations to serve as data suppliers for innovation indicators, and to potentially serve as partners in an effort to design and implement a system that will work to gather new and/or derivative data that are developed as meaningful innovation vital sign indicators for their industry.

Industries Evaluated for Review of Innovation Vital Signs Applicability

NAICS Industries Reviewed in this section of the Innovation Vital Signs Phase 1 Report – Summary

	NAICS Industry	Description	Sector GDP $B in 2004	% of Private Industry	Number of Establishments	Number of Employees
	31-33	Manufacturing	$4311.6	20.20%	350,828	14,966,536
	42	Wholesale Trade	$1023.0	4.79%	435,521	5,878,405
	44 - 45	Retail Trade	$1231.4	5.77%	1,114,637	14,647,675
	51	Information	$1,107.0	5.19%	137,678	3,736,061
	52	Finance and Insurance	$1541.8	7.22%	440,268	6,578,817
	53	Real Estate & Rental and Leasing	$2078.2	9.74%	322,815	1,948,657
	54	Professional, Scientific, and Technical Services	$1269.7	5.95%	771,305	7,243,505
	62	Health Care and Social Assistance	$1298.3	6.08%	704,526	15,052,255

The above lists the NAICS two digit industries that are reviewed in the following pages. These were chosen as a function of their importance to the overall economy, and by implication, their importance to the potential to use existing statistical indicators in these industries as candidates for use as innovation vital signs for the US at large.

The industries listed above comprise about 75% of the value of total US private industry Gross Domestic Product.

Manufacturing is given special attention in the following analysis of data sources from the private sector, as there is a large and well-developed structure of manufacturing data available from trade groups and other parties such as consultants and market research firms. These programs vary significantly by industry and by the trade group representing the sector. Some are highly developed; others are entirely lacking in data collection capabilities.

The analysis here focuses on leading trade groups within the sector. In manufacturing, the analysis provides case studies of the statistical programs of three organizations that are well known for their provision of industry statistics to members and to the general public.

Survey of Activities for Innovation Vital Signs Applicability – Summary by NAICS Industry

	NAICS Industry	Description	Sector GDP $B in 2004	% of Private Industry	Number of Establishments	Number of Employees
	31-33	**Manufacturing**	$4311.6	20.20	350,828	14,966,536
		The Manufacturing sector comprises establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products. The assembling of component parts of manufactured products is considered manufacturing, except in cases where the activity is appropriately classified in Sector 23, Construction.				
	Innovation Activities Reported	Manufacturing is a source of considerable innovation in products, processes, inputs, and business practices. Because of the ability to readily identify any of the above listed items as new, measuring innovation in manufacturing is easier than in other sectors, but has nonetheless not been widely adopted due to a variety of difficulties in developing meaningful metrics.				
	42	**Wholesale Trade**	$1023.0	4.79%	435,521	5,878,405
		The Wholesale trade sector comprises establishments engaged in wholesaling merchandise, generally without transformation, and rendering services incidental to the sale of merchandise.				
	Innovation Activities Reported	There has been some innovation in this sector, though much is unknown as there are few meaningful statistics about industry activity, much less so statistics on innovation. The challenges to wholesalers are to keep up with innovations in retail to maintain their position of adding value to the overall distribution and supply chain. Wholesalers are therefore becoming more active in their use of IT to augment customer service, and in developing a more sophisticated intermediation function.				
	44 - 45	**Retail Trade**	$1231.4	5.77%	1,114,637	14,647,675
		The Retail Trade sector (sector 44-45) comprises establishments engaged in retailing merchandise, generally without transformation, and rendering services incidental to the sale of merchandise.				
	Innovation Activities Reported	Innovation in retail is widespread but disaggregated across a wide variety of retail markets. The advent and continued growth of e-commerce is just one indicator of innovation. Many retailers are also finding that they are now required to grow their level of capability in supply chain management and customer research in order to meet financial goals. Much retail innovation relates to IT and communications applications, but significant shifts that have also occurred in business models and practices.				

Survey of Activities for Innovation Vital Signs **Applicability – Summary by NAICS Industry –** Page 2

	51	**Information**	$1,107.0	5.19%	137,678	3,736,061
		The Information sector comprises establishments engaged in the following processes: (a) producing and distributing information and cultural products, (b) providing the means to transmit or distribute these products as well as data or communications, and (c) processing data.				
	Innovation Activities Reported	This sector is witnessing significant innovation in most of its constituent parts. Most notable among these are the telecommunications – including wireless – industry, the publishing industry - including the software publishing industry, and the motion picture and music recording industry. Wireless telecom Is a hotbed of innovation, with the continual development of new products tied to an array of services, e.g. the Blackberry. Similarly, the book publishing industry has been transformed by the advent of the internet and e-publishing. The motion picture industry and the music sectors have also seen significant change and innovation both in terms of how their products are created and in terms of the methods used to provide those products to consumers.				
	52	**Finance and Insurance**	$1541.8	7.22%	440,268	6,578,817
		The Finance and Insurance sector comprises establishments primarily engaged in financial transactions (transactions involving the creation, liquidation, or change in ownership of financial assets) and/or in facilitating financial transactions. Three principal types of activities are identified:				
	Innovation Activities Reported	This industry group is not usually seen as a hotbed of innovation, but it can argued that there has been as much innovation here as there has been in manufacturing. The difference is that the innovation here has been product and service driven with a heavy layer of enabling IT systems and processes to thank. Significant innovations in finance would be items such as the growth of on-line brokerage services for anything from bonds to equities to loans and mortgages. In the insurance sector there has been a similar revolution in products offered on-line, and there is a similar growth in back office support services and products that make the retail aspect possible.				
	53	**Real Estate & Rental and Leasing**	$2078.2	9.74%	322,815	1,948,657
		The Real Estate and Rental and Leasing sector comprises establishments primarily engaged in renting, leasing, or otherwise allowing the use of tangible or intangible assets, and establishments providing related services. The major portion of this sector comprises establishments that rent, lease, or otherwise allow the use of their own assets by others. The assets may be tangible, as is the case of real estate and equipment, or intangible, as is the case with patents and trademarks.				
	Innovation Activities Reported	This industry effectively reduces to two prime sub-sectors: the real estate related industry, and the equipment related component. Innovation in both of these is reported by participants to be minimal. Most of the innovation is viewed as being related to the introduction of new business processes and the application of new technologies that are provided by outside sources. In both sectors, most noteworthy would be the continuing proliferation of IT and IT-related products and services that enable revised and novel business processes and practices.				

Survey of Activities for Innovation Vital Signs Applicability – Summary by NAICS Industry – Page 3

	54	**Professional, Scientific, and Technical Services**	$1269.7	5.95%	771,305	7,243,505
		The Professional, Scientific, and Technical Services sector comprises establishments that specialize in performing professional, scientific, and technical activities for others. These activities require a high degree of expertise and training. The establishments in this sector specialize according to expertise and provide these services to clients in a variety of industries and, in some cases, to households. Activities performed include: legal advice and representation; accounting, bookkeeping, and payroll services; architectural, engineering, and specialized design services; computer services; consulting services; research services; advertising services; photographic services; translation and interpretation services; veterinary services; and other professional, scientific, and technical services.				
	Innovation Activities Reported	Innovation in this sector comes in many forms. Clearly, the architectural and engineering communities have done much to innovate through the use of new technologies in their basic value adding processes through the use of IT. They have also seen significant changes occurring as a result of the introduction of new materials and processes. In other sectors, such as the legal and accounting professions, there have been similar evolutions of products and services that are enabled by innovation in the support infrastructures based on new IT. Other elements of this sector have also experienced innovation in business models and in the services being offered. Veterinarians are applying the same novel technologies to the care of animals that are being applied with humans. Marketing and advertising services have undergone a revolution due to the development of the Internet and the creation of entirely new categories of business that resulted.				
	62	**Health Care and Social Assistance**	$1298.3	6.08%	704,526	15,052,255
		The Health Care and Social Assistance sector comprises establishments providing health care and social assistance for individuals. The sector includes both health care and social assistance because it is sometimes difficult to distinguish between the boundaries of these two activities. The industries in this sector are arranged on a continuum starting with those establishments providing medical care exclusively, continuing with those providing health care and social assistance, and finally finishing with those providing only social assistance. The services provided by establishments in this sector are delivered by trained professionals. All industries in the sector share this commonality of process, namely, labor inputs of health practitioners or social workers with the requisite expertise. Many of the industries in the sector are defined based on the educational degree held by the practitioners included in the industry.				
	Innovation Activities Reported	This sector has experienced significant innovation resulting from the need to control costs and the introduction of new technologies and processes that enable efficiency, as well as new services and products. In the medical field there have been breakthroughs running the gamut from sub-molecular to high-end devices providing new types of imaging. There have also been significant shifts in patient record keeping and quality/process controls that have permitted better care and follow-up while reducing the likelihood of errors in services, many enabled by IT and related networked and automated systems.				

Survey of Activities for Innovation Vital Signs Applicability – Summary by NAICS Industry – Page 4

	Other Sources by Industry	Description	Sector GDP $B in 2004	% of Private Industry	Number of Establishments	Number of Employees
	Privately Produced indicators and statistics	Below is a listing of organizations that have developed and maintain statistics on industry activity in a wide variety of industry sectors. These firms typically compile these data for private industry on a prepaid subscription or a for-hire basis. Most of these indicators are related to market activity and shares of market determined by product type rather than industry of production.	N.A.	N.A.	N.A.	N.A.
	Innovation Activities Reported	There are numerous private sector providers of information related to industry activity, usually market information and statistics, that might serve as either an innovation indicator or as an input to a derivative indicator, e.g. some number divided by another. The section below is a brief summarization of some of the larger, better known providers of such data and the information or statistics they have that might contribute to the development of innovation vital signs.				
	Examples of Private Sector Organizations Monitoring Industry					
	Name of Organization	Gartner Group, Thomson Financial, The Conference Board, IDC, Venture One, Forrester Research, McGraw-Hill, IRI, Aberdeen Group				

The items above are a summary of the findings to–date in our investigation of industry statistics that might be used as innovation indicators and potentially be used in the Innovation Vital Signs framework that this report will seek to construct. Details on the specific potential sources of information on an industry-by-industry basis appears in Appendix A.

Conclusions

Summarizing all of the data presented above presents several difficulties, as there is a considerable amount of uncertain and ambiguity evident in what has been discovered. The overarching conclusion is that the raw material for the a meaningful set of vital signs is out there, but candidates need to be filtered and evaluated to determine their usefulness, their ability to truly reflect innovation, and their ability to become part of an ongoing structure of reporting.

Looking over the findings of this section, several things are exceedingly clear. When looking for the sources of data that support innovation investigations:

- Manufacturing data is readily available at levels of detail that are most likely more than adequate for the purposes of developing industry indicators,
- Other industries are far more difficult to evaluate either through a lack of data or as a result of the fact that innovation in non-manufacturing industries is far less tangible and therefore far less susceptible to measurement.
- Service industries are a source of significant innovation, but there is little being done to track it as there is no framework that can be applied and used as a reporting structure to capture innovative activities
- The challenge do filling the apparent innovation metrics void is to figure out a way to work within industry definitions (e.g., NAICS or other organizing principles such as those implemented by the SIA) and structures to see if it is possible to capture innovation in services and how best to begin to make some headway in that direction

Conclusions and next steps

Follow up activities suggested by this research indicate that there is a need to talk to and work with the organizations reviewed here, and others, determine their ability/desire to participate in ongoing surveys/research on innovation within their industries. This raises the question of the sorts of resources that would be required and what an initial reporting model and structure might be.

There is also the issue of who is the right person to work with within the industry organizations and within their member firms. Finding someone who holds the innovation metrics brief in the organization might be a challenging task. Something this simple might actually serve as a showstopper. After all, few individuals in corporate America have titles containing the term innovation.

Stumbling blocks to successful next steps activities also include:

1. the best candidates indicators are, at this time, not self-evident,
2. there is a need to evaluate indicator criteria and develop practicable definitions,
3. following the definition phase, work will have to be done to determine the need and ability to structure composite indicators that identify trends that are constructed of manageable business indicators.
4. a need to evaluate and compile indicators that relate to government policy options and policy support so that the metrics developed can be used to determine regulatory and legislative options that are actionable.

5) Process for Assessing the Value of Available Indicators as Innovation Vital Signs

In order to properly determine the value of the literally thousands of indicators that were identified and compiled for the work in the IVS project, a structured and systematic approach to grading or 'scoring' candidate indicators was developed. The process employed was akin to a standard product development scoring exercise in which various types of candidate products or services are ranked according to a pre-determined set of criteria on the basis of a numerical scoring system. While not necessarily a highly rigorous process, the outcome of such exercises are typically very valuable in that they serve to structure impressions and catalyze thought into replicable and defensible positions. Also, when conducted with multiple parties engaging in the scoring exercise, the combined and averaged scores frequently tend to prove remarkably robust.

For the scoring of candidate indicators, in the IVS exercise we employed a simple five-point scale for ranking each of the candidate indicators according to a set of evaluative criteria. The scale was structured with 5 being the highest possible score and one being the lowest. Zero was left out as a candidate score as this would have effectively resulted in the scale being a six point ordinal, and there would have been no midpoint score available to the evaluators. The five-point scale was also chosen for the sake of being able to graph the outcomes of the scoring exercise with values that do not reside on either the vertical or the horizontal axis.

The actual scoring process was then structured to reflect the characteristics of the indicators in a way that would be meaningful to the determination of the potential for each indicator to be one of the key contributors to the final set of innovation vital signs that was the objective of this project. To do this we developed two primary scoring paradigms that had within them an additional four scoring measures each.

The primary scoring structures were the indicators' utility and quality. We used these concepts in the context of the scoring as appropriate key determinants of potential indicator value. Put briefly, we were concerned with both the quality of the indicator, that being defined as the factors that determine how well it actually represents what it purports to, and the utility of the indicator being an examination of how well it actually serves policy makers as a valid indicator of innovation activity.

The utility and quality scoring structures were further refined by employing an additional set of concepts, principles, and performance characteristics. This secondary set of criteria enabled us to rate the quality and utility of a given statistic or indicator relative to others on what is a subjective, but normative scale. These sub-criteria were developed with special attention to the intent of the exercise, as well as the need to develop a replicable methodology. The sub-criteria chosen to address the specific issues that we determined as key to considerations for selecting a set of realistic, and real world, indicators of innovation activities and outcomes.

The table below contains a summarization of the sub-criteria for both the utility and quality evaluations of candidate indicators.

Innovation Indicator Scoring Criteria

Table 5.1 Innovation Indicator Criteria - Utility	
Scoring Criteria	**Description**
Significance	This criterion is a measure for the relative significance or sensitivity of the indicator is as a measure of innovative or innovation activity, or as a determinant of innovation outcomes. It is also a subjective measure or how well the indicator is thought to correlate with innovation inputs, processes, and potential outputs. A low significance score indicates that the indicator's link to innovation is tenuous.
Policy Relevance	The policy side of the scoring has to do with the usefulness of the indicator to be connected to the policy process, and its helpfulness in assessing the *a priori* impact of alternative policy choices and policy-driven innovation outcomes. Ultimately, a high policy score should indicate that the measure in question is a lever that can be employed in driving policy-related innovation indicators, within the economy or the area under scrutiny.
Clarity	The clarity of the indicator, as defined for the purposes in our screening process, deals with the fundamental question of how well the indicator can be readily understood by a wide variety of stakeholders, and how well it actually represents the item that it appears to at face value. In general, direct indicators are given a high clarity score; indicators that are derivatives or composites tend to receiver lower scores. For example, total venture capital investment in an economy would receive a high clarity score. The average dollar value of venture investments over a five-year time span would receive a lower clarity score.
Acceptance	Or the scoring criteria used here, this might be the most subjective and hard to define. Essentially, this score is based on the evaluators' judgments on how well received an indicator is within the community that it serves, but it is also a judgment as to how well it might be accepted as a measure of innovation within that same community. It is also an evaluation that may be influenced by the number of other official and private sector sources rely on this data as a solid indicator of innovation activity. As an example, the R&D spending statistics for private business reported by a government statistical agency would have a high acceptance score. Unemployment rates for graduate engineers would have a lower acceptance as an indicator of innovation.

Table 5.2 Innovation Indicator Criteria - Quality	
Scoring Criteria	**Description**
Accuracy	The accuracy score is based on the reviewers' knowledge about the indicator being based on a credible primary source using a reliable methodology for data collection, analysis, and reporting. This is also the case for scores that might come from less reliable sources or covering an area where the ability to properly measure the data being reported come into question. Labor force participation data are well developed and regarded as highly accurate. Certain measures of the quality of the labor force, items such as educational attainment and participation in advanced training or employer-sponsored programs are liable to be regarded with a higher degree of skepticism.
Timeliness	The timeliness score is based on several items. The first is the fact that an indicator is reported on regular. The second element of the timeliness score is the frequency of that reporting. The third evaluative element would be whether or not the item under review, even if it is an irregularly reported item, is reported on with a minimum of delay. Industry data that is reported on a monthly basis with only a 4-week delay from the end of the previous month would receive a very high score. An indicator that is reported on annually with a 24 to 36 month compilation delay would receive a low score.
Comparability	There are several elements to a comparability score. The first is whether the indicator reports on the same item for each release of data, and this reporting is maintained consistently over time, with adjustments being made to maintain comparability. Another element of comparability is how well the indicator can be harmonized across domains (e.g. industry sector, regional, international, time). Does the indicator report on the same activity in all cases? Also, comparability can be called into question for items where the definitions of a process or a specific activity or achievement are not the same. An example is the number of employees in a given job category or activity. In some cases and engineer by one definition is not an engineer in the definitions used in other countries or industries.
Accessibility	The elements used to derive our accessibility scores were based on two factors. The first is whether or not the indicator is published in readily and publicly available data sources. The second is a consideration related to private sector data sources. In these cases, there was a second scoring concern added to the evaluation, that being consideration of whether the data collectors and compilers would technically be able to report out selected subsets of their data in order to track innovation. Another concern with private sector data, especially that compiled by market research firms, would be the ability or desire of such firms to report innovation-related data at no cost to the users of the data; users who would be looking to use the data primarily as an innovation context rather than within an industry context.

6) Results of the Scoring and Sorting Process

Taking all of the above factors into account, the actual scoring exercise yielded results that were interesting, and somewhat problematic, in their depth and range. The inputs to the scoring and sorting process are summarized in the tables that appear in Appendix B and Appendix C.

The Innovation Vital Signs indicators that are rated on Table 6.1 are the result of an analysis involving multiple factors. First of all, the indicators on this table are those that were identified by the individual members of the IVS project team. As such, more than one individual saw these as core innovation indicators. The actual scores are not presented on this table simply to limit the amount of data that is presented. The scores are available in the spreadsheet that appears in Appendix 4.

The indicators that appear in the table below are those that received the highest scores across the various utility and quality measures that were established. There were no particular cut-off criteria established for inclusion on this table. Rather, the scores are those indicated as the absolutes that were generated by the evaluation performed by the individuals on the IVS Project Team. As such, there are very few scores in which an indicator would rate a score close to a perfect 20 in either the utility or the quality score sheet. In fact, most of the high scores tended to arrange to round 15 or 16 out of the possible 20 on the utility side of the ledger, with a high score a quality side being somewhere in the 16 to 17 range.

Table 6.1 Innovation Indicators Scoring Summary

Indicator	Global	National	Regional	Enterprise	Private	Total
R&D	2	4	7	1	1	**15**
Talent	2	6	7	3	4	**22**
Capital	7	4	5	1	5	**22**
Networks	7	4	5	0	1	**17**
Management	3	1	0	1	1	**6**
Product Development	1	0	0	3	0	**4**
Efficiency	0	1	0	1	0	**2**
Process	5	3	2	1	5	**16**
Output	4	5	2	5	8	**24**
Impact	4	4	3	2	2	**15**
Macroeconomic	5	6	0	1	0	**12**
Policy	7	0	1	1	0	**9**
Infrastructure	2	4	3	1	3	**13**
Mindset	2	4	2	1	1	**10**
Total	**51**	**46**	**37**	**22**	**31**	**187**

The table above reveals a variety of interesting conclusions from the analysis that was performed. First of all, of the more than 3300 indicators evaluated to compile the chart, only about 6% of the total end up being selected as prime potential innovation indicators, i.e. innovation vital signs. It is also noteworthy that there are some substantial gaps that appear in the totals. Clearly, the categories of management, product development, efficiency, process, and mindset are all somewhat underrepresented relative to the totals for the other categories. It is also relatively self evident that there are an abundance of global and national indicators, but there seems to be a significant lack of enterprise-level indicators that might be employed to indicate innovation.

This is all the more interesting, given that the enterprise is where it is generally agreed that most innovation takes place. As such, this would seem to imply that a great deal of work needs to be done to better understand enterprise level innovation, and to develop indicators that would be useful and meaningful for innovation at the enterprise level.

It must be noted that Table 6.1 above there is a column for private sector indicators. The methodology employed to derive these indicators, and to break them up into their constituent elements, will be described in the next section. The indicators are presented here simply as a matter of choice, as it seemed logical to include them in the exposition of the various categories that were summarized in the table. It is interesting to note that the distribution of private sector indicators is not that different from that for the other national through enterprise-level indicators. The one exception would appear to be in the output indicators, where the private sector appears to have a better than average component of these types of data available. This is not entirely surprising, and quite in keeping with the nature of private sector indicators, which do tend to reflect industry output, and market oriented achievement.

From these preliminary summaries and indications, it is clear that there are more than enough indicators to serve as candidates for the innovation vital signs category for the US economy. The next steps in the project and therefore are relatively obvious. In the 180 plus indicators that have been derived from the evaluation to this point, must be further refined In order to bring the total down to a manageable level.

There should also be a concurrent effort to determine which of the 14 categories that the vital signs were grouped into are the most important. At this point, all categories appear to be getting equal weighting across the score sheet. This may be an appropriate. It may well be the talent and capital are more important drivers of innovation than our infrastructure and mindset, however, that is simply supposition and must be tested with other inputs noted to verify or qualify those possibilities.

This being the case, the project’s next step of conducting a data user and data preparer expert-driven workshop to review the indicators identified at this point, and to solicit their perspectives on which should be prioritized, seems to be an extremely desirable activity. This workshop will help validate the output of this project by reviewing the results and the value of the exercise to date. It will also enable us to solicit the suggestions from the assembled experts for how the work can best proceed in the next phase. Collecting the opinions of those within the innovation community, and the innovation measurement community, is therefore a vital next step in identifying and determining which of these indicators are indeed the best candidates for consideration as innovation vital signs.

7) Process of Compilation of Private Sector Indicators

This section discusses and summarizes the potential to use private sector sources of information – as provided and maintained by industry associations and other organizations working at the industry level – as a source of innovation indicators that might serve as contributors to the development of the select set of indicators that are found to be *innovation vital signs* for the US economy.

Organizing Principle – we chose to use the economic/industry framework that is mapped by the US Census Bureau and the Bureau of Economic Analysis in the NAICS system as the basis for considering and examining the sources and uses of innovation indicators within the private sector of the US economy. This provided an established foundation upon which to build the compilation of industry information that might be available. This also gave us the ability to perform the scoring exercise that was done for the extensive list of public sector sources that is described above.

Prioritization of Industries Examined – the search for private sector innovation indicators was limited to private industry and was further narrowed to include a prioritization of industries that was included on the basis of their relative contribution to GPD in 2004, the last year for which the data is available. This prioritization was narrowed using an algorithm that was based on two digit NAICS industry groupings. These industries and their contribution to GDP were reported on in the initial project report provided in December and are not repeated here.

Identifying Leading Organizations – under the assumption that statistical information programs are usually maintained by the larger, established industry associations, a quick survey of industry sources was conducted to find a) the organizations who are the leaders in their industry, and b) industry groups who are leaders in the development and maintenance of industry statistics. Having these characteristics combined in a single organization was not a unique occurrence. What did prove problematic was the discovery that in non-manufacturing organizations and industries there is not a great deal of statistical information available, much less information that either directly, or by proxy, tracks innovation.

Identifying alternate (non-industry) sources of information – while industry and trade groups are obvious candidates to be sources of industry data that might serve as innovation indicators, there is also an industry of firms who research industries, their evolution, and events in them. Some of these are repositories for time series data and other information on the industries in which they specialize, which range from manufacturing to health care, but are heavily represented in the information technology sector, as well as other emerging industries where changes are rapid as they mature and evolve. A sampling of such organizations was contacted and findings about their ability to become sources of innovation data are summarized through the evaluation of their statistics that were scored according to the same methodology as that employed in the analysis of public sector sources.

Process of Evaluating Available Indicators for Inclusion as Innovation Vital Sign - while the nature of the private sector indicators is somewhat different than is the case for the public sector indicators, the analysis and scoring mechanism employed to identify the appropriate potential innovation, vital signs was essentially the same as that used in evaluating the public sector indicators. This means that the indicators are identified with the various industry and professional groups, as well as the market research firms, were evaluated based on the utility and quality criteria that had been established earlier.

In some cases, this was a bit of a forced fit as the indicators were items that were not compiled in an ordinary statistical type of a construct. An example of where this might be the case would be for a professional society that publishes a journal for its occupational cohort. These journals are frequently full of all manner of indicators for the population that serves, frequently sour indicators with things dealing with other forms of benchmarking, but these data are not gathered routinely for the purposes of analysis and relaying to the audience.

Such instances were, however, the exception rather than the rule. For the most part, utilizing the utility and quality criteria for the indicators that are compiled in the private sector appears to be a reasonable fit. One of the key differences is that the majority of the indicators that were examined tend to be items that are compiled and reported to a participating group within an association's membership. This being the case clearly impacts the factors that were used to determine the quality of the indicator. If it were not widely available, then clearly it would tend to receive a low accessibility score. This is also the case for indicators that are compiled by market research firms. While many of them do develop a significant database of indicators for specific industries or specific activities within their client firms, the large majority of such statistics and data are not readily available to the general public.

Results of the Sorting and Scoring Process – One thing that can be concluded from the examination of the private sector data sources that were evaluated and scored is that these data sources provide a very rich and potentially very fertile area from which significant numbers and varieties of innovation indicators might be developed. The caveat here is that the majority of the data sources that are available are not focused on innovation as a topic. Therefore, potential use of private sector data as innovation indicators is something that must be carefully considered, and something that must be approached with an element of caution. While there are many indicators available, and many of them lend themselves quite well to an analysis of the drivers of innovation within an industry, this is not to say that the indicators that are currently available can be directly translated into an innovation construct.

When reviewing Table 6.1 containing the innovation indicators scoring summary in Section 6 above, there is a clear overrepresentation of private sector indicators. This is essentially a matter of choice on the part of the IVS project team. Given that there was so much fertile ground and high potential for innovation indicators that can be elicited from the data sources that were examined, we chose to perhaps overweight the potential that these data sources had relative to what could be elicited at present. This is especially the case were some of the emerging areas within industries, and also for much of what might be termed the soft side of the entire innovation process.

Given that we recognize this relative over representation of private sector indicators within the 187 total that were elicited from the other areas that were scored, this is an area that can easily be remedied with further analysis. This is precisely our intent, as we planned to gather a variety of private sector indicator experts from within the user and data supplier components of the private sector at the innovation indicators workshop that is a part of the activities of the IVS project. We believe that these individuals are best equipped to deal with the uncertainties and ambiguities that we have found in the private sector data. We will expect to look to them for guidance as to the ability of these indicators to meet the targets that we have set for them. It should make for a lively and her revealing set of discussions.

8) Combined Results of Screening and Sorting of Highest Ranked Indicators

Table 8.1 shown on the following page presents a summary overview of the results that were generated from the scoring and ranking process described above. What we have tried to show in the chart are the results from two different perspectives.

The first is an effort to portray the number of indicators that were examined across the global national, regional, and enterprise categories that we established. As can be seen on the chart, the global indicators are by far the most numerous, followed by national, regional, and enterprise in that order. This is interesting, and perhaps unsurprising. Given that there is such an intense interest in the relative competitiveness of different economies and countries, the existence of an established structure of the global indicators tied to innovation and competition should be no surprise. In fact, if the global indicators were not in the lead, it would be surprising.

What is readily apparent on this chart is that there are several areas with considerable Information gaps that can be identified. The categories of management, product development, efficiency, and mindset are all relatively underrepresented. What can also be seen is that this relative under- or over-representation is reasonably consistent across the geographic categories employed, though there are some areas in which that is not the case across the board.

We could spend considerable effort in reviewing these categories and the various indicators in this report, but at this point it seems somewhat premature to engage in a detailed discussion and analysis. There are simply too many unanswered questions remaining regarding both the nature and the application of these indicators within the various categories and subsets that we have identified. There are too many unknowns to be able to draw firm conclusions regarding which of these indicators might be the best for the purpose of identifying innovation in all its various manifestations.

This being the case, rather than engage in direct analysis, we took an alternate tack to evaluate where our scoring left us with respect to the quality and utility of the indicators that we had identified. In the left-hand side of the table below, the area labeled *percent of available indicators selected*, there is a summarization of the percent of the available indicators that were sorted and filtered through our mechanisms that ”made the grade" as a candidate for further analysis, and ultimate selection as one of the final innovation vital signs.

The figures on the table or a combination of the data presented in table 7.1 above, and the count of available indicators on the four were right-hand columns of table 8.1. The breakdown revealed in this cross comparison is intriguing. The range in the percent of available indicators that ultimately were selected to the next round of candidacy runs from 100% to zero.

Perhaps the best benchmark for determining the quality of individual indicator through its ability to survive the sorting process would be to view the center column labeled total. This column has the combined total of all the indicators that were available for the individual categories running down the page a left-hand column. At the bottom of the center column, we show that only 5% of the available indicators were ultimately selected through the filtration process that we employed to find and prioritize the available indicators. From this benchmark, any indicator grouping with a value of above 5% is higher than average, conversely, any grouping with a value below 5% is below average.

Judging from the available statistics, it appears that the national and regional indicators are, as a group, stronger than the enterprise and global indicator selections. This appears to be particularly the case for the national indicators, which should be no surprise since they would be expected to show particular strength in the macroeconomic, capital, and mindset categories.

One thing that is clear from the analysis and the exposition in the table below is that we have a potential problem with what might be termed small sample bias. There are clearly a variety of categories in which there simply are not that many indicators available, as such in a judgment made against those indicators is something that is subject to further analysis and potential error. It is most likely safe to assume that any category that has fewer than 25 indicators is most likely prone to some serious concern about the quality and veracity of these indicators. It may be that these are indeed among the best indicators in the entire population, but it would be reassuring to have more, and more established, indicators across some of the areas with these small sample sizes.

One final observation with respect to table 8.1, we intentionally and left the private sector innovation indicators off of this comparison sheet. This is because we did not truly perform the same sort of evaluation for the private-sector indicators as is done for the publicly source data. The primary difference being that in the public sector world, especially in areas such as global or national indicators, we had a very large array of choices to make and candidate indicators to evaluate. In the private-sector organizations that we reviewed and analyzed, we found a variety of potentially interesting indicators, but we are quite certain that we came nowhere near to having the same degree of coverage across the different trade and professional groups that we have for the public sector data.

This is especially true in the case of the market research/market information firms that we identified and reviewed. Many of these firms have dozens of data series that they maintain, and others are routinely perform special studies for individual sectors based upon client interest. While it is theoretically possible to perform the same kind of exhaustive senses of available indicators across the private sector, the parameters of this project do not have the resources available to even begin such a large and complex endeavor.

However, despite the limitations of the capabilities of this project, there is every reason to continue to explore alternative sources of data for potential use as innovation indicators. The vibrancy and the dynamism of the economy indicates that in many industries and the practitioners within a discipline or well ahead of the statisticians who would like to monitor the activity. It is in these emerging areas that the private sector works to provide information that is needed and highly valuable to market participants. Keeping abreast of such activities, even though there may be no official statistics available, is one way of ensuring that the foundations are laid for a future in which some version of consistent and robust monitoring of the emerging industry is provided for the similarly, monitoring these emerging sectors and activities might result in the development of some version of an indicator of overall innovation activity that no one has currently managed to put together.

Table 8.1 Innovation Indicators Scoring – Percent of Total
Indicators Selected as Candidate Innovation Vital Signs

	Percent of Available Indicators Selected					Count of Available Indicators			
Indicator	Global	National	Regional	Enterprise	**Total**	Global	National	Regional	Enterprise
R&D	0.8%	2.1%	8.8%	50.0%	**522**	253	187	80	2
Talent	0.9%	3.6%	4.8%	42.9%	**550**	227	169	147	7
Capital	2.8%	12.5%	9.3%	5.9%	**353**	250	32	54	17
Networks	14.0%	14.8%	10.6%	0.0%	**132**	50	27	47	8
Management	23.1%	100.0%	0.0%	4.8%	**35**	13	1	0	21
Product Development	100.0%	0.0%	0.0%	9.1%	**36**	1	1	1	33
Efficiency	0.0%	25.0%	0.0%	25.0%	**18**	10	4	0	4
Process	7.8%	100.0%	18.2%	0.6%	**253**	64	2	11	176
Output	8.0%	55.6%	8.7%	3.1%	**244**	50	9	23	162
Impact	3.2%	6.9%	2.5%	18.2%	**315**	126	58	120	11
Macroeconomic	5.5%	10.7%	0.0%	50.0%	**149**	91	56	0	2
Policy	5.9%	0.0%	50.0%	5.9%	**141**	119	3	2	17
Infrastructure	1.4%	6.3%	5.1%	4.0%	**292**	145	63	59	25
Mindset	12.5%	18.2%	4.9%	14.3%	**86**	16	22	41	7
Total	**3.6%**	**7.3%**	**6.3%**	**4.5%**	**5.0%**	**1415**	**634**	**585**	**492**

9) Innovation Vital Signs Workshop – Processes and Results

In addition to the research component of this project, there was also a workshop conducted in order to gather outside opinion on the topic of innovation and potential ways to identify, develop and deploy indicators for innovation. The workshop was also used to present the results of the analytical work to-date to an audience of individuals who are knowledgeable in the area of economic statistics and related metrics to get their feedback on the processes used and the conclusions reached by the IVS Team.

Figure 9.1 Periodic Table of Innovation Elements

Periodic Table of Innovation Elements

R&D														
Expenditures														
R&D	Capital											Impact	Impact	MacroEcon
Patents	Gross Capital Formation											# Innovative Enterprise	Birth Rate New Enterprises	Average Hourly Earnings
Talent	Capital											Impact	Impact	MacroEcon
# Researchers	ICT Investment											S&T Employment	Net Change Enterprises	Gross Private Investment
Talent	Capital	Networks	Networks	Networks	Management	Prod Dev.	Process	Process	Output	Output	Output	Impact	MacroEcon	MacroEcon
No. with Higher Education	Initial Public Offerings	Broadband Penetration	SMEs with Cooperation Arrangements	# Business Incubators	Entrepre-neurship	# Approved Patents	# Cooperation Agreements	R&D Used From Overseas	Sales New to Market	# New Products Introduced	New Markets Created	Leading Competitiveness Indicators	Real GDP	Real Interest Rates
Talent	Capital	Networks	Networks	Networks	Management	Prod Dev.	Process	Process	Output	Output	Output	Impact	MacroEcon	
Verbal SAT	Angel Networks	Computer Use per Capita	Intern'l Alliances	# Internet Domains	Quality of Management	Time & Money to Develop	Early Stage Entrepreneurial. Activity	Innovation Expenditure	Sales New to Firm	Output per Sector	Export Sales	High Tech Jobs Gained & Lost	Real GDP per Capita	
Talent	Capital	Networks	Networks	Management	Management	Efficiency	Process	Process	Output	Output	Impact	Impact	MacroEcon	
Math SAT	SBIR Funding	Internet Use by Business	Federal Lab CRADAs	Shareholder Value	# of Ideas	Availability Competent Managers	Research Quality	Enterprises Innovating In-House	Royalty, License Fees	New Companies Created	High Tech Exports	Income per Capita	Inflation Rate	
Talent	Capital	Networks	Networks	Management	Prod Dev	Efficiency	Process	Process	Output	Output	Impact	*Future*	*New*	*Metrics*
Pop with Life Long Learning	Investment Risk	Broadband Costs	University Spinouts	Customer Satisfaction	Technology Absorption	Cost Reduction	Quality of University Collaboration	Product Launch Speed	Overall Productivity	Value Add of SMEs	Employment in High Tech Sector			

Policy	Policy	Policy	Policy	Policy	Infrastruc	Infrastruc	Infrastruc	Infrastruc	Mindset	Mindset	Mindset	*Future*	*New*	*Metrics*
Corporate Tax Rate	# New Taxes, Excises, Duties	Time Required to Start Business	Foreign Ownership Restrictions	Rule of Law Governance	IP Rights	Environment Governance	Legal Rights Index	Home Affordability	Public Source of S&T Information	Informed about Policy Issues	Value Place on Creativity			
Policy	Policy	Policy	Policy	Infrastruc	Infrastruc	Infrastruc	Infrastruc	Mindset	Mindset	Mindset	Mindset	*Future*	*New*	*Metrics*
Overall Tax Burden	# Procedures to Start Business	Trade Barriers	IP Protection	Judicial Independence	Infrastructure Quality	Openness to Competition	# of New Bldgs Designed	Youth Interest in Science	Public Interest in S&T	Science Literacy	Wish to Own Business			

Innovation Element Groups (Families)*

Inputs	Process	Outputs	Impact
Macro-Economy	Policy	Infrastructure	Mindset

Overview and Intent of the Workshop – the workshop was part of the project schedule from the inception of the work. The concept and focus of the workshop was reasonably straightforward. One underlying concept being that the IVS team, while knowledgeable in the area of innovation, could expand its own understanding of innovation measurement issues by tapping into a larger experience base and more diversified group. Therefore, the intent of the workshop was to collect and synthesize the combined insights of identified thought leaders who could provide perspective on the innovation ecosystem as it functions from their viewpoint and within the context of their specific needs.

The audience for the workshop was divided into two major subgroups. The first of these was what can best be termed data providers, or data developers. The other population consisted of individuals who are experienced data users and analysts.

People in the data provider category can be broken down into two primary groups. The first of these were government statistical professionals. These are people whose professional responsibility includes the production of statistics that are published by government agencies. These statistics include everything from the research data compiled by the National Science Foundation, to the economic data compiled by the Department of Commerce, to the workforce and employment data that is compiled and published by the Department of Labor.

Members of the other major subgroup of data developers invited to the session were from organizations that are private sector statistics providers. The majority of these tend to be trade associations or professional groups who collect data on their particular industry. While their mandate typically is focused on the collection of market-oriented data, there is keen interest in many of these groups on the topic of innovation and how they might be able to contribute innovation statistics to their industry that is incremental to the data currently being collected and compiled.

The data users in attendance at the workshop were a very diverse group. Among these were representatives from manufacturing organizations who are very interested in the compilation of innovation statistics as it relates to their particular industry sector. Similarly, there were representatives from the service industries who are facing the issues of understanding innovative processes and innovation inputs and outputs as it impacts their industry. The data users were also represented by individuals whose organizations are driven by public policy concerns. Measuring innovation is critical to their ability to gain a better understanding of the economy; specifically the economy as it transforms itself from the industrial age to what is frequently referred to as the information age. Other user communities represented included educational institutions, organizations interested in the financing of innovation, and organizations whose mandate is targeted to economic development within a specific geography or industry. Clearly, the user community is very broad and diverse. It is equally apparent that the need within the user community for better innovation statistics and metrics is tangible and growing.

Rather than seek to engage in a broad-brush discussion of the need for innovation indicators and better statistics on innovation, the workshop focused on strictly the following three items:

- Which of the innovation indicators identified and evaluated by the IVS Project team are the most potentially useful and why?
- What gaps can be identified in this initial list — and what might be added to remedy the gaps?
- What are the options for accessing and reporting these indicators in a timely manner, and what presentation formats might be employed to maximize their information impact?

The format of the workshop was one of the unique attributes of the activity. Rather than focusing on a structured, traditional 'speaker then question from the audience' type of session, the workshop had a series of brief presentations by knowledgeable speakers followed by small group discussions. These were enabled by the physical setting that included tables with no more than six seats for participants at any given table. In order to facilitate a maximum amount of group interaction, participants were given instructions for changing seating after each of the presentation sessions. The intent of this was to ensure that in the breakout groups no two individuals where at the same table for any of the discussion sessions. The workshop agenda appears as *Appendix G*.

In addition to the session being structured to be interactive, the intent was to also maintain in informal environment and extract tacit knowledge and learn through interaction. The theme for the session was the "Innovation Café," and the setting within the room where the session was held was equipped to resemble a restaurant. The tables were covered with white paper. The idea being to enable the participants to scratch notes on the table, draw designs, record key discussion points and connect ideas. Each table was also provided the day's program as a menu of selections that would be presented as a multi-course banquet of focused thought and discussion.

Adding to this atmosphere, where several devices designed to collect ideas for later compilation into a collective wisdom of the group. The first of these was the creation of the *"Periodic Table of Innovation Elements"* that appears as Figure 9.1 on the first page of this summary. The periodic table was conceived to depict the many elements of innovation that need to be considered when the objective is to review and provide an evaluative structure for innovation within the economy. The Table does just that, with apologies to Mendeleev, categorizing elements according to sub groups and placing them on the Table according to, at least in theory, their position, and relative weights in the innovation ecosystem.

Another device that was created and used in the session was the depiction of the *"Global Geography of Innovation Measurement."* This was constructed as a mapping of the key 'continents' and other topographical features of the geography. The intent of the geography was to facilitate the collection of information on hexagon shaped Post-it notes that were then posted on a larger wall-mounted map of the "Global Geography." The group informally called it the *innovation beehive*. These notes were captured electronically and the data on them compiled for this report. A summary of the information appears in the discussion below. This is supplemented by a detailed listing of the individual comments that were collected and pasted onto the map. This detail is provided in Table 9.2 presented at the conclusion of the summary.

Figure 9.2 Representatives 'Geography of Innovation Measurement'

Each breakout session tables was assigned a preselected moderator. The moderator's guided the discussion, keeping participants focused on the key questions to be covered, and also captured the contributions of the individuals at the table engaged in the dialog. These comments have been compiled and summarized in the discussion appearing below.

Figure 9.3 Representative 'Geography of Innovation Measurement' – filled with participant notes

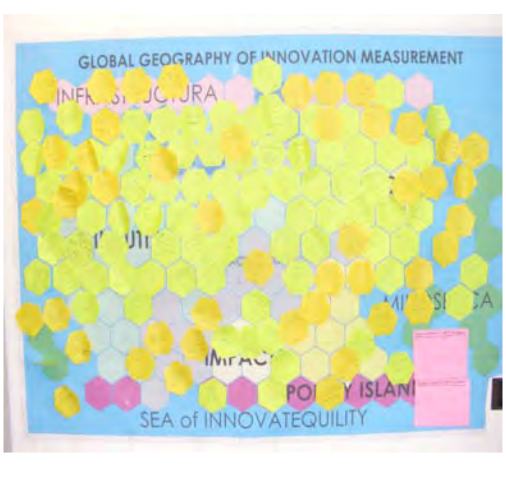


Figure 9.2 above, and Figure 9.3 immediately to the left, depict the before and after of the Innovation Vital Signs workshop. As this was an interactive exercise, capturing the comments of the participants was one of the key objectives of the day. Figure 9.3 is an image of the 135 comments that were captured as Post-it Notes that were applied to the "Geography of Innovation Measurement." These Post-it notes were placed on the large map at the close of each of the three topical sessions and were designed to serve as a first order summary of the group discussions. The comments themselves, their placement on the geography, and their qualification as either a favorite indicator or a gap are summarized in Table 9.2 that appears at the close of the discussion of the group session comments.

As such, there is a correlation between the posted notes and the items that appear in the detailed discussions. However, this is not a one-to-one correlation as there was no attempt made to eliminate duplication of items on the Post-it notes. Thus we captured patterns of similarity and divergences among discussion groups. Indeed, it was possible for two discussion groups to develop the same indicator and post them independently. Similarly, items that were shadings of the same issue would also appear on the geography.

Participant List –Attendance was by invitation only. The individuals and organizations invited were selected on the basis of their being active in innovation issues, their knowledge of innovation processes, and their familiarity with the topic of measuring and quantifying innovation. As such, this was not an average group. Nor was it a random sample of minimally interested parties. The knowledge that the invited parties brought to the session enabled a far deeper and richer discussion to take place at the workshop. Table 9.1 below is a summary of the individuals who were participated in the workshop.

Table 9.1 Innovation Vital Signs Workshop Participants

Organization	Contact	
AAAS	Kei Koizumi	
ACS	Anthony Pitagno	
Applied Materials	Bill Morin	
ASEE	Eric Iversen	
ASTRA	Burk Kalweit	
ASTRA.	Bob Boege	
Athena Alliance	Kenan Patrick Jarboe	
Center for Accelerating Innovation	Egils Milberg	
Coalition for Academic Scientific Computing	Sue Fratkin	
Delmarva Strategies	Lewis Perelman	
Duke University	Vivek Wadhwa	
Eiger Lab	Tom McDunn	
Federal Lab Consortium for Tech Transfer	Ed Linsenmeyer	
General Motors	William Peirce	
General Motors	Pat Schuch	
George Washington University	Dr. Elias Carayannis	
George Washington University	Tony Stanko	
George Washington University	Brock Rolfes	
GUIRR	Merrilea Mayo	
IBM	Taffy Kingscott	
IBM	Susan Tuttle	
IBM	Christopher Francis	
IEEE -USA	Martin Sokoloski	
ITIF	Robert Atkinson	
Massachusetts Innovation Initiative	Michael Tavilla	
Materials Research Society	Ron Kelley	
National Cancer Institute	John Hewes	
National Science Foundation	John Jankowski	
NCMS	Richard F. Pearson	
New Economy Strategies	Steve Miller	
NVCA	Emily A. Baker	
OIDA	Gordon Day	
Orbital Research	Bob Schmidt	

Organization	Contact	
OSA	Laura Kolton	
Semiconductor Research Corporation	Larry Sumney	
SIA	Daryl Hatano	
SIA	Ian Paul Steff	
Southeastern Universities Research Ass'n	Greg Kubiak	
Techvision 21	Kelly Carnes	
Techvision 21	Carroll Ann Mears	
University of Arkansas – Little Rock	Mary L. Good	
Univ of Central Florida	Greg Schuckman	
Univ of Massachusetts	Jeffrey Brancato	
Univ of Missouri	Lex Akers	
Innovation Consultant	Dawn Meyerriecks	
Dept. of Commerce, Tech Admin.	Mark Boroush	
Dept. of Commerce, Tech Admin.	Connie Chang	
Dept. of Commerce, Tech Admin.	Donald Devereaux	
Dept. of Commerce, Tech Admin.	Harold Pyon	
Dept. of Commerce, Tech Admin.	John Sargent	
Dept. of Commerce, Tech Admin.	Marjorie Weisskohl	
Dept. of Commerce, Econ & Stats Admin.	Patricia Buckley	
Dept. of Commerce, Econ & Stats Admin	David Brede	
Dept. of Commerce, Econ & Stats Admin	Cassandra Ingraham	
Dept. of Commerce, Econ & Stats Admin.	Jane Molloy	
Dept. of Energy	Elliott Levine	

Workshop Activities – The workshop was divided into three separate sessions, each of which consisted of a series of brief presentations by a panel of speakers that was followed by group discussions among the workshop participants. The presentations provided by the speakers are summarized below. The electronic versions of these presentations have been provided to the Technology Administration in advance of the submission of this report. The presentations are therefore not included in the body of this text, nor are they contained herein as an appendix. Those wishing to obtain copies of the presentations can obtain them either from the Technology Administration, from ASTRA, and from the individual speakers.

The discussion below summarizes the remarks of the speakers and also contains a summary of the high points of each presentation.

Panel I Topic: **Exploring Currently Collected Innovation Data, Including Economy-Wide and Sector-Specific Indicators, How to Include the Perspective of Small Companies and Entrepreneurs**

Panel Participants:

Michael Tavilla – John Adams Innovation Institute, Massachusetts Technology Collaborative
John Jankowski – National Science Foundation
Daryl Hatano – Semiconductor Industry Association

Michael Tavilla
Mr. Tavilla's comments were focused on the experience of the John Adams Innovation Institute and its activities in promoting economic development for the state of Massachusetts. The Institute is both a user and a provider of innovation data. This gives it a unique perspective on the issues being addressed in the workshop. The organization is very familiar with the sorts of innovation indicators it employs, is knowledgeable about the indicators it would like to have, and it is equally familiar with the issues related to actually compiling and reporting such data. Mr. Tavilla focused his comments on the nature of the data that the Institute compiles, that being primarily a collection of governmentally provided statistics that are compiled for a geographically targeted provision of information just for the state of Massachusetts and its regional neighbors. One of the issues raised in compiling such regional or state level information is comparability. Comparability, as defined by Mr. Tavilla, included both the concept of being able to compare state data to state data across different geographies, but also includes the concern that at times the data series are not comparable from year to year as there are shifts in employment and shifts in the types of industries that are in operation within the state. To the degree that there is an ongoing transformation of the state economy, the challenge to organizations such as the Institute is to do the best they can to capture what is currently available, while also working to lay the groundwork for future indicators.
John Jankowski
Mr. Jankowski's comments were appreciated by the participants, given his specialized role within National Science Foundation, where he is one of the people responsible for the compilation of many of the indicators that are currently used to measure innovation within the US economy. Mr. Jankowski focused his remarks on the efforts that are ongoing within the National Science Foundation, and across the other governmental statistical agencies, to capture those elements of innovation that are the most meaningful. While he currently supports significant educational achievement and research and development surveys, Mr. Jankowski fully appreciates that the statistics that are available are less than ideal. He concluded his comments by saying that he appreciated the opportunity to speak to the group, and looked forward to their remaining engaged in the processes that are ongoing to develop the next generation of innovation indicators and/or metrics. He noted that there is much activity ongoing within the US and across the world, but at this time no one has the answers to finding the best set of indicators for innovation. That being the case, he suggested that the broadest possible participation by all elements of the economy would be required to ensure that the indicators that are ultimately developed will be well suited to their intent. He declined to offer any perspectives on when improvements to existing indicators or any new, innovation-targeted new data series might begin to surface.
Daryl Hatano
Mr. Hatano spoke from his perspective as the person responsible for the compilation and reporting of one of the most advanced technology, and potentially innovation-related, statistical series in the world. The Semiconductor Industry Association currently compiles market statistics on semiconductor production and sales, and has done so for over 20 years. In the process, it has

compiled a unique picture of its industry and the migration it has gone through as it has been the enabler of Moore's law. While the market statistics compiled by the SIA are among the best for any industry, Mr. Hatano focused on the fact that there are some significant issues related to the data that must be acknowledged and can serve as lessons for the compilation of innovation data.

He also pointed out that the industry has globalized and changed so rapidly that it is difficult to keep up with the definition of what a semiconductor manufacturer is. The development of fabless chipmakers is one of these. Similarly, there are questions about the nationality of production and sales. He described how the statistics are currently assembled, but also examined how the statistics can be misleading to those who are not knowledgeable about the process employed in the data gathering and compilation.

Mr. Hatano concluded his remarks by saying that his industry's problems are not unique. He is quite certain there are similar issues at hand in many other industries. That being the case, he emphasized his support for the position taken by Mr. Jankowski. He agreed that without industry support, and industry knowledge of the subtleties and nuances of manufacturing and distribution processes, any metrics of innovation within an industry would be sub-optimal at best, and significantly in error at worst.

Session 1 – *Exploring Current Innovation Data* – participants were asked to consider the array of currently available innovation indicators and statistics, and from their own knowledge and experience, offer observations on the strengths and weaknesses of the indicators they are most familiar with in adequately measuring innovative activity across the economy.

	Summary of observations captured from IVS breakout session 1 The items below are some of the observations that were provided by the groups in the breakout discussions. What will become self-evident is the fact that the line between current innovation data and what was discussed as gaps is relatively indistinct. The discussions frequently ranged from a perspective on favorite indicators to a listing of the flaws with those indicators and how they might be improved to be more accurate, more timely, or more reliable.
1	**Venture Capital Data --** it was the opinion of the group that venture capital data is one of the stronger data points reflecting innovation and innovative activity. This was not to say that the data was perfect, far from it. But the overall belief was that the data was a reasonable proxy for the volume of innovative activity occurring in the economy. In order to improve any indicator based on venture capital data, the group believed that breakdowns of the data would be desirable. There are a number of options available to further disaggregate the venture capital funding data. Among the options discussed were items such as funding levels by a specific type of activity being sponsored (i.e., whether the funding was an initial round, or a secondary or tertiary round). There was also a discussion about whether funding trends could be tracked by the type of firm or firms involved. There was a recommendation that venture capital activity be followed on a geographic basis at a more refined level than it currently is. There was also a belief that venture investment broken down by type of industry or technology would be useful. Overall, the group and viewed VC funding as a solid proxy for innovative activity, but not one without problems. That being said, the group agreed that most of the problem areas that were known regarding tracking venture capital activity could be solved.
2	**Value-added Growth --** this measure was suggested by a participant who came from Europe and is familiar with the mechanisms used to derive such statistics there. It was the thinking of the particular individual, as well as the group, and that this offered an interesting proxy for the application of innovation within an industry. There were, however, was some questions as to how accurately this could be applied in the United States. Also, given that value added growth -- defined as the change in value added over time within a firm, industry, or an economic sector -- is what is being measured, this would appear to be an indicator that is perhaps two or three steps removed from the actual innovation that might be occurring. There were also some questions raised as to the methodology for measuring this value added construct. This uncertainty was reflected in the discussion. A concern was that the statistic might be subject to being manipulated

	by financial considerations within a firm. An example would be a reduction in work force that is administered arbitrarily yet yields an increase in value add.
3	**Patents** -- patents were universally viewed as being an indicator of innovation in virtually all sectors of the economy where patent activity is rigorously track. However, the concern was that the current patent system does much to mask innovation in favor of staking out "technical turf" that might be useful in generating some form of future value for the technical breakthrough that is being patented. There was a lively discussion as to what element or aspects of patents might be tracked as good indicators of innovation. The group agreed that there is a need to follow up on some of the work done recently that indicates patent value tends to cluster over time around key researchers and key technologies. This being the case, the consensus of the group was that an effort to track these cross- correlations as an indicator of true innovation might be a valuable exercise. There was also a discussion related to the actual use of patents over time. This is another area fraught with concern due to the considerable lag in the patent approval process that currently exists. The concern is the application for so-called defensive patents; patents that are incremental on earlier work, but nonetheless appear to be patentable despite the minimal incremental technology contained. The group believed that sifting through the patents to attempt to find high-value patents relative to those that appear to have less potential value might be warranted as an indicator of innovation.
4	**Capacity Measures** -- there was considerable discussion on appropriate ways to measure innovation capacity. One of these was determined to already exist in the form of the statistics available on R&D investment. Others that were offered as examples of capacity measures were things such as educational achievement, or perhaps measures that would quantify faculty and staff within institutions of education at all levels. It was believed that while much attention has been paid to such measures, the linkage between them and the economy's overall innovative capacity still has far to go in terms of establishing firm correlations and/or causative links. Other measures of innovation capacity offered for potential inclusion were items such as early-stage funding from either venture or angel investors, the adoption of broadband Internet access across the nation, adult education being pursued at a variety of levels, and finally, changes in workforce composition. All of these are items that are at some level measured today, but all of these are also recognized as less than ideal measures of the capacity for innovation.
5	**Measures of Corporate Culture --** this was something that was discussed under the assumption that statistics on culture are kept within larger corporate environments, but largely not kept at most smaller firms. The issue raised was whether it is possible to measure a firm's anthropology in terms of how it treats innovation and the people within the firm who are identified as, or choose to be, innovators? The discussion concerned whether or not such measures would be, or could be, made available to the public. Clearly there are a variety of privacy concerns related to any measure of corporate culture. But equally true is the fact that an organization's approach to innovation, if quantifiable, would be a valuable statistic to compile and assemble into an indicator of the nation's belief in the value of innovation. The significant hurdle here, of course, is that measures of culture are not something that are as easily quantifiable as measures of output or sales. There was nonetheless keen interest on the part of participants in considering ways that corporate culture might be captured and reported as part of the nation's overall innovation and innovative vitality.

6	**Public Sector Enterprise Innovation Indicators --** part of the discussion was devoted to a consideration of the fact that in many nations the public sector is a significant provider of services. This is particularly true in European countries where it is relatively commonplace to have transportation systems that are nationalized, energy distribution systems that are nationalized, telecommunications providers that are nationalized, and a myriad of other types of organizations that are chartered by governmental entities and operating as quasi-corporate organizations. Given that these types of organizations are an important and significant part of the economy, their ability to innovate as successfully as private sector concerns is important to their economic success, as well as the success of the economies in which they operate. For a variety of reasons, there is an expectation of a difference between the performance of nationalized firms and the performance of private sector firms. However, recognizing that nationalized firms in some locations perform the same services as private sector firms puts the onus on those nationalized firms to make an effort to be as productive as their private sector counterparts. This is, of course, easier said than done. Given that nationalized firms operate with some element of policy imperative that transcends the economic, their operations, and their ability to change operations to suit changing and regional and global economic environments, would be expected to be different than those seen in private sector firms. That factor notwithstanding, it may well be that measuring innovation and understanding the ways in which these organizations innovate is as important, if perhaps not more important, than the innovation potential of private sector firms in the same industry. Given this difference of objectives and organizational mission, developing appropriate measures that apply equally to both sides of the supply equation – public and private – is an exercise that will require thought as well as a deeper understanding of the uniqueness of these organizations.
7	**Service Sector Innovation --** this was an area that was mentioned as a significant weakness in the current structure of reporting innovation. The individual raising these concerns noted that innovation in the service sector comes in many guises, ranging from things such as patents, which are relatively easily quantified, to items such as business model innovations that are highly productive and highly profitable for the firms that employ them, but largely unquantifiable for most observers. There was also the issue of segregating the service sector into its multiple components, all of which have very different productive processes, and frequently very different levels of expertise and knowledge required to perform the duties of a service sector organization. One need only think of the difference between a contract-engineering firm, a financial services firm, a hospitality firm, and a hospital to get some sense of the difficulty of creating appropriate measures of innovation for *each* that would also be applicable for *all* of these very different types of services. But the need to do so is indisputable given that in most of the developed economies services are well over half of gross domestic output. Quantifying the processes of innovation within the service sector is one of the weakest points of those measures that are currently employed as indicators. The group did note that there were a variety of corporate and academic efforts ongoing to that were focused in codifying and capturing better data on the service sector of the economy. It was thought that keeping close scrutiny on these efforts is something that should be a priority for those government agencies charged with maintaining and developing statistics on the service sector. This is an area of significant need.

8	**New Product Portfolios** -- innovation as reflected in the breadth and depth of new product offerings was seen as a potential indicator that could be mapped from existing data. However, there are concerns as to the ability to compile what is essentially data that belongs to one organization into a national statistic of some kind. It is generally acknowledged that many leading firms within a specific industry closely monitor the proportion of their overall product set that is either new or less than three years old. While not necessarily a direct measure of innovation, it was the consensus of the group that information on the product portfolio's age is reflective of a higher degree of product development that is, in its own right, an indicator of more innovation within a company or an organization. It was acknowledged by the group that there are many difficulties in trying to implement such an indicator. Most of these are technical or definitional issues. For example, how does one qualify the level of innovation of a next-generation product that is essentially a derivative of a previously existing product? A good example might be in the consumer electronics industry where a new, improved model of television is larger than previous models and perhaps has some ability to display at higher levels of resolution than before. Is this a product innovation, and how does one rank the level of innovation contained in this product relative to the previous generation? By the same token, one could look at the software industry and question the level of innovation in a product such as Microsoft Vista versus its previous generation of operating systems. There is clearly some element of innovation within the product, but how much and how important it is to the overall product are things that are open to speculation and review.
9	**Science Prize Participation --** this indicator was offered as a measure of current and potentially future innovation that might be worth monitoring as an indicator of where a nation or region currently stands in its innovative capabilities. The reference here is to the various contests that are run by organizations such as FIRST and the Intel Prize. The thinking behind the use of gross participation counts in these types of contests is that this measure would give an indication of the level of skill of young people in science and technology topics, as well as an indicator of the overall level of interest in the science and engineering activities that are thought to be closely connected to innovation. The person offering this as a potential indicator was unsure as to whether or not statistics were kept on the number of applicants relative to the number of actual participants.
10	**Sector-specific Productivity Measures --** this topic was raised as part of the overall discussion. The thinking was that there are measures of output or throughput within various industry sectors that are reasonable proxies for innovation, but they only make sense within that particular industry. As such, they may be important indicators of innovation for the industry, and have some contribution to the overall level of innovation within the nation. However, because of their close ties to a single industry, they are hard to combine into a meaningful innovation indicator on their own or as an aggregate. The thinking was that what most likely would be mapped would be changes in these productivity measures; items such as the volume of output per worker, some ratio of financial turnover per employee, or some other measures of input a relative to output that are specific to a given industry. There was some thinking that these types of measures might be useful in the above-mentioned discussion of service sector innovation. An example might be in measures of e-commerce transacted within a retail organization, either as a per employee indicator or as a ratio of e-commerce sales to total sales. The problem in implementing such measures is that it is difficult to segregate productivity from innovation. The assumption is that innovation leads to gains in productivity, but it may well be that the process could go full circle and enhancements to productivity potential lead to the revelation of the next round of innovation within the productive processes.

11	**Quantity of Available Talent (for R&D or other functions) --** this topic was raised by the group as one in which there are a number of sources of confusion. While there are abundant statistics on employment within industries and employment by occupational categories, the group noted that there are ways in which these types of statistics might be improved or be somehow modified to more accurately reflect the innovation potential of the economy. The example given was the often cited, and somewhat contentious, statistic on the 'shortage of engineers' in the United States. While the Department of Labor maintains copious statistics on employment by functional categories, and maintains data that showed the aging of the work force over time, the official statistics do not seem to reflect the contentions of industry regarding a shortage. This disconnect between jobs available, and able-bodied, professionally trained individuals prepared to fill those jobs, is something that the group thought worthy of examination. The group recognized that there were a number of complex factors at play in this apparent statistical anomaly, primarily and apparent interdisciplinary mismatch between employee qualifications and emerging-market demands.
12	**Level of R&D Expenditures --** not surprisingly, R&D spending was mentioned by many of the participants at the workshop as one of the key indicators of innovation. Given the available statistics on both public sector and private sector research and development activities, and the reasonably forthright conceptual connection between research and development and innovation, there was the consensus in the group that R&D has to be one of the leading innovation indicators. With that has a precursor, the group also noted that there are a number of difficulties in the collection of R&D data, both from the perspective of where the money is being spent and by whom, but also from the perspective of what it is being spent on. There were several mentions of the fact that, depending upon the industry being examined; the line between research and development is murky. It was also noted that this is the case in much of government R&D spending. The list of potential qualifications could go on at great length, but the majority of the group was quite familiar with these issues. These qualifications notwithstanding, the group was significantly in agreement that R&D expenditures are one of the strongest statistical areas that we have available to measure the innovation ecosystem.
13	**Level of SBIR Awards and Funding --** the Small Business Innovation Research program, and funding for the activities of the program across the country, was mentioned by several people as an interesting innovation indicator. This is primarily due to the fact that the contract awards in this program are typically quite small, and are typically awarded to small enterprises. As such, one can make the case that using awards and funding levels from this program as an innovation indicator is warranted as they program reaches to the grassroots level of economic activity.
14	**Number of New Products Introduced --** this indicator is one that is widely used at the corporate level as a measure of innovation within the firm. To the degree that new products can be defined and measured as a component of an overall product portfolio, this was believed to be a valuable statistic in measuring the innovative vitality of a given organization. However, there are several drawbacks to this approach that were noted. The first of these is simply the fact that it is at times difficult for firms to identify new products as opposed to those that are undergoing a generational transformation. We have all seen the 'new and improved' label placed upon existing products. Upon trying the product, one frequently finds that the new improved product seems to function in a manner that is not unlike the unimproved product. This is a situation similar to that described in the classic business text, "The Innovator's Dilemma" by Clayton Christensen. In this book the author discusses at some length the fact that innovation can be packaged into existing products so that the innovation is transparent to the user, though that innovation may well be significant in terms of generation skipping technologies. Similarly, there are times where the so-called disruptive technologies are introduced into a market, i.e. those in which new products are actually completely new technology displacing an existing functional category. An example might be the application of personal computers to replace typewriters. The computer can certainly not be regarded as a new product that is replacing the typewriter. Instead, the computer becomes a platform for word processing software, and the combination of the computer and software, augmented by newly developed printing technologies, displace the typewriter.

	Additionally, another concern with respect to the application of measuring new product introductions is the difficulty of aggregating such statistics across industries into a single number that is coherent and meaningful. At present, industry associations are having difficulty attempting to accurately capture generational changes within their industry. Expanding the attempt to measure new product introductions across multiple industries, not to mention the service industries where new products are more difficult to identify and qualify, is indeed a daunting task. In summary, the group agreed that this statistic is useful for the company, and was interested in advancing this type of measurement to the next level.
15	**International Math and Science scores (TIMS)** -- given that so much of innovation is connected to technology related topics, they participants agreed that these measures of math and science achievement and knowledge were quite useful in terms of obtaining an indicator of a nation's innovative capacity. What makes the summary scores so interesting is that this activity is one of the few that is conducted on equivalent basis across international boundaries. As such, the summaries reflect what might be close to a standardized achievement indicator that is far less likely to be biased in the ways that are not understood than would be other types of indicators of educational achievement. One might make the observation that the bias toward the scientific method, and the fact that mathematics is the universal language, are closely related to the attractiveness of this particular indicator. There were some discussion related to the weakness of these indicators as well, but their attractiveness was not disputed.
16	**New Research Starts** -- discussion relative to this statistic focused on the fact that these measures are available at some reasonably discreet level of granularity, but they are typically maintained at the organizational level and rarely aggregated upward into a broader picture at a disciplinary, regional, or national level. The topic was raised primarily in recognition of the fact that one of the best indicators of the overall vitality of the innovation ecosystem is the number of new ideas that are being taken aboard for further study and investment by corporations, government agencies, or universities. It was the belief of several of the participants that the simple gross aggregation of new research project starts would be an interesting measure, even without being normalized for a variety of potential qualifiers. To the extent that this quantification by discipline, by industry, by any one of a number of things, could happen, this makes an effort to begin to examine methodologies and mechanisms for the identification and collection of such statistics a matter worthy of further investigation.
17	**US Share of Peer-reviewed S&T Publications** -- national shares of peer-reviewed literature in a variety of scientific and engineering disciplines is an indicator that is well-known and often cited as a key metric of the vitality and creativity of the nation's scientific community. There was little disagreement that these measures are useful at the aggregate level, and are similarly useful in that they have been built into an extensive time series, one that reveals the development of the innovation ecosystem as a global phenomenon. The attractiveness of this particular indicator is that it has a long history. As such, it has been in use for many years, and been in use in a variety of fora during this time. This makes it an impactful indicator as it is easy to understand. This also means that the trends that are in evidence in the data, whether reassuring or alarming, are most likely reflective of actual events.

Panel II Topic: What's Missing? Closing the Gaps and Identifying the 'Known Unknowns' about Innovation Indicators

Panel Participants:

Kenan Jarboe – The Athena Alliance
Dr. Robert Atkinson – The Information Technology and Innovation Foundation
Lewis Perelman - Consultant
Dr. Elias Carayannis – George Washington University

Kenan Jarboe

Mr. Jarboe's comments pertained to the need to follow intangibles in the economy, and by inference in the innovation ecosystem. He noted that the economic and statistical constructs of the United States, as represented in the economic and financial data gathering that is done by the multiple government agencies engaged in such activities, are still largely focused on their roots in manufacturing. This is fully understandable, but Mr. Jarboe contended that this is a bias that needs to be addressed in consideration of where the economy has migrated in the past 50 years, and where it is likely to go in the next 50.

The concern that needs to be addressed is a combination of factors, much of it having to do with the proper accounting for, and recognition of, what are termed intangible assets. One might say that the intangibles issue is one that has arisen out of the development of the information economy. The question is quite simply one of how to properly value and evaluate the knowledge and intellectual capacity or intellectual equity of any firm or organization. What is the value of a brand? What is the value of a patent, or a portfolio of patents? How does one properly account for the inherent value of a product portfolio? How can one properly value an item as ephemeral as customer loyalty? What is the best way to recognize the value of research and development over time?

These and many other issues are embedded within the various statistical constructs that are currently being used to identify, categorize, and report on innovation. Mr. Jarboe underscored the importance of considering the issue of intangibles when working to develop the next generation of innovation indicators. Just as we are being challenged to recognize and define innovation, it will be equally challenging to revise, modify, and improve our statistical and accounting constructs to keep pace with the transformation of the economy.

Lewis Perelman

Mr. Perelman brought a different perspective to the session's discussion of what's missing in terms of measuring innovation. His focus was on the human side of innovation rather than on the business or technological side. His approach is one in which innovation and its impacts should be measured in a more holistic construct. His contention is that, as is the case with most things, innovation is not necessarily universally solely beneficial. That is, while a majority of the population considers innovation as an improvement to an existing product or service because the impact of innovation tends to reduce cost or improve the functionality or benefits received, there is also a downside to innovation that is rarely examined.

Consider the example of the automobile. Going back roughly 100 years, there is no doubt that the invention and rapid adoption of the automobile and related technologies has had a significant beneficial impact on the lives of literally hundreds of millions, if not billions, of people. However, one can easily make the argument that there have been downsides to the evolution of the automobile and its place in our society. Pollution is clearly the most readily apparent of these. Similarly, the reconstruction of the nation's topography to accommodate the automobile is something that is not without its problems. Along those lines of thought, Mr. Perelman argued that nanotechnology, while widely expected to generate significant benefits across virtually all aspects of the economy, has some observers worried about the potential environmental impacts, and the potential health impacts, of nanotechnology as it proliferates into new applications.

In such cases, Mr. Perelman contends that innovation is something that might be more carefully targeted to the achievement of the desired social and human outcomes. He had no particular mechanism defined for doing so, but the point of the talk was to provoke thought for the participants, thought that broaden the horizons of the traditional construct of innovation impacts.

Dr. Elias Carayannis

Dr. Carayannis comments addressed the complex interrelationships between creativity, innovation, and competitiveness. He noted that while innovation is frequently seen as a good in and of itself, there actually is no value realized for the innovation until it is put into practice in a commercial environment. His comments also provided perspective on different methodologies for evaluating innovation and putting it into an analytical context.

He observed that innovation and invention are handmaidens. While it is not necessary to have invention in order to innovate, it is true that most inventions are indeed innovative. From an organizational context, it is easy to observe that much innovation is like invention. That is, it begins with the activities and insights of a single individual.

The next step in the process of converting innovation or invention into value involves a migration within the organization from early stage activities focused on “productizing” the idea. As the process moves forward, frequently involving engineering and product development type efforts, the organization puts an increasing amount of financial and physical resources behind the innovation. Concurrently, the organization also puts an increasing number of people, usually arrayed into functional teams of one sort or another, to work in the process. When the new idea is ultimately introduced to a market, and assuming that it succeeds, it will have an impact on the competitiveness of the firm and those sectors in which it competes.

And it is this competitive dynamic that is of interest to all manner of industry observers, industry analysts, and persons involved in public policy. The combination of thousands, if not tens of thousands, of ideas being pursued across the economy domestically and in the global market is what adds to the vibrancy of the innovation ecosystem that we talk about. The challenge is to recognize the fact that all these interactions occur in what is essentially a randomized process. There is no way of knowing ahead of time which will be successful innovations, and which will not succeed. As such, there is no way of knowing from a policy perspective which sectors of the economy are improving in their domestic and global competitiveness posture and which are lagging relative to others.

The takeaways in terms of innovation indicators that need to be evaluated and developed, from Dr. Carayannis’ perspective, is that the innovation metrics effort should focus on three elements that are directly related to innovation activities at the firm level. These are:

1) Firm innovativeness — a measure of the firm’s ability to be creative and derive innovative solutions,
2) Innovative performance -- that being an actual measure of how many new products and services firm has been able to create over time; this could easily be a benchmark type of statistic
3) Innovative competence -- this would be a measure of the quality of the firm's innovation. Such a measure would take into account the ability of the firm to drive new solutions for its customers, and new solutions for its own internal processes. Such a measure could be very far ranging in terms of the particular items that it chose to measure and report upon.

Dr. Robert Atkinson
Dr. Atkinson was unable to attend the session due to weather-related travel problems. His organization is the author of the State New Economy indices. The report, sponsored by the Ewing Marion Kauffman Foundation, employs 26 indicators to assess the extent to which the 50 state economies are poised to succeed according to the tenets of the New Economy. The changing economic landscape requires state economies to be innovative, globally linked, entrepreneurial, and dynamic, with an educated workforce and all sectors embracing the use of information technology. The report, which updates and expands on the *2002 State New Economy Index*, ranks the states according to the same algorithm that was employed in the previous report. With these measures as a frame of reference, the report outlines the next generation of innovative state-level public policies needed to meet the challenges of the New Economy and boost the incomes of all Americans. Dr. Atkinson was scheduled to speak to the participants at the workshop on the processes of compilation of the data that appears in the report, as well as the content of the report itself. That report is notable in that it has employed a consistent framework over time enabling comparisons and the identification of leaders or laggards among the states being examined. By implication, the report also can implicitly identify the results of concerted actions within individual states over time -- theoretically showing the effectiveness of public policies and changes in those factors that would be expected to produce changes in a state's relative ranking. The report can be downloaded at the following Web address: http://www.itif.org/index.php?id=30.

What's Missing Breakout Discussions **–** the second breakout session focused on gathering participants' input on the types of information or indicators they believed were needed for evaluating and quantifying innovation beyond those measures that are in current widespread use. The effort was to focus on finding the innovation measures the participants would like to see, those they believe to be most relevant to the sectors of the economy they are the most familiar with.	
1	**Quantifying the Research and Development Services Sector --** one of the groups mentioned this has being one of the most significant, yet largely undefined, areas of the economy at present. It is an established fact that many corporations that formerly ran their own research and development activities have since turned to a model in which these activities are contracted out to specialist firms. However, this being the case, there is relatively little information available on the sorts of work being done by these independent research organizations. It was suggested that there might be an effort made to attempt to quantify the type of research that goes on within these organizations. One can see that this might be a valuable contribution to the ability to understand how the innovation ecosystem within the country has been transformed over the past 30 years or more. If a significant component of the R&D being done were never categorized by industry or by technology, then this would appear to create a problem of undercounting the investment that is ongoing within different industries, or on behalf of specific technologies. Addressing this through the development of a refinement of current measures would appear to be a useful, and potentially highly productive, endeavor.
2	**License Income --** this is a question that was raised by one of the groups. Given that there is a considerable level of interest in creating and registering patents, it was thought that a measure of revenue from those patents might be an interesting indicator of the value of innovative activities that yield patents. The group seemed to believe that many patents ended up being registered but ultimately were proven to have little specific value to the firm or individual receiving the patent, except for defensive purposes. It was thought that a measure of licensing revenue would be a potentially useful proxy for the value created by the innovation cited in the patent. However, it was recognized that in many cases the best patents are those that are kept in-house and developed by the originator of the technology, i.e. they are not licensed. That being the case, developing licensing income as an indicator of innovation is a topic that would need considerable review and analysis before a meaningful and robust indicator might be constructed.

3	**Federal Funding Flow-throughs** -- given the importance of the Federal government in funding research and development activities at the university level, it was thought that an indicator measuring and tracking these funds to various technologies would be useful. This data is currently available in the form of details of funding for specific projects at particular recipient organizations, but these data are not compiled by the technology being developed. It was thought that an indicator showing the level of Federal funding for different technologies, regardless of the recipients, would be useful in tracking and laying the groundwork for an input-output structure of research dollars for the ultimate technology produced. Such an indicator might also be useful in terms of tracking the focus and concentration of different types of Federal research spending.
4	**ROI of Research Spending --** this was offered as a measure that might be considered the Holy Grail of research investments in any sector. The question that is continually left unanswered is what are the long-term payoffs on research work done today in the so-called basic research areas. The group recognized that there had been some work performed by various groups, and that in certain cases there have been some significant strides made in measuring the return on investment over time in specific sectors. But even in those areas there are as many questions as there are answers. The consensus of the group was that such an indicator of innovation would be extremely useful in justifying future investments. They also agreed that a simple ROI calculation was not by itself a particularly solid or desirable innovation indicator. In essence, having ROI statistics for basic research investment would be useful, but it would not necessarily be a great contributor to an understanding of the innovation ecosystem within the nation or globally.
5	**K-12 Education – Inputs and Outputs --** similar to the discussion of ROI in the previous item, there was a stated need to have better linkages between the investment in K-12 education and the future innovation that is theoretically enabled by improved levels of science and math education at the primary school level. The concern of the group was that there is a co-mingling of policies and intents that makes it extremely difficult to use this information to establish the connecting links between education that happens at the elementary school level and the future performance of students in developing the next generation of innovative products and technologies. It was the belief of the group that much of what is currently being quantified as educational achievement is being done at the cost of quality. While the group had no particular recommendations for approaches to dealing with these issues, it was noted that the currently available indicators fall far short of what would be needed to be able to say with a high degree of confidence that we are measuring education in a way that is meaningful and closely correlated to future achievement.
6	**Multi-disciplinary Interactions in Research --** this topic was raised by several members of the group. Their concern is that the available statistics on innovation and performance in research, as being categorized by the existing structure of accounts, falls far short of capturing an emerging and evolving research model that is far more complex than it has been in the past. The belief is that in virtually all areas of academic and corporate research there is an increasing focus on, and need for, a multidisciplinary approach to solving technical issues. However, there is not a corresponding effort ongoing to capture this change in the way research is being conducted. There are some concerns that would need to be addressed in order to begin defining the contribution of the different sciences to a specific project, but the group felt it was important to consider at least addressing this issue and beginning to derive some sort of first cut approach to quantifying the relative shares of inputs of the scientific fields. This could be accomplished with some gross measures such as budget allocations within projects, but there are as many negatives as there might be positives to the implementation of such an approach. The need exists. The mechanism for addressing the need is highly uncertain.

7	**Competitiveness Scale --** within several of the groups there was a discussion of the need to have a competitiveness scale as a part of the innovation indicators that might be compiled. When asked what was meant by this, the response was that this should be a multi-factor sort of scale that could be assembled for organizations of all types. The participants offering this as a potential indicator believed that most organizations are very familiar with their competitors and generally know the strengths and weaknesses of others within their industry. Translating this knowledge to a global scale was also believed to be something that would not be that difficult. However, it was acknowledged that determining which factors to use as indicators of competitiveness is a difficult exercise. The thinking of the group was that these sorts of measures might be derived from the financial statements of the firms or organizations and then linked to other measures of physical, financial, or human capital assets that are employed in the organization's productive processes. The belief of the group was that knowing which industries are relatively more competitive within the national economy is an important indicator of potential future competitiveness. A competitiveness indicator would also serve to reflect the current state of innovation within those industries or organizations, and also serve to indicate which industries might benefit most from an increase in innovation.
8	**Research and Development in the Services Sector --** one of the conclusions of the discussion was that there is a significant paucity of data on the research and development activities that go on within the service sector. This is an especially muddled area because certain components of the services sector, as mentioned above, do nothing but research and development work. That being the case, there is a need to begin with a segregation of research activities being performed by a service sector organizations for their own internal consumption, and the R&D activities that are carried out on a contract basis for clients. An impediment to the measurement of R&D in the service sector is that many participants in the sector don't view themselves as doing pure R&D. Instead, they largely view themselves as being development organizations that are constantly in search of improved ways of providing their service to their clients and customers. The fact that there may be new technology involved, and new business models being developed to meet particular needs, is not captured as an R&D activity. Instead, it is seen simply as part of an incremental business practices evolution — i.e. practices that are continually evolving within industry. This is just one example of the kinds of issues that would be faced in attempting to derive indicators of such activities. However, there is no doubt that R&D activities in the service sector are a rapidly growing component and should be recognized for their contribution to innovation within the overall economy. The need exists; the solution is not readily self-evident.
9	**Globalization --** this was a topic that was debated within one of the groups. They believe that there is clearly a need to develop some indicators of globalization, if not explicitly globalization of innovation. Their concern was that the present talk of globalization and the offshoring of R&D activities and the outsourcing of jobs is just that, mostly talk. There appear to be few hard statistics available on the topic of globalization. Therefore, coming up with some structure of measures that would quantify and categorize these phenomena would be highly useful, both from the standpoint of people understanding trends within their industry, and also from the standpoint of government policy-makers who need to be aware of ongoing transformations within the economy. One of the things that was specifically cited as being an area in which there is nothing currently available is a categorization of globalization by industry and by geography. It was thought that having information available on these trends within just these categories would be highly useful in achieving better knowledge of events that are occurring now, as well as a better understanding of trends that have been emerging over the past few years.

10	**Improved Detail in Current Statistics --** this topic was raised in a discussion of the adequacy of currently available indicators. Several participants offered the observation that even in the case where some indicators of innovation are available, they are frequently not available at the level of detail that is meaningful for the types of examinations and analysis that people wish to do. There were several items mentioned as being high priority needs. One of these was for better information on the level of innovation by technology -- this being a desire to have a better understanding of critical investments by industry sector. It was the opinion of the group that the currently available R&D data simply did not go far enough in providing information on the newer technologies, e.g. nanotechnology in all its various formats. Similarly, there are data available on computer and information technology in general, but most of the categories employed by the government statistical agencies tend to be obsolescent, if not outright obsolete. There was also a desire expressed to have better breakouts of the data by geographic locations in order to be able to see in the data support the clustering phenomenon that is so often discussed by analysts and industry observers. As things currently stand, clustering is an anecdotal phenomenon, with little hard data to support events that are being witnessed on a daily basis.
11	**Improved Gross Measures of Innovation Activity** -- by this comment the participants were referring to the fact that while it is frequently difficult to measure innovation at the firm or organizational level, it is perhaps easier to measure innovation's impact at the highest levels of aggregation. An item that was suggested as an example of a potential indicator would be energy use per real dollar of gross domestic product generated. Such a measure is far from perfect, but it was offered that changes in such a factor relative to changes in the overall economy would indeed be an indicator of innovation, though the innovations that are contributing to the macro level change may well be deeply buried within the overall system. Such measures are not new to statisticians who follow industry groups. One need only look at the agricultural output statistics to see an excellent example of implicit innovation having occurred without any particular analysis or acknowledgment of the sources of that innovation. Similar phenomena can be seen in the IT industry where hardware costs on a chip level transaction basis have plummeted, implying a significant improvement in productivity and innovation. However, the exact sources of that innovation, whether in the hardware, in materials, or in the software, are not ordinarily ferreted out for analysis and interpretation.
12	**Summary Statistics on Corporate Acquisitions of Smaller Firms --** this potential measure was offered up as an indicator of how the innovation that is found in smaller firms might be absorbed and transformed into a new stage of diffusion when repositioned within a larger company. The concern expressed was one of the need to track what happens to smaller firms and their impact on innovation, particularly those firms that have received funding from organized venture financing activities. The group believes there is no current indicator tracking the fate of smaller companies when a larger company absorbs them. This is problematic when the firm is absorbed by a firm in the same industry, and even more of an issue when the firm becomes part of another organization that for purposes of statistical reporting is not in the same NAICS industry. While this is a very common activity, the innovation impact of such acquisitions, and the impact on the growth of the larger firms, is not tracked. Following an item such as this would be one step in the direction of gaining better knowledge of how innovation is diffused across the economy, and how innovation is ultimately brought to market within specific industrial sectors.

13	**Tracking Science and Math Ph.D.'s --** this issue was raised because, while there are solid data available that track the career path of Ph.D.'s overtime, these data appear to be somewhat limited in their coverage. They also appear to be unreliable over the longer term. Having such data available, while hardly definitive as the link between Ph.D.'s and innovation is not necessarily proven, would at least be a step in the direction of getting a better understanding of where highly educated scientists and technologists migrate within their career paths. From a policy perspective, it could be important to understand the forces and factors that are driving decision-making within the populations of these highly skilled workers and researchers. The challenge, of course, would be in establishing a voluntary system of some kind that would enable the tracking of Ph.D.'s for the duration of their career in specific industries of interest. There are also other factors at play — for example, the natural career migration of scientists from the lab into management. It would be difficult to avoid making the value judgment implicitly that laboratory work is more valuable than management work being done by scientific Ph.D.
14	**Measures of the Drivers of Innovation --** this topic was suggested as a potential remedy to a question of how innovation and innovative processes reveal themselves over time. The thinking was that there are certain pressures that arise within an industry, or within an economic sector that lead to an amplified need for an innovative solution. In essence, this is almost a reverse indicator. If things were not going well within an industry, one would expect to see an increased level of innovation to correct the course of the industry. At least that is the supposition. One might see this as a parallel to nature abhorring a vacuum. If there is some version of an enhanced need, the presumption is that innovation will step forward and serve to meet that need. However, the difficulty here is in identifying which are the sectors or industries that might be under stress. Secondly, there is the unanswered question of what the appropriate measures or indicators of that stress might be. While such measures might be highly useful, and do probably exist in certain industries, trying to cobble these together into a unified framework for measuring distress -- and therefore the need for a ramping up of innovation potential within the economy -- is an exercise in that would most likely prove to be difficult.
15	**Measures of Startup Companies --** while startups are not necessarily always related to what might be considered innovation, the group did believe that monitoring startup activity across the economy would be a useful indicator and proxy for innovation. While there are measures of startup activity that are monitored, the conventional wisdom is that the available statistics only capture a minor component of business startups nationwide. The group thought that it would be useful to develop a comprehensive measure of startup activities across the entire country, and then add to that a series of categorizations by industries served, by technology employed, and/or by any number of other potential sub-sets of activity or industry. If nothing else, such a measure would give a much stronger sense of the dynamism of the economy as a whole relative to the statistics that we currently have on startups, statistics that appears to be biased toward venture investing type activities. This might be particularly true in many service industries where there are many innovative, small startups that are routinely ignored in official statistics until such time as they become larger, more well established firms. One need only look at Starbucks to get a feel for what might be missed and the impact of such firms over the longer run.

16	**Measures of Innovation in Socially-focused Technologies --** the discussion in this area was driven by a desire to capture some of the secondary and tertiary innovation impacts of social technologies such as YouTube, Facebook and the like. The consensus was that these new firms and their application of existing technologies to the social networking space was indeed an innovation that has had considerable impact. But measuring that impact and its effect on the economy and future related innovations is something that is a considerable challenge. This led to a lively discussion of the nature of innovation and the impact of innovation across traditional boundaries. There was, however, no consensus developed on how one might even begin to approach the measuring the innovation impact of these emerging and evolving types of social networking firms. In fact, it was offered by one attendee that studying and quantifying these types of firms, and the innovation they represent, might better fall to disciplines that are not normally a part of the innovation ecosystem discussions, disciplines such as anthropology and sociology.
17	**Attitudes of Regulators --** this potential innovation indicator was raised as one of the items that is clearly missing in the things that are measured today. The person offering this as a potential indicator believed that in many industries regulatory processes promote or inhibit growth and adaptation. The fact that no such indicators currently exist does not mean it that is not data that might be very relevant to the nation's overall innovation performance. The chief concern, of course, is determining how one might measure and quantify a regulatory environment. There are some efforts afoot to do just that, but they tend to be fairly narrow in scope and are relatively new and unproven in terms of actually reporting what they purport to. That factor notwithstanding, there was general agreement that a regulatory framework is an important indicator. It was also mentioned that this is not necessarily a negatively biased indicator. In many cases the regulation seems to be tied to the imposition of limitations on growth and expansion. However, the opposite case was also made. Regulations, when well considered and applied in a way that establishes a foundation for economic activity, can serve as a substantial and powerful promoter of industry and growth. From that perspective, this adds further to the need to carefully consider what sorts of indicators might be useful in indicating both the positive and the negative potential impacts of a regulatory environment.
18	**Measure of Social Benefits of Innovation –** this potential measure was introduced by one of the session speakers for consideration. And the perspective behind this indicator is that much of what we typically see as innovation is closely connected to an organization's culture. As such, the value of innovation is expected to be captured and realized by that organization in some form of a return on investment. This type of analysis leaves out the social benefit aspects of innovation. The argument made is that any accounting that does not pay homage to the broad social benefits resulting from innovation is incomplete. This is an interesting concept, though perhaps one that is difficult to implement in a meaningful way since most innovating organizations are not concerned with the social benefits of their innovative activities. This is a topic that could bear further discussion and examination.
19	**Find Ways to Distinguish Innovation Capacity from the Effective Use of that Capacity** – this item has managed to wrap itself into a two-part conundrum. The first is that there are presently no measures that can be said to accurately map innovation capacity. With that as the precondition, the ability to quantify the efficiency of use of that capacity becomes strictly an academic/intellectual exercise. While this would be an interesting and potentially useful measure, given the gaps that we currently struggle with, this indicator would seem to be and one that is relatively low on the overall wish list.
20	**Quality-adjusted Peer-reviewed S&T Publications Statistics --** this item was raised as something that is needed since the current publishing and review processes do not take into account the evolutionary versus the revolutionary scientific work that is done in the various scientific fields. One measure that was offered was a quantification of citations of papers to each other over some pre-determined time period. There are admittedly numerous issues to be solved with using a measure such as this, given that it is primarily backward looking and also prone to problems of how to collect the data in a timely and meaningful way. Those concerns being recognized, the group offered up the opportunity for the academic and scientific community to take the lead in developing

	new measures that address current issues. The thinking was that practitioners in the specific scientific fields would be best equipped to identify and build consensus on how to measure quality in peer-reviewed publications.
21	**Review of European Community Innovation Survey to Determine Gaps in Their Practices and Processes --** The participants were generally aware of the efforts of the innovation community in Europe to develop and standardize measures of innovation that are focused in getting a unified perspective on such activity among the leading economic powers in the Community. Using the European approach as a basis for US activity in measuring innovation is an approach that has been recommended by a number of authorities as something that offers a variety of potential benefits and relatively few drawbacks. Among the benefits are the ability of the US to learn from the European experience and thus avoid any errors that were made. This approach also avoids having to 're-invent the wheel' by employing those aspects of the Euro program that have worked well. Following the Euro model also will enable the international comparisons of innovation and competitiveness that are widely sought by analysts and policy makers. The primary drawbacks noted were not that numerous but potentially significant. One of the major ones cited was a concern that the measures being used in Europe, while appropriate for their economic system and industrial structure, might not be appropriate for the US economy and the mix of activities that comprise the domestic innovation infrastructure and innovation ecosystem. The second item mentioned most frequently was that much of what is being done in Europe at this time is relatively 'soft ' in terms of the indicators being developed and monitored. This softness applies to both the definitional constructs of the statistics being collected and the way in which they are being reported and gathered. The impression of the workshop attendees was that there was not a great deal of statistical rigor in the data being collected through the Oslo manual process. These concerns notwithstanding, the consensus of the group was that US statistical authorities should closely monitor the activities of their European colleagues in the area of innovation metrics and indicators. The work being done there does have value in terms of breaking new ground and doing the pioneering work that needs to be done to expand the field and push the boundaries of our understanding of innovation. What was especially noted was the need to monitor methods and practices as well as the actual data being gathered. This is again due to the ability to learn from the Euro experience to avoid issues and complications that might be remedied through alternate indicator selections and alternate methodologies for data collection and reporting.
22	**Impact of Privately Funded R&D --** While there is some work that has been done on the impact of government funded R&D, the group noted, more needs to be done in that area. They also noted that there was a significant lack of data in the impact of privately funded research and development on both corporate and national prosperity and competitiveness. This issue was raised by several of the session participants as something that needs to be addressed at the industry level, and might also be examined at the level of scientific discipline within industrial sector, for example chemical or physics research being performed in the medical devices industry. The issue raised is that the current mechanisms used to account for this type of activity is deeply flawed in several respects. First are the simple measures of actual flows of funds that are defined by the standards of GAAP. While providing uniformity of practice and method, such measures are not designed to directly assess the benefit of the R&D activity to the business. Given that research is an empirical process, a case can be made that there is valuable learning going on in work that fails to achieve its intended purpose. There is also the issue of defining the benefit of R&D that is done for a specific firm or project that goes on to create tremendous value in an array of future applications that are, at best, third or fourth derivatives of the original work. The classic examples are the transistor and the laser. There is no way to truly define the impact of these breakthrough innovations on the economy. But what of the more mundane work? How can we measure the impact of the work in catalysis and real time gas sensing that enables modern automobiles to emit virtually no pollutants in normal operations? Measuring the benefits accurately also requires an expansion of the nominal benefits to a global scale. This is true in the context of breakthroughs at private firms being rapidly converted into global products, either through the marketing activities of global firms, or through smaller firms being able to use global distribution channels to deliver new innovations to a global market even though the firm itself Is not global. Overall, it is easy to make a case that we need better measures

	of the impact of private sector R&D. The question becomes what is it that is to be measured and what is the correct context for that measurement. Perhaps the answer lies in one suggestion that there are multiple aspects of benefit to innovation – those which is privatized and recognized in terms of revenue and profits for the firm, and those which have other non-private benefits that greatly expand social welfare but for which we have not bothered to capture the impact.
23	**Information About Intellectual Property Other Than Patents --** The discussion of this topic was driven not so much by the fact that such measures are valuable and need to be monitored as by the fact that such measures are largely unavailable, either as measures of financial value or as measures of the value of innovation that is evidenced by intellectual property of all kinds. The specific suggestion in this item is that there needs to be a structure of intellectual property - other than patents - developed and monitored as part of the US innovation ecosystem. The first question this raises, of course, is what might those alternate measures of intellectual property be, closely followed by are there mechanisms available to enable such an accounting? If so, is it possible to map its connections to the nation's competitiveness and innovative capabilities? The basis for an answer to the question lies in the definition of intellectual property. For the purposes of the workshop, intellectual property was defined to include the following: assets with legal or contractual rights including patents, trademarks, designs, licenses, copyrights, film rights, and other such items that are recognizable and can be sold in a transaction. In effect, this definition includes only items that fall into the category of tangible assets, rather than intangible assets. This is a key distinction, and one that is important to the ability to measure and track such IP over time. What is interesting here is that this issue revisits the earlier discussion about the need to find out more about the flows of licensing revenues to patent or licensing right holders. Expanding the discussion to include items beyond patents and into the related items such as those listed above is a significant challenge. Just as challenging will be the need to define and develop links to innovation for these types of indicators. This is especially true in the service side of the economy where, in certain fields, significant amounts of value are generated through the application of copyrights and licensing arrangements. Narrowing the list to some specific and easily identifiable categories, e.g. technology licensing arrangements for university-developed IP that is not yet patented, might be a good way to begin to get some sense of the intrinsic value of measuring and monitoring these flows.
24	**Statistics on Capacity Utilization of Innovation Potential --** This item was mentioned as something that constitutes a significant gap in our current measures of innovation, though there was an accompanying admission that this potential indicator is one that is not among those that are being tracked anywhere. The idea behind the indicator is relatively straightforward, that being an analog of the capacity utilization measures that are available in the manufacturing and other industrial sectors. Constructing such a measure is difficult, though not impossible. The first requirement, though, is to develop a construct that enables the measurement of innovation capacity in the economy at large – no simple task, that. Theoretically, such a measure could be constructed as a function of the workforce, the development of IP, the creation of new companies, the level of R&D in industry and government, the application of new business models – in fact, one could look at the entire list of items that were discussed in all three of the workshop sessions to identify candidates for inclusion in this putative statistic on innovation potential. Putting them all together into a single unified measure of innovation potential, and then measuring the level of accomplishment relative to the potential, would be an interesting and useful bit of data, just as capacity utilization in industry is. However, defining and putting such a statistic into practice would be a significant challenge to define and implement.

Panel III Topic: Opportunities and Challenges in Measuring Innovation

Speaker: Patricia Buckley, Executive Director,
U. S. Department of Commerce
Advisory Committee on Measuring Innovation in the 21st Century Economy

Ms. Buckley's presentation centered on what the Commerce Department was currently doing in the area of innovation metrics. She described the work that has been in process since late in 2006 when the Secretary created the *Measuring Innovation in the 21st Century Economy Advisory Committee.* The Committee is charged with helping develop ways to measure innovation so that the public and policy makers can understand better its impact on economic growth and productivity. The committee has been studying metrics on effectiveness of innovation in various businesses and sectors, and work to identify which data can be used to develop a broader measure of innovation's impact on the economy.

The Committee has had one official meeting where a variety of issues and problems were raised and discussed by the members of the Committee, a membership which consists of a combination of Fortune 500 CEOs and academics with a background in studying innovation and potential innovation measures. More detail on the Committee and its work can be obtained at the following link:

http://www.commerce.gov/opa/press/Secretary_Gutierrez/2006_Releases/December/06_Gutierrez_Innovation_Advisory_Panel_rls.htm

Ms. Buckley summarized the current state of Committee activities and noted that the work being done by the workshop participants would be used to serve as a complement to the activities of the Committee. The perspective offered in summarizing the differences between the IVS workshop and the focus of the Committee was that the IVS activity was targeted to summarizing where things stood in terms of the current state of the art of innovation indicators. While the focus of the Committee, on the other hand, was to engage in forward-looking activities, ones that would serve to identify needs and potential approaches to developing new innovation metrics to meet those needs.

With that as the introduction to the work of the Committee, Ms. Buckley then asked workshop participants to shift their focus, to the extent possible within the context of the workshop, to addressing the current primary Committee activity, this being the current request for comments that was issued by the Economics and Statistics Administration in the Commerce Business Daily on April 13, 2007. The entire text of the request for comment is presented immediately following this introduction. This notice was also provided to all IVS Workshop participants in their pre-meeting information packets. They were asked to review the item to be prepared to incorporate its mandates within their deliberations during the workshop session.

Secretary of Commerce Request for Comments – April 13, 2007 From the ***Commerce Business Daily***
The Secretary of Commerce determined that the establishment of the Measuring Innovation in the 21st Century Economy Advisory Committee (the ''Committee'')was in the public interest in connection with the performance of duties imposed on the Department by law. The Committee will advise the Secretary on new or improved measures of innovation in the economy that will help explain how innovation occurs in different sectors of the economy, how it is diffused across the economy, and how it impacts economic growth and productivity. The Committee consists of fifteen members appointed by the Secretary of Commerce and is composed of individuals from business and academia. The Committee will function solely as an advisory body, in compliance with the provisions of the Federal Advisory Committee Act. The Charter was filed under the Federal Advisory Committee Act. The Committee is charged with developing innovation metrics that inform policy decisions and enable policymakers and the business community to better monitor innovation. Among other

things, the Committee's work should build on the way firms assess the effectiveness of their own innovative activities. The recommendations should not only focus on measuring innovation activities and inputs, but should also focus on the results and output of innovation. Furthermore, the recommendations should allow for analysis at industry, sector, national, and international levels. The type of innovation for which measurement improvement is sought is defined as:

> "the design, invention, development and/or implementation of new or altered products, services, processes, systems, organizational structures, or business models for the purpose of creating new value for customers and financial returns for the firm.''

The recommendations will cover the following four major categories identified by the participants during the initial meeting of the Advisory Committee:

1) Improvement of the underlying architecture of the U.S. System of National Accounts to facilitate development of improved and more granular measures of innovation and productivity;
2) Identification of appropriate economy-wide and sector-specific statistical series or other indicators that could be used to quantify innovation and/or its impacts;
3) Identification of firm-specific data items that could enable comparisons and aggregation; and
4) Identification of specific ''holes'' in the current data collection system that limit our ability to measure innovation.

Comments are solicited to address new and/or improved innovation measures in each of the above categories. Following are some specific issues and suggestions raised by Advisory Committee members, grouped according to the measurement categories listed above, on which the Committee specifically invites comment. Comments need not be limited to these issues and suggestions, but should address the specific data categories.

1. *Improvement of the underlying architecture of the U.S. System of National Accounts to facilitate development of improved and more granular measures of innovation and productivity.*

Our national accounts are the main source of information about the growth of our national output, usually measured by the gross domestic product or GDP. Total Factor Productivity (TFP), which measures growth of output per unit of input for the economy as a whole and for individual industries, is not included in the national accounts. Is the concept of TFP sufficiently related to innovation to warrant the inclusion of economy-wide and industry level TFP in the system of national accounts? If so, what is the most effective way to incorporate the concept into the national accounts? Are there ways to disaggregate the innovation component of TFP to differentiate innovation from other productivity drivers?

2. Identification of appropriate economy-wide and sector-specific indicators that could be used to quantify innovation and/or its impacts.

Are there measures that accommodate economy wide (or macro-economic) and sector-specific notions of innovation? What elements of innovation could serve as a foundation for statistical series? To what extent would the collection of better data on service sector outputs and services inputs used by all firms improve innovation measurement? Is market share growth a good indicator of innovation? If so, would estimates in the change in U.S. firms' shares of regional, national, and global markets be useful innovation measures? Could/should collaborative connections between entities be captured? Since a characteristic of markets is that the benefits of innovations flow, at least in part, to buyers, are there ways to identify the flow of innovations across firms and sectors?

3. Identification of firm-specific data items that could enable comparisons and aggregation.

Current corporate innovation measurement appears to be done primarily on either a project or a portfolio basis. Are these measurement practices sufficiently widespread and uniform to make data collection on either of these bases practical? Is it possible or necessary to collect information on company culture, incentive structures, and organizational change? If customer satisfaction is an important measure of an innovative firm, how can that be captured? How important is it to distinguish between types of innovation (*i.e.* radical versus incremental)? What data would be needed to differentiate the characteristics of innovative firms within industry sectors from non-innovative firms? What are the most important measures of the underlying process of how innovation and productivity advances are initiated or stimulated? Could/should an understanding of innovation from the consumer perspective be developed? Could data items from SEC filings be used to enhance understanding of innovation in public companies? Are there proxies for relative innovative success (e.g. percent of total revenue attributable to new—or significantly improved to the point where they could be considered new—products, services, or processes introduced within the last two years into markets where a firm has a growing market share) that would provide insight into relative innovative strength? Is two years long enough?

4. Identification of specific "holes" in the current data collection system that limit our ability to measure innovation.

Some specific types of data holes were identified during the meeting, including lack of data on firm formation, intellectual property licensing costs as a type of purchased input, and insufficient product detail. What should be the prioritized list of specific data items needed to fill the holes? Limitations on our ability to link and coordinate across various data sets were also mentioned as a hole or deficiency of our current data collection system. Are there cost-effective ways of building on existing data sets to develop more information on innovation drivers and their link to success? How could data sharing and cooperation among federal agencies be improved insofar as such agencies maintain data series related to the measurement of innovation? Could existing private and/or foreign data be combined with existing official statistical series in order to better measure innovation? Are there changes that could be made to make such combinations possible or easier?

To assist the Advisory Committee in evaluating and comparing specific ideas for new or improved innovation measurement, comments on proposals for new or improved innovation measurement should provide the following information:

1. Description of proposal - Proposals for new or improved innovation measurement should include the following:

- Specific description of the proposed change.
- Identification of the specific Committee category to which the proposal applies.
- Rationale for the proposed change.
- Data description, sources and method of collection.
- Approximate cost and burden estimate.

2. Impact of proposal on innovation measurement - Proposals should include:

Description of how proposal improves measurement of innovation as defined by the Advisory Committee.

- Description of the particular elements of innovation measurement that are improved by the proposal.
- Description of how the proposal addresses the issues and questions raised by the Committee.
- Description of how the new or improved measure would provide appropriate signals of changes in business behavior for the purpose of informing policy debates.

With this as a background to the challenges and opportunities in the recognition and measurement of the innovation, Ms. Buckley asked the workshop participants to do what they could, within the confines of the IBS workshop activities, to provide some input all in the four key points that are to be addressed in comments to the Commerce Business Daily posting. The final discussion session, therefore, did focus on the points that were raised by the Department of Commerce committee. However, given the specificity of the issues to be addressed in the Request for Comments, the comments of the participants in the final discussion session ranged farther afield than the specifications in the Commerce request.

As such, the details of the discussions that were captured in the text below are a hybrid of the specifics that the Department of Commerce sought, and the particular issues and challenges that the workshop participants were aware of. Given the profile of the average workshop participant as being an informed layman in the area of innovation indicators, and of statistical collection and reporting in general, one can make a case for the participants choosing to discuss and present issues that they were familiar with rather than being bound by the requests of the Department of Commerce. This is, after all, why the participants were asked to come to the session. The intent was to gather a broad and diverse perspective on innovation as they understood it within their particular organizational and industrial context. While their perspective on the specific points in the Commerce request raised for discussion would undoubtedly be valuable, their perspective on the issues that were the most relevant to innovation within the sectors of the economy they are most familiar with will be at least equally as valuable.

The section below is therefore a combination of these many different perspectives. The moderators were asked to focus their groups on the major points raised by Commerce, but the individual participants had the option, and indeed a predilection for, presenting the issues that they were the most familiar with. The result is that the participants in effect provided a prioritized listing of the sorts of indicators and innovation metrics that they would like to see. One might call this a wish list. From that perspective, this wish list should be valuable to the Commerce Committee in its own discussions of where to place priorities, and what sorts of measures are likely to be the most valuable to the various constituencies that have indicated a desire to have innovation metrics.

The bottom line to the entire discussion is that there are many ways to examine innovation from an intellectual, academic and statistical perspective, what is really needed is a set of measures to which people relate. The IVS workshop audience of analysts, data users and data providers offered their insights on where the high value is. It is now the role of the professional statisticians and data collectors to do what they can to accommodate those priorities and needs

Opportunities and Challenges Breakout Discussions **–** A deeper and richer understanding of innovation is important in developing useful measures. Discuss opportunities and challenges in measuring innovation. What are suggested approaches to: understanding various types of innovation, identifying performers of innovative activities, aggregating official statistics with private data, improving the timeliness of data collection, and offering new ways of reporting innovation data	
1	**Measuring Firms that are Spin-outs from University Research --** the discussion in this area focused on what might be considered an output of the overall innovation process. The question mooted and discussed was one of maintaining a proper focus on the desired end product of innovation rather than simply focusing on the measurement of the innovative process itself. The group noted that at present there are no statistics uniformly unavailable on the number of firms being created as a byproduct of university research. There are some regional and state level efforts that are ongoing, but these have not yet been translated into a broad national effort to compile such data. The underlying issue is important to the overall innovation ecosystem discussion. The assumption being that for innovation to have value it must be translated into some form of usefulness, a usefulness that is usually evidenced by the application and use of the innovation in a commercial environment. Without that migration from the laboratory to a business, the innovation itself becomes purely an intellectual curiosity.
2	**Number of New Research and Development Projects --** while so much attention in discussions of innovation is focused on research and development activities, the workshop attendees noted that most of the quantification of this research and development activity takes place in the form of dollars. They proposed that instead of a financial metric for research and development, perhaps it would be equally as useful to quantify and track the number of new research and development projects that were put in place in a given year. This, of course, would set the stage for a potential quantification and disaggregation of these projects by discipline, by various scientific disciplines, by performers either by name or by type of organization, and by any number of other metrics that might be applied. This is an interesting alternative viewpoint of the innovation process and the need to develop metrics for it. Clearly, having a direct count of the number of projects in existence any given time would prove most useful, and most likely very illuminating. Similarly, the ability to take that gross quantification of projects and correlate it to funding levels would also be instructive.

3	**Quantification of the Path to Commercialization --** this topic dovetails to a degree with the items mentioned above in Item 1. The issue being raised here is one of defining the typical path to commercialization for an innovation, be it in products or services. Knowing the path that is typically employed to go from the idea to the commercialization stage is, in a sense, the same as mapping out the pipeline from one place to another and the stages in between. Knowing the course of the pipeline, and the relative mix of throughput at various stages versus output at the ultimate end of the cycle, would be highly useful. From a policy perspective, knowing that there is an abundance of innovative ideas that are at an early stage of commercialization, and knowing what can be expected to result as products and services offered to the market, would be an important component of knowing the state of health of the innovation ecosystem. The critical assumption here is that such a path can actually be defined and mapped. The truth of the matter may well be that while the way-stations along the path can be identified, the actual path followed by innovative firms and ideas may not be clear enough to ever map and/or quantify in any meaningful way.
4	**Private Sector Innovation Data Providers --** one of the more interesting service industries that exists in this nation is the marketing and market research provider sector. The discussion here raised the question of the potential participation of private sector innovation data providers to the overall innovation statistics system. The issue was the potential for these consulting organizations to possibly collaborate with government statisticians to develop some rudimentary indicators of innovation for the industries in which they work. There are several firms in the research industry that maintain very large databases of proprietary information they have gathered themselves through collaborative agreements with their clients. Similarly, there are other firms that maintain data series on industries that are similar to those maintained by trade associations. In either case, these data might prove highly useful to the definition and characterization of innovation within these industries. The question becomes whether these firms would be able and willing to work with government agencies to provide some of their proprietary data at an aggregated level that would be useful for policymakers and other industry analysts. The potential here is a significant. The issues that would need to be overcome are equally significant. But in the context of firms that, for example, gather bar code data on consumer electronics sales nationwide on a daily basis, the implications for the measurement of innovation and innovative technologies are intriguing.
5	**Examine the Potential for Improved Global Comparability of Data --** a significant concern of the session attendees regarded the need for any new innovation metrics to be globally comparable. Both from a policy perspective, and from the standpoint of corporations engaged in global businesses, this suggestion would seem to be of paramount importance. The open issue is how one goes about ensuring that such comparability does indeed exist. There are a number of approaches that were suggested. Some were private sector focused; others would rely on government statistical agencies to drive the process forward through collective efforts at the unification of an innovation lexicon and topology. Regardless of who would be driving the process forward, it was agreed that comparability of the data was one of the highest priorities. In fact, several of the participants in the discussion offered that comparability of a limited set of data is perhaps desirable to having a broader array of innovation data that pertains strictly to the domestic economy. The reasons behind this are fairly clear, and from a policy perspective, one can see the arguments for both sides of the debate. Ideally, any effort to develop innovation indicators and metrics would contain elements that were particular to a given nation's economy, as well as indicators that are directly comparable on a global basis.

6	**Define the Infrastructural Conditions that Produce Innovation and Report on it as an Environmental Variable --** part of the discussion of innovation and its impact on competitiveness and the economy usually trends toward consideration of the infrastructural factors that promote innovation, usually factors that enable individuals to benefit directly from their innovation through some form of commercialization. That being the case, there are any number of infrastructural preconditions that must exist for this to happen. But to the knowledge of the participants in the workshop, no one has yet attempted to define, in a rigorous and quantitative way, what these infrastructure conditions for innovation are. We know there are components of the legal system, the financial system, and the education system, the transportation system, the energy system, and other elements of the total package of infrastructure that are part of creating the necessary preconditions for successful innovation. What is unknown it is the relative mix of those conditions that is required to have a successfully innovative economy. What is also unknown is the relative weighting of one factor versus the others, or whether there is some critical mass that must be developed in order for infrastructural elements to be a true indicator of innovation potential. There may also be a further issue in terms of the degree to which certain systems contribute to an innovative economy. With all that being said, this would appear to be a relatively promising area for compilation into some form of metric or indicator because much of this data, or subsets of what might be required, are currently compiled.
7	**Seek Industry Level Input from Trade and Professional Groups to Define Innovation and Innovation Metrics for Their Industry --** one of the areas that was considered in the discussion of potential future innovation metrics was the ability of trade and professional organizations to work within the industries and professions they represent to define what innovation means for their specific sectors. Historically, governmental statistical agencies have focused at the enterprise level and used this as the foundation for their data gathering activities. What was proposed in the session is that it might be possible to redefine innovation measurement around the individual, and the industry in which he participates through the organization that employs him. It was suggested that associations or societies might contact their members to survey them to find out what innovation means to their industry, and how they go about currently gathering information on innovation whether directly or indirectly. If there is no such innovation measuring activity, then the exercise could become one of working with these groups to have them identify what they believe are the most important indicators of innovation within their industry, or within their chosen profession, or perhaps both. Any exercise such as this might prove to be extremely valuable in those areas of the economy in which little work is currently being done to identify and quantify innovation. Sectors that come to mind are in service industries, as well as some of the more traditional manufacturing and product producing enterprises that are not ordinarily seen as being innovative.
8	**Use Modern Systems to Speed the Collection and Reporting of Data --** one of the ongoing issues with any data collection activity is the speed with which it is implemented. There was the consensus among the participants that any innovation measurement activity going forward should actively seek to employ all of the latest technologies in order to surmount this obstacle. While it is known that in many cases a lag of some duration is required simply to enable data providers to gather, compile, and validate the data they will be reporting, there is every reason to believe that these data providers would be more inclined to provide data in electronic formats than they would be to having to send in paper reports. This is equally true across the range of reports where it may be possible to gather statistics on an automated basis. The web-based technologies needed to do this exist. There are few, if any, firms and/or reporting units that do not have access to the Internet. The combination of the two would seem to make it imperative that whatever innovation metrics are ultimately developed and implemented across a reporting structure would use innovative methods in its collection and reporting. This would seem to be another area in which government statistical agencies and representatives of the private sector may work together to create and deploy systems that are seen as useful and minimally burdensome.

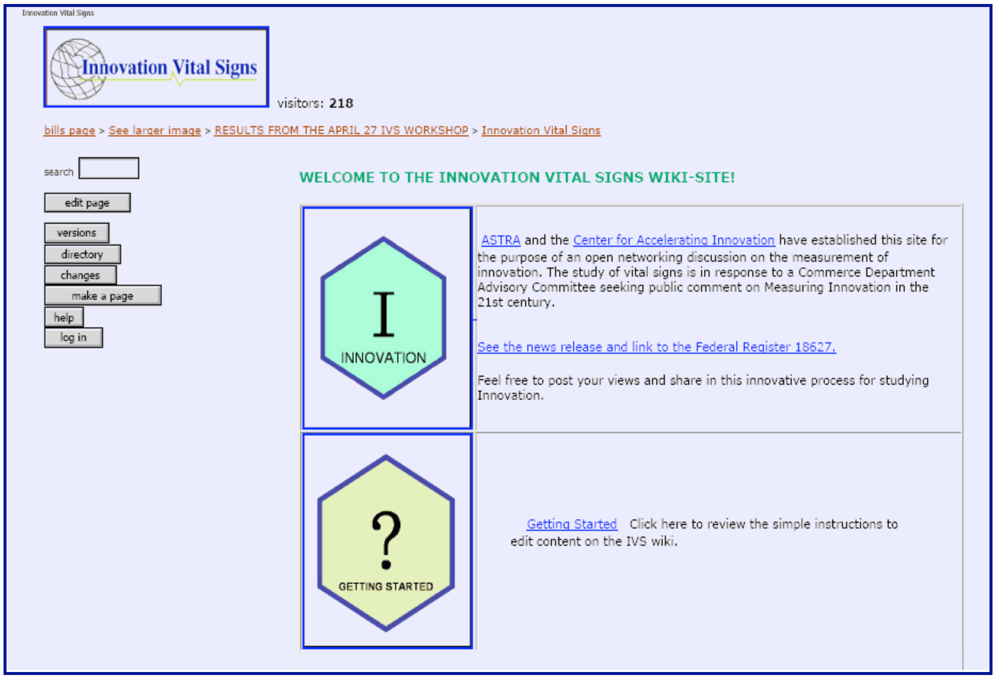
9	**Determine and Define How to Map the Entrepreneurial and Small Business Components of the Economy and their Contribution to Innovation --** the small business sector, as well as the entrepreneurial side of the economy, are areas that drew much discussion from the workshop participants. It was generally acknowledged that much of what we consider innovative activity happens at the entrepreneurial and small firm level. It was equally acknowledged that very little is currently being done to measure the innovation contribution of either of these sectors to the economy. This is the case for a variety of reasons; most of them have to do with the difficulty of measuring small businesses, as well as the difficulty of defining what is an entrepreneurial firm as opposed to simply a small business. These factors notwithstanding, the consensus of the group was that any future effort to measure innovation and its impact on the economy must include the small business and entrepreneurial sectors. How to do this becomes the open question. One proposed solution would be to work with the organized venture capital industry to aggregate and define those firms into which venture investments have gone. Others suggested that there are trade groups that have components of small business in their membership. The thinking being that these are natural points of data collection for industries that, at this time, are not well represented in the statistics. There is also the entire range of activities that fall into is currently being termed the angel investing infrastructure of the country. Organized angel investing activity has ramped up significantly in the past 10 to 15 years, and now comprises what is viewed by some as an investment component that is as large as the organized venture capital industry. To the extent that these types of investors are funding small, early-stage and start-up businesses, an organized approach to angel investor groups might be another alternative to getting a better grasp of the level and nature of this activity. One thing that was agreed on is that whenever statistical agencies are attempting to capture innovative activities in this portion of the economy, they must be concise, well defined, and easy for small business to respond to if they are to succeed.
10	**Define the Public Sector's Contribution to Innovation --** earlier in this discussion there was mention made of the need to incorporate the public sector into the overall innovation debate. Clearly, in the United States the public sector, as defined by governmental entities of all types, is a significant contributor to innovation. At the Federal level, numerous departments and agencies fund a majority of this nation's basic research activities. But this is only the beginning. Consider the contribution of the Department of Education to the nation's innovative capacity. Consider the contribution of the Department of Health and Human Services to the nation's innovative capacity --- where maintaining a healthy workforce is the key to overall productivity and the ability to succeed economically. A case can be made that virtually all aspects of government activity, from the local level up to the highest Federal levels, make a contribution to the overall environment that promotes innovation. For example, consider the role of many economic development agencies as they work with their local universities to promote industrial development within their state boundaries. Consider the role that the local public education system contributes to innovation. Consider the activities of the community college network that exists across the country and its contribution to innovation. Consider the importance of a smoothly functioning and efficient local government as a foundation for creating an environment that attracts industry, and attract skilled workers for those industries. When reviewing this contribution at the lower levels of government, it becomes clear that, with the exception of those large Federal agencies, much of the public sector contribution to innovation goes largely unnoticed and is most likely greatly under-appreciated. This activity needs to be monitored, quantified, and reported upon in order to get a better sense of how all of the various pieces of the innovation ecosystem work together.

11	**Quantify the Public Sector's Implementation of Innovation --** this topic was natural derivative of the previous mention of government contribution to the creation of a positive innovation environment. A case can be made that efficient and effective government needs to be as innovative in its processes and activities as any business in a service industry. While this is not something that is met with widespread enthusiasm, there are governments at the state and local level that pride themselves in their ability to implement innovative ideas and processes. In fact, there is an industry organization that is sponsored by three government trade groups whose primary mission is to identify and speed the deployment of innovative ideas and technologies to state and local governments. The stated purpose of the deployment of innovative solutions at these various government levels is the same as it is within industries, to provide a better level of service while using the same resources, or to provide an enhanced level of service using fewer resources. In either case innovation, and the application of innovative solutions, leads to an outcome that is desirable. That implies that if we are to track innovation across the economy, there is every reason to include innovation within the government sector as one of the key indicators of the economic and innovative vitality of the nation at large.
12	**Develop Indicators that are Uniform and Consistent that enable Aggregation from Micro Level up to National Statistics --** rather than being a topical discussion about the need to develop new metrics for particular aspects of innovation, the discussion on this topic focused on what might be termed a more mechanical aspect of innovation indicators and the metrics that might be deployed. One of the concerns expressed by the group was that because of the diversity of the nature and structure of innovation, as well as the diversity of sources that provide innovative technologies and solutions, a system of innovation metrics and indicators that might be derived in the future may have a tendency to become disjointed. This would be a byproduct of working to serve the many disparate aspects of the innovation ecosystem. This was seen as a potential difficulty as a series of indicators that are too finely honed to specific industries or applications may be less than useful in other sectors of the economy. This being the case, the suggestion was made that any system of innovation measures that might be derived by government or private sources should be crafted in a way that permits the smooth upward aggregation of data from the local level up to the national level. In other words, the system should be collapsible. Concerns expressed by the group centered on the need to employ constructs that are simple and easy to understand, as well as uniform across all industries. While this may be asking quite a bit, the proposal is certainly one that merits attention. After all, the least desirable outcome of any innovation measurement activity would be to have a system that works very well for only a limited segment of the economy. The consensus was that we would be better off having fewer indicators that were reliable and migrate across industries, rather than have many highly specific indicators that were not comparable from one industry to the next. The need to be aware of international comparability was also a part of this discussion. But it was mentioned more in passing because of the nature and complexity of working to get global cooperation, much less national and state cooperation, for such a system of innovation measurement.

13	**Develop a Bare-bones System of Innovation Metrics that Jump-starts the Process --** following closely on the discussion in the item above, was a suggestion that whatever activity is sponsored to move forward on the innovation measurement front, that the early stage of the activities might be well served to be limited and experimental in nature. The concern was a combination of issues. One of these is timing. Another is a question of complexity. Yet another is the issue of relevance. In terms of timing, the concern was that an effort to begin to define and quantify those factors that are related to innovation might easily get bogged down in an extensive discussion of potential priorities for data collection, both in terms of the industries to be surveyed, and in considering which specific data items should be selected for compilation. This relates directly to the issue of complexity. The more complex the survey effort, the longer it will take to identify and define the elements that are to be reported. Similarly, complexity reduces the likelihood that reporters of data will accurately fill out the report on a timely basis. Which ties directly to the issue of relevance. Given the pace of innovation across the economy, any efforts to survey and define innovation within industry groups, at whatever level, might find that the issues being surveyed are no longer current. It may prove that entire industries have rapidly change production models, or business models, or the locale of their manufacturing facilities. The implications are clear. Efforts to measure and quantify innovation need to be carried out at a pace that is in agreement with the pace of innovation itself. And that may serve to be a substantial challenge to the individuals and organizations that are charged with gathering and reporting innovation statistics.
14	**Define Corporate Innovation Scorecards that would be Comparable Across All Industries --** this topic was another that was essentially technical in nature. The discussion focused on a derivative of the topic discussed above, that being the need to have uniformity and comparability and collapsibility of survey data across industries and across geographies. The suggestion was made that if the innovation and monitoring activities occur at the level of new product development and new product development cycles, then an effort should be made to ensure comparability of the data collection efforts across all industries. This is admittedly a limited perspective on innovation, but it is one that is widely accepted and thus cannot be dismissed out of hand. Ensuring that innovation defined in this context is uniform and comparable across all industry groups is an appropriate goal. The use of innovation scorecards that are comparable across industries is in keeping with some of the earlier suggestions – that creating simplified constructs is preferable to developing elaborate and complicated ways of view innovation within industries. A uniform structure for capturing such product innovation detail would also be useful in enabling policy makers and industry analysts to better understand which industries are succeeding and which appear to be flagging. That being said, the ability to actually create such a unified and universally applicable construct is not a task for the uninitiated. Consider the simple need to have such a scorecard apply to both manufacturing and services industries. Considering the diversity of productive activities within those industries, in essence comparing hospitals to florists to chemical manufacturers to power generation firms. One can easily conclude that this would have to be a very high-level activity. However, given the earlier suggestion to start simple, this may not be a bad approach to employ.

15	**Be Innovative in the Development of Innovation Metrics --** one of the more interesting suggestions to come out of the workshop session was that whoever is charged with developing innovation indicators and measures should seek to be as innovative in that activity as those whose activity they are attempting to monitor and quantify. Exactly what was meant by this was a bit fuzzy. One suggestion was that efforts to compile innovation data should do what they can to steer clear of, or away from, the traditional measures that have been employed as proxies for innovation. This is, of course, much easier said than done. However, the directive is well intentioned. Given that the innovation measures world is a world populated by statisticians and economists, the expectation of the discussion group was that different approaches to going forward on the issue would be confined to those tried-and-true methods and models that have been implemented since the institution of the national income and product accounts and the industry surveys and censuses performed by the Bureau of Census. This was thought to be potentially sub-optimal. The discussion encouraged creativity in consideration of the mapping of innovative processes and innovative outcomes. This is a nod to the fact that we live simultaneously in the physical world and in the virtual world. As such, innovation is occurring around the world on a 24/7 basis. Equally true is the fact that many innovators are far too busy conquering the world on behalf of their innovation to be overly concerned about the reporting of their innovation. What we have is a world in which the bits and pieces of innovation are coming at us from all directions. With that as a backdrop, it may well be that traditional measures, and traditional ways of collecting statistical information on innovation, simply will be inadequate. The onus is on the statisticians and the parties attempting to collect the data to create the means and methods that fit the events and processes they are trying to map. Perhaps it is more important to capture and quantify product life-cycles than it is to capture product sales. Perhaps it is more important to measure entrepreneurial business failures than it is to measure entrepreneurial business successes. Perhaps it is more important to measure the need for innovation than it is to quantify existing research activities. There are many open-ended issues such as this around the entire topic of innovation and the adoption of innovative practices and methods. Perhaps the most important directive of this discussion was the suggestion that individuals responsible for innovation indicators keep an open mind and actively work to explore alternative approaches and options that are not obvious or based on historical structures of data collection.

IVS Workshop Wiki – The presentations, innovation geography, indicator Post-its, periodic table of innovation elements, and other information related to the workshop can be found at a Wiki site created to make all these available to interested parties. The address is: www.seedwiki.com/wiki/innovation_vital_signs.



Spreadsheet Summary of Workshop Results – The preceding exposition of the workshop discussions contains considerable detail about the specifics of the conversations that were held, and the items that were of interest to the workshop participants. The table below depicts these same discussions, but focuses on categorizing the comments received and mapping them according to their place in the innovation ecosystem.

Table 9.2 Summary of Comments from Participant Discussion Sessions – Part 1

Summary of Comments for Gaps and Favorite Innovation Indicators - by Classification

			Classification										
		Number of Citations	4	6	48	34	5	7	12	7	8		
Pic Number	Gap or Favorite	Continent	Infrastructure	Policy	Input	Output	Context	Impact	MacroEconomy	Process	Mindset	Comment	Secondary Comment
1	G	I			■							New technology degree programs at colleges and universities; robotics, wire	new areas of technical training at community colleges
2	G	I			■							Need a wider information about intellectual assets/IP portfolios	
3	G	I			■							Insights on innovation and effects of primary R&D investments - constrained by proprietary data	
4	G	C					■					Impact of standards setting bodies on and innovation	
5	G	O				■						Leapfrog technology spring boarding from original ideas	
6	G	T						■				Correlation of anything with anything else	
7	G	I			■							Services DATA - R&D related services, valuation of services, products by sector, etc.	
8	G	I			■							Cultural indicators for entrepreneurial inclinations	
9	F	F	■									Sociological/cultural indicator -- political liberty/rule of law	
10	F	I			■							US share of world science and technology research workforce	
11	G	I			■							Level of industry spending on R&D (normalized) - potentially as a share of sales, or as a share of total R&D spending	
12	G	E							■			Data on workforce demand -- as defined by want ads in journals, newspapers, or other specialized sources	
12B	G	O				■						R&D output -- quantity of technical -- peer-reviewed -- publications	R&D quality -- as indicated by citations to specific articles
13	F	O				■						Research publications -- with impact factors, such as number of citations	
14	G	O				■						Ratio of new products or services to a total product/service offerings -- I.e. Percentage less than five years old	
15	G	O				■						Percent of sales from new products or new processes	
16	G	O				■						New markets created	
17	G	O				■						Sales to new markets	
18	G	F	■									Migration of ideas into other sectors of the economy	
19	G	O				■						Royalty or license fees for intellectual property usage	
20	F	O				■						Patents	
21	G	I			■							Sustainability measures for innovation and value creation	
22	G	P		■								Policy framework to create environment to stimulate innovation	
23	G	F	■									Granularity by industry	
24	G	E							■			Measure of innovation value -- societal value	Measure of innovation value -- consumer surplus
25	G	I			■							Talent pool -- percentage of foreign nationals who wish to stay in the US but cannot because of INS policies	
26	G	I			■							Availability of early-stage funds	
27	G	I			■							R&D expenditures and eight digit in NAICS code level	
28	G	I			■							R&D expenditures by performer f(universities, federal labs, corporate, etc.	R&D expenditures by sector
29	F	I			■							R&D expenditures	
30	F	I			■							SBIR program statistics	
31	G	O				■						Number of new products introduced	
32	G	O				■						Number of new products introduced	
33	G	O				■						Infrastructure not tracked -- design firms, ethnographers, sociologists, marke	countries receptiveness to building and creating these types of enablers
34	G	O				■						Number of new products introduced	
35	G	O				■						Number of new markets entered -- as measured by sales ratio	
36	G	O				■						Impact of marketing dollars on innovation	
37	G	I			■							Number of high-value patents -- patents that are highly cited in research papers	
38	G	I			■							Patents as measured by citations, bibliometrics, classification as high-tech	
39	F	I			■							Patents that are highly cited	
40	G	S								■		Product efficiency as measured by cost reductions, making Invention marketable	

Table 9.2 Summary of Comments from Participant Discussion Sessions – Part 2

Summary of Comments for Gaps and Favorite Innovation Indicators - by Classification

			Classification										
		Number of Citations	4	6	48	34	5	7	12	7	8		
Pic Number	Gap or Favorite	Continent	Infrastructure	Policy	Input	Output	Context	Impact	MacroEconomy	Process	Mindset	Comment	Secondary Comment
41	G	C										Interdisciplinary alliances	
42	G	I										Statistics on the angel networks	
43	G	O										Value added	
44	G	F										Measuring interactions by scientific researchers across industry sectors	
45	G	O										Data on employment by specific industry of the firm not of the establishment	information on occupations by Firm rather than establishment
46	F	I										TIMSS - international math science scores survey at 4, 8, 12 grade	
47	G	I										Measure the percent of students who take remedial classes in college, parti	measured percentage of faculty who are engaged in research versus purely instruc
48	F	I										Percentage of population with SMET degrees	
49	G	I										Talent pool -- broad measures that cover both manufacturing and services	
50	G	I										Measure of start up activity -- entrepreneurship	
51	F	I										Number of engineering graduates	
52	G	O										Number of research papers	
53	G	O										Total patent disclosures -- as defined in quantification was	
54	F	O										Chemical industry patents	
55	G	O										New markets created	
56	F	O										Exports	
57	G	I										Venture capital investment -- investment in late stage companies as an indication of achievement	
58	G	O										Number of pilot or prototype products that are turned into commercial products or services	
59	G	I										Industry capabilities -- in design, innovation, or sustainability	
60	G	C										Links between innovative elements	
61	NA	NA											
62	NA	NA											
63	G	I										Tracking foreign Masters and Ph.D. science engineering math degree earners to determine the rate of US retention at 1, 3, 5 and 10 years	
64	G	O										Patents -- both the number and quality; perhaps a ratio of the number to quality as an index	
65	G	I										Human talent -- measure the number of SMET degree holders remaining in tl	measure percent of college students enrolled in SMET degrees relative to total en
66	G	I										Financing availability and flexibility	
67	G	O										Patents -- a quality based index	
68	G	I										Early stage venture capital funding	
69	G	C										Measure of firm size relative to bureaucratic lethargy	Risk aversion in large corporations
70	G	O										Tools to slice data by entities one wants to compare. i.e. innovation by country, by state, by industry sector, even within an international company	
71	F	O										Birth and death rates of startups and entrepreneurs	
72	F	O										Product launch speed	
73	F	E										Productivity growth	
74	F	O										(Chem industry) process technology improvements	Input and output
75	F	S										(R&D process) How much is spent to develop new, or improved maufacturing processes	
76	F	S										Innovation expenditure (broadly defined)	
77	G	I										Are we measuring move of workforce from lost manufacturing jobs ot service jobs and impact on income	
78	F	I										Time spent (in degrees and postdoc) before entering workforce	
79	F	I										No. of university startups per year, Angel/VC dollars/Total Mkt cap, Entrepreneur risk taking tolerance index	
80	F	I										Total funds for early stage development (private, public) available -SBIR/STTR, ATP, Angel , VC, etc.	

Table 9.2 Summary of Comments from Participant Discussion Sessions – Part 3

Summary of Comments for Gaps and Favorite Innovation Indicators - by Classification														
			Classification											
		Number of Citations	4	6	48	34	5	7	12	7	8		
Pic Number	Gap or Favorite	Continent	Infrastructure	Policy	Input	Output	Context	Impact	MacroEconomy	Process	Mindset	Comment	Secondary Comment
81	G	O										Number of patents by university research	Untenured professor driven by tech [peer] reviewed publications NOT patents to pr
82	F	I										Relative difference in income per capita	
83	F	I										Median education level	
84	F	I										Innovation culture	
85	G	E										Better knowledge about net social, rather than narrow points, return to focus on innovation	
86	F	E										Real GDP per capita	
87	F	E										Value Add growth (eg value add scorecard)	
88	G	E										Unseparable factors i.e. firm specific element that can't be measured by outside value	
89	F	S										High tech exports	
90	F	S										Number of ideas moving from one stage of the process to the next	
91	G	D										Are we measuring trade in services?	
92	F	I										High tech industries worldwide market share	Semiconductor -software -computer hardware -communications equipment -intern
93	F	I										(Chem industry) quality of talent - R&D and marketing input	
94	F	I										Collaborative Networks	
95	F	P										R&D tax credit --> effect on innovation (unknown)	
96	F	I										Patent	
97	F	I										Entrepreneurship	
98	F	I										Productivity growth	
99	G	E										Average hourly and annual earnings	
100	G	O										Education culture	
101	G	O										Support of innovation by K-12 teachers	
102	F	O										Company Culture sources of external information (oslo subsection)	
103	G	D										Happiness, Surveys indicate that residents of wealthy countries are not necessarily happier or even happy	
104	F	D										Value placed on creativity -- Innovation process and corporate culture	
104	G	D										Speed metrics time from decision to create product to market implementation	
105	G	I										Efforts in innovation & output from public sector investments	
106	F	I										Creativity of workforce (missing indicator)	
107	F	I										R&D investments	
108	G	E										US's continual non-participation in innovation	Outcome surveys such as EU commissioned Innovation Survey (EIS)
109	F	T										The length of time you maintain 15% market share of a specific market sector	
110	G	T										Role models	
111	G	D										Degree of user-driven deisgn and innovation	
112	G	D										Degree of receptivemess or readiness for "arbitrage & serendity" of knowledge	
113	F	D										Corporate culture openness to examining new ideas & brainstorming.	Observe and adapt others processes or ideas to your unique situation
114	F	D										How to determine important indicators that affect innovation cause--> effect ex: absence r&D tax credits (~2 yrs) in 90's what happended?	
115	G	I										Patent pendency (600,000 "pending" patents) affects patent quality	
116	G	E										What is happening vis-à-vis innovations in service sectors of economy	
117	G	E										Innovation component measures is one thing. Organizations use of the infrastructure's cpmponents and levers	
118	F	T										Total factor Productivity growth by industry disaggregates	
119	F	T										Rate of growth in statistical indicators of "Not elsewhere classified" as metric of new activity	
120	F	T										US median salary/world median salary	

Table 9.2 Summary of Comments from Participant Discussion Sessions – Part 4

Summary of Comments for Gaps and Favorite Innovation Indicators - by Classification

			Classification										
	Number of Citations		4	6	48	34	5	7	12	7	8		
Pic Number	Gap or Favorite	Continent	Infrastructure	Policy	Input	Output	Context	Impact	MacroEconomy	Process	Mindset	Comment	Secondary Comment
121	G	S								X		What happened to innovative ideas after M&A	
122	F	O				X						Per conversation on "dark side", need more than increased productivity, new	descreases in some metrics Energy use/GDP by country carbon use/GDP
123	G	I			X							Good data on China and India	
124	F	T						X				GDP per capita	
125	G	S								X		Are there good health outputs we should include? Increased cancer survival	other cures?
126	F	P		X								Degreee of free markets, lack of barriers	Free market competition
127	G	C					X					Promoting or support for multi-disciplinary or cross cutting disciplines at college, graduate school and firms and government	
128	G	E							X			Too much attention for narrow indicators that are more ?? non-causal correlates	
129	F	P		X								Sales or revenue	
130	F	P		X								Number of procedures, steps or time required to collaborate and/or to start a business	
131	G	P		X								Business Environment	Regulatory climate

Key to Table 9.2	
Column 2 – Gap or Favorite	
G = gap in innovation metrics	F = favorite innovation indicator selected by a workshop participant
Column 3 – Continent – (These are abbreviations for the Global Map of Innovation depicted in Figure 9.2)	
F = Infrastructura	P = Policy Island
I = Inputia	O = Outputia
C = Contextual	T = Impact
E = MacroEcon	S = Process

Footnote: Sorting Indicators by Classifications

In the above summary the classification of indicators by the various 'continents' was taken from the inputs of the workshop participants. Their efforts to classify the indicators is an interesting exercise demonstrating the fact that efforts to classify indicators do not have a common taxonomy. This is evident in several types of indicators, most notably patents and patent related items. Participants included patent indicators as inputs to innovation, an innovation output, and as part of the innovation infrastructure. It is possible to argue that all of these category assignments are supportable, again highlighting the difficulty of the task of finding and defining the 'correct' innovation indicators.

Workshop Conclusions

The following is a brief summary, with discussion, of items that the IVS Team thought were conclusions that could be derived from the structured activities at the workshop and from the unstructured conversations held and observations shared with participants.

Significant interest

Providing a set of conclusions regarding the workshop activity is a task that is perhaps more complex than one might initially expect. One thing that is abundantly clear is that there is a need for the US to develop some sort of innovation indicators, or innovation metrics in order to be better able to drive an understanding of the evolution of the economy and to better understand the relative position of the US and US firms' competitive positions in an increasingly global economy. The participants in the workshop repeatedly cited examples where they had a need to better understand innovation within their particular industry or economic sector, but the indicators or statistics that would enable them to do so are either nonexistent or not up to the task.

Imperfect art

It was abundantly clear to the majority of the workshop participants that the entire area of innovation, much less innovation metrics, is one that might better be defined as an art rather than science. Economists and other analysts have been struggling for years to develop a concise understanding or mapping of innovation and its processes. While there are a number of conceptual models that have emerged, and there are some incipient efforts at measuring innovation within firms, within industries, and even across nations (as is the goal of the current European effort based on the Oslo manual), these efforts are largely in an experimental stage. There is no concise mapping of how innovation inputs in a given amount will yield innovation outputs in another quantitatively defined amount.

At present the best we have appears to treat innovation's quantifiable byproducts – those being new products, new industries, new technologies, new knowledge, and new global flows of all of the above – as a residual to the economic processes that we understand. That is, we measure the labor and physical capital inputs to a productive process and to the degree that we obtain net outputs that are higher for those inputs than what we expect, and we call that unexplained output the product of innovation. While this is intuitively correct, a case can be made that we should be able to do better than that. And that is precisely the reason why ac activity such as the IVS workshop attracts attention. Our current understanding of the innovation process might be termed to be at the X-Files stage: we see much evidence, we collect data what we can, but ultimately the answer is still out there.

Difficult science

Presentations in the IVS session by statistical professionals such as John Jankowski of the NSF and Daryl Hatano of the SIA were extremely useful in providing a more grounded perspective on the issue. While the majority of the audience had their favorite set of indicators they use for measuring innovation, and also had an agenda regarding the sorts of indicators that they would like to see in the future, the presentations by these two gentlemen helped to reveal the underlying complexity of, and difficulties in, the collection and reporting of indicators connected to innovation. If nothing else, their commentary was extremely enlightening in terms of revealing what the available statistics actually reported. One might term this to be a nomenclature error that occurs when a given set of statistics are compiled. Mr. Hatano raised the issue of the assignment of semiconductor production values based upon the geography of the headquarters of the firm producing the physical output, regardless of where the production facility actually was located. Mr. Jankowski pointed out similar detail issues that existed in the NSF R&D surveys. In both cases, we see statistics that are compiled in a very rigorous and robust way. In both cases it can be demonstrated that the statistics do not necessarily report what most observers and analysts believe is being reported. And this is most likely not an uncommon phenomenon.

Work with business

One theme of the workshop that was repeated in each session was that the individuals involved in innovation metrics at whatever level need to work with business in developing innovation indicators. The work by the Secretary of Commerce in establishing the Committee was applauded for being firmly on this track. The link to business was seen as critical to ensuring that the innovation measures that are developed are relevant – relevant in terms of provide information that is useful to organizational and competitive strategies, and relevant to the needs of policy makers. One thing that needs to be studiously avoided is the development of statistics that do not drive action. Similarly, statistics that are created as a function of little more than intellectual curiosity should be shunned.

Copying is OK

The participants were unanimous in their belief that, if it provides a meaningful, productive alternative to starting from scratch, there is nothing objectionable about learning from others. There were several qualifiers to this general statement. The first is that there is no point in patterning US activities after those of other nations if the measures that are being put into practice elsewhere do not have reasonable analogs in the US. Another key qualifier would be concerns about scope and scale. It may well prove that measures that work effectively in smaller, more tightly-focused economies simply cannot be duplicated in a more diverse, much larger US innovation ecosystem setting. The list of things to be aware of when trying to build on the foundation of others could be quite extensive. Perhaps the best universal caveat for what the IVS participants thought is simply to advise that a certain degree of caution is needed. Overall, they see no point in copying indicators or innovation metrics practices that are not likely to be high value for the US.

Design for aggregation from local to global

This item was one of the primary objectives cited by the workshop participants. At the most fundamental level, there was a universal desire to create a system that was definitionally consistent from the lowest level of data collection up to the highest level of national or global aggregation. The desire here is understandable. This would be an ideal world in which the innovation statistics collected and reported on at a local level are identical to those that are reported for our region, state, for the nation, or across multiple missions. Similarly the definition of industries being reported on would be equally consistent and able to be aggregated. Having these sorts of indicators — ones that enable meaningful comparisons — are the holy grail of any statistical activity.

Expedite the schedule

The participants in the session appreciated that the creation and selection of innovation indicators and measures was a complex task. They also appreciated that the development of measures that are not accurate and consistent over time provides no value at best, and might be very costly in terms of not properly reflecting what is actually happening in the world, errors that could result in the implementation of incorrect strategies and tactics. That being said, the participants expressed a bias toward action. Their concern is that the development of globalization in many markets, and the ongoing rapid shift to a knowledge economy requires that we have a better sense of where we are and where things are going. This means that we need meaningful indicators to help guide policy and strategy as soon as possible.

This implies that those charged with developing innovation statistics for the US should consider implementing something that is not unlike the Innovation Vital Signs approach that has been described in this project. The participants' recommendation is that there is a need to determine where the priorities are, and from that prioritization, begin the process of developing some high level indicators around the key drivers of innovation that we know and recognize. In other words, having something is vastly preferable to the current situation in which there are oceans of data available but no clear ability to chart a course through the innovation waters based on that data. For want of a better way to phrase the suggestion, participants believed that US statistical authorities might use a building blocks approach to creating these measures. Start with the things that are available now that are known to be meaningful, and use those as the foundation for future work in creating new, innovation-specific indicators.

The significance test

Closely correlated to the discussion about expediting the development of key indicators was a discussion of employing the significance test on proposed metrics. What the participants meant by this is that when considering whether or not to launch a reporting structure around a particular indicator or series of indicators, statistical and policy-making authorities need to ask themselves about the significance of such potential indicators. Will they provide unique insight? Are there other ways of perhaps getting at the same trends without the new indicator? And perhaps most importantly, what would be lost if these new indicators did not exist?

All this is simply another way of saying that the selection of activities, processes, and indicators needs to be highly focused at the outset to make sure that there is a maximum return on investment for the activity. This is return on investment in terms of the actual processes and resources employed, but also return on investment in terms of the knowledge gained and its implications for US competitiveness.

There is no doubt that creating the innovation indicators that are meet present and projected needs will be a more difficult task than anyone can truly envision at this point. It is most likely a situation that will be, at some level, analogous to the Silicon Valley entrepreneur's comment when reflecting back upon the years of struggle that were required to ultimately achieve success in business. He stated, quite simply, "if we had known how difficult it was going to be, we never would have started." Hopefully the pursuit of meaningful and valuable innovation indicators will not be quite that difficult.

Final takeaway

With all those qualifiers and cautions having been recorded, the workshop participants concurred in one final evaluation and recommendation regarding the Innovation Vital Signs Workshop. They wanted to express their appreciation to the Department of Commerce, and to the Technology Administration, for addressing the issue, and for making the effort to raise innovation, and an awareness of the need to have innovation indicators, to a higher level of visibility both within the government and for all those who ultimately will be impacted by the ability to have high quality innovation indicators. Everyone appreciated that it was much easier to identify problems and issues related to the thorny topic at hand than it will be to develop the answers. Being a critic is much easier than being an author. But there was an even a greater appreciation for the fact that the journey of 1000 miles begins with a single step. The group seemed pleased that it had been able to collectively take a few of those steps in the course of the workshop.

10) Presentation of Selected Indicators for Analysis and Monitoring

In the process of selecting the Innovation Vital Signs that we have outlined to this point, we encounter an incremental issue that needs to be considered once the various source data have been reviewed, filtered, and in some ways assembled into a more cohesive and manageable mass. The next question quite naturally, becomes what is one to do with the jumble of indicators and data sources that have been compiled?

Clearly, having the data available and structured is the first step in any analysis and further prioritization of these data sources and data series. Once this compilation has been performed, the next step is one of presenting the actual indicators in a way that is meaningful, cohesive, and coherent to even the most casual of observers.

Following this chain of logic naturally leads to the conclusion that the assembled data needs to be visualized in some form to enable interpretation, pattern recognition, trend identification, and to ultimately derive insight. However, the entire topic of data visualization is one that is similar to innovation. Everyone is aware of it, and the fact that it is an area drawing much attention. But like the understanding of innovation, the field is embryonic. Much is going on in the emerging science of the visualization of complex numerical data structures and there are all manner of potential forms of visualization for the innovation indicators that we have assembled. However, there is no clear and obvious form of visualization that will serve all the interpretive purposes that we will want to use the data for. There is no 'one size fits all' visualization format or presentation framework that will serve all the evaluative needs that will present themselves. Instead, alternate forms and structures will be required to properly reveal the multi-dimensional aspects of innovation that have been revealed and reviewed.

Many of the statistical sources that we have assembled in our set of candidate indicators practice some form of visualization of the data they provide. However, most of them use what might best be termed as rudimentary visualization tools. These are frequently simple bar charts, line charts, pie charts, and scatter plots -- usually the kind of tools that one receives with a typical office productivity software suite. While these tools are sufficient to many needs, the task that we have embarked on, defining innovation drivers and results, will require something far more advanced. Our preliminary judgment is that a comprehensive and balanced presentation of innovation indicators will require leading edge visualizations and visualization tools to properly present the complexity of the innovation picture.

One need only look at the 14 innovation factors that we have employed in our analysis of innovation indicators to get some sense of the need for higher levels -- more complex levels -- of data visualization to bring the available data sources to life. We see many opportunities for creating three-dimensional types of charts. We see many opportunities for creating visualizations that contain numerous types of data that are not ordinarily presented within a single visualization structure. We see a need to cross correlate indicators from alternate sources. We see a need to have a visualization structure built into the innovation indicators that not only reveals events and trends, but also sparks insight and promotes discovery and discussion.

This is an extremely ambitious goal, and one that is potentially realizable. However, doing the work required to meet this goal is well beyond the parameters of this initial innovation vital signs project. What we will endeavor to do, however, is to review the options for a visualization scheme that could be implemented once the final set of innovation indicators has been chosen. Simply reviewing the current data visualization tools and their application will prove useful in driving a few first order conclusions about how one might approach reporting and visualizing the various types of indicators that are of interest in the effort to refine the innovation vital signs as a set of indicators that will be easily recognized and understood.

However, before we even consider beginning with this next activity, a brief exposition on the art and science of data visualization might be useful. The essential conundrum that we face is that there are few limits on what might be presented in terms of visualization schemes for the available data, however there is probably a limited set of things that we should do in order to best represent the data, and to optimally enable analysis and insight.

Figure 10.1 below shows a typical business-type digital executive dashboard. As such, it contains elements that might be useful in evaluating its applicability for potentially structuring a dashboard like this for the innovation vital signs. One thing that is readily apparent is that there are a number of data sets that are represented on this page, or perhaps more accurately stated, on this screen. At the top left there is a line chart showing three different variables graphed in a two-dimensional format. This shows some element being tracked across three different components or perhaps for three different items simultaneously. Within the construct of an innovation vital signs dashboard, these lines might represent a series on R&D expenditures for different sources.

Figure 10.1 – Executive Dashboard Example

Next to that is a series of multi-colored bars that would seem to indicate the summarization of five different elements into a combined stacked bar that reveal totals, and contributions to the total, over time. A construct like this could easily be used to display innovation indicators such as the composition of a workforce by education levels.

Next to the series of stacked bars is a simple gauge construct. These are frequently used to indicate a level of attainment relative to some pre-specified goal. In this case, it appears that the gauge is actually structured in a way that lower levels are desirable -- as indicated by the color green in the dial's scale -- and higher numbers are undesirable, indicated by the color red. An indicator that might usefully be mapped by something like his gauge would be something as simple as the number of days required to start a business. We know this data is currently being tracked and collected in the European Community, but are not sure if they use this sort of a presentation mechanism to show how well they are doing. What is also possible is the use of multiple smaller gauges that might indicate the levels attained in subcomponents that are then presented as a single number summarized in a larger gauge.

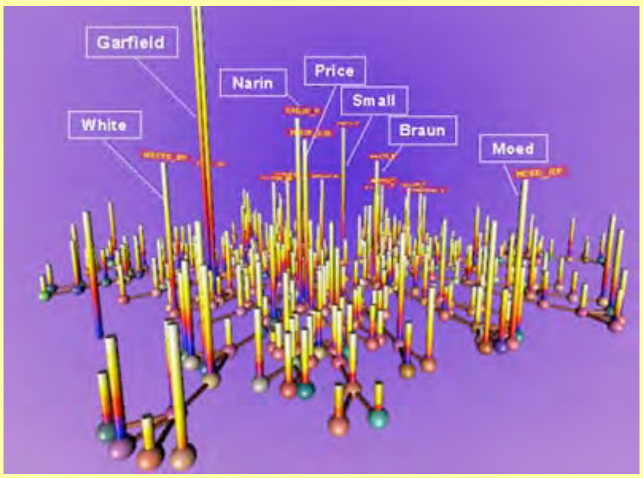
On the lower left is perhaps the most interesting visual of this entire dashboard. While it is not possible to read exactly what it is represented on this chart, and it was chosen specifically for that purpose, it is nonetheless clear that there are different things happening within the various states that are mapped. Visualization structures such as this are highly valuable when drawing regional comparisons, and also useful for showing the effects of clustering. These maps are also frequently structured with animation, so that viewers are able to see the changes that occur within states or geographic regions over time.

The final graphic device on this dashboard is the series of small pie charts that are shown at the lower right hand corner. These are, by virtue of their size if nothing else, the least interesting feature on the page. They are also, by virtue of the level of complexity presented, probably the least valuable contribution to the entire page. Assuming that these are some version of regional or product sales breakdown, one can see that the various pie wedges are different sizes for the different pies presented, but it is difficult to infer any meaningful differences from one pie to the next.

This figure is a good representation of the sorts of things that one sees in a typical data visualization executive dashboard. There is clearly a lot of information captured, but the translation of that information into analytical perspective varies as a function of what is being presented and the format in which it is being presented. This is the challenge of effective dashboard design and implementation. This would be a significant challenge to the development of an innovation vital signs dashboard. Given that we expect to need to capture time series, discreet levels, trends, and relative performance by selected indicators, a traditional dashboard tool might be useful. However, given that we are also looking to capture a variety of indicators that are captured quantitatively but are being used to display qualitative data, we are going to need to engage in visualization processes, and use visualization tools, that are nonstandard.

Figure 10.2 below is an example of the kind of advanced visualization that may be highly useful as a presentation tool for the innovation vital signs. This is a chart that displays a series of patent citations and the linkages of referential cross-citations for different investigators. While such data is sometimes presented on bar charts which show the quantitative linkages of citations, there is clearly far more information relayed in the graphic in figure 10.2 than there would be in any bar chart that would attempt to provide perspective on the same data.

Figure 10.2 Patent Citations and Cross-References



These kinds of charts are frequently used to show the network linkages that exist in the scientific enterprise. As such, they are extremely useful in enabling the recognition of key characteristics of the activity that might otherwise go unrecognized or unnoticed. While such charts are not ideal for many kinds of representation, they are highly useful when chosen for applications such as this.

Charts such as Figure 10.2 can also be used in other constructs. For example, these types of charts are frequently used to display business linkages. Imagine a parent company that has a visual such as this showing links to either a supply chain relationship, or a relationship that shows investments by the parent in other companies. This might serve as a graphic showing spin-out companies, or the distribution of technologies that have been derived from the core parent group that are in use by the various related subsidiary firms. The uses of such graphs are only limited by the nature of the data available and by the imagination of those attempting to present complex relationships in simple and revealing formats.

Figure 10.3 – Radar Chart

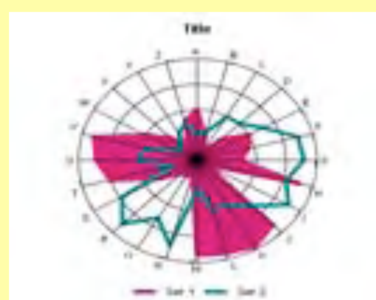


Figure 10.3 to the right, displays what is usually referred to as a simple radar graph. This type of chart has a unique capability for showing the performance of a firm, a region, a nation, or any other construct to be evaluated, and it does so relative to a benchmark or in comparison to other like units. In the case at the right, the evaluation is being done according to 24 separate measures for two separate entities. Ideally, the objective of any entity being evaluated is to maximize the area contained within the boundaries presented on the radar chart. In the case being displayed in figure 10.3, it appears that the organization identified with the blue outline is functionally superior to that identified with the purple areas defined if it is assumed that a greater surface area is desirable. But what we also see is that the two entities being mapped are functionally dissimilar as their relative areas of highest performance are in entirely different measures.

This kind of chart is frequently used to show the relative performance of countries with respect to a series of innovation measures. The most recent European Union report uses radar graphs to demonstrate the innovation performance of 25 different European Union nations relative to each other and relative to the ideal that is represented within any radar chart. This type of construct may well become a standard part of any innovation vital signs data visualization option that is developed because of its usefulness in displaying performance across multiple dimensions relative to an ideal, and also showing where different entities rank in comparison to other like entities, be it countries or companies.

Figure 10.4 Network Mapping

Figure 10.4, to the left, depicts a visualization used to better understand network functions in science and business. These images illustrate a representative network in operation.

This chart presents various institutions (circles) that are engaged in joint activities designed to promote the public understanding of science and technology. The participating institutions are members of networks that are represented as various color-coded fields.

Among the different types of entities that are represented, the color codes are as follows: Enterprises (purple), schools (light green), advocacy groups (blue), universities (orange), political organizations (yellow), museums (teal), media (turquoise), non-university research (red), and non-governmental organizations (dark plum). The color-distribution shows at one glance the interconnectedness between various fields: political organizations, for example federal government departments and agencies, are located in the center of the network. Universities and non-university-research are strongly tied together. Enterprises, on the other hand, play a peripheral role in the network. The authors of this particular chart indicate that one of the conclusions to be drawn from it is that enterprises appeared to have very weak links to the media network.

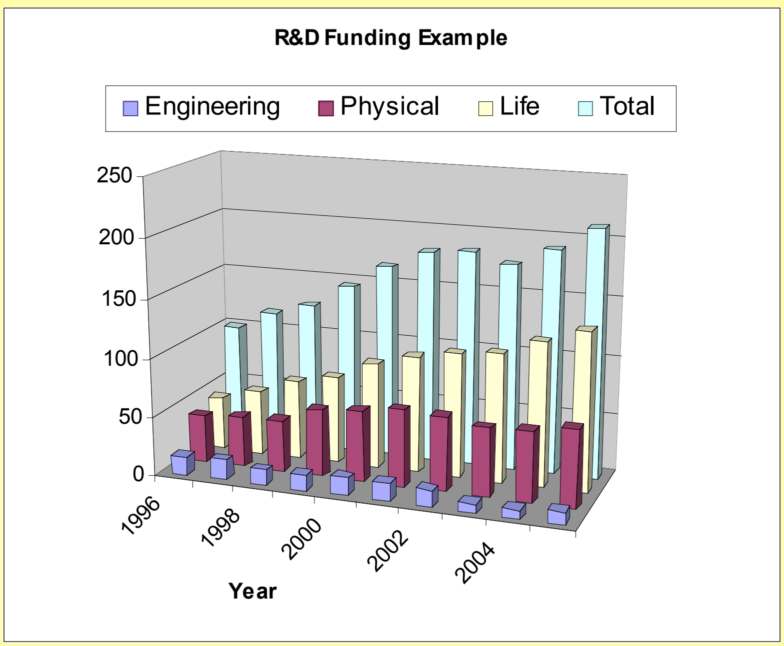
This type of representation, while extremely complex, can also be viewed as being highly useful. It could be used to simultaneous visualize both the structure and the quantification of the network linkages that are generally acknowledged to exist within the innovation ecosystem. Tracking these connections is difficult, but mapping them offers one potential solution for better understanding the connections that are occurring on a daily basis.

As noted earlier, this exposition of data visualization devices, and by inference the options available to the visualization of the innovation vital signs, could go on at considerable length. Suffice it to say that the development of visual representations for the innovation vital signs will be extremely important. Using the right type of visualization might potentially make the difference between a data series being easily understood or completely misunderstood. Using the right visualization might also make the difference between confusion and clarity in terms of the competitive and innovation implications of a data series.

Gathering input from experts in the field of visualization should become an important component of the next phase of moving the vital signs from concept to reality. The work of the project to this point has been focused on finding the right indicators to enable a determination of the state of the nation's innovation ecosystem. But this is only half the battle. Getting the presentation and visualization right is equally as important. Having the right presentation and graphical representations will be critical to moving the vital signs data forward along the often cited spectrum that ranges from data to information to knowledge to wisdom. The appropriate visualization tools applied to the vital signs will hopefully enable users of the vital signs construct to make a rapid migration from data to knowledge and to the potential wisdom that is the reason for data compilation and presentation.

In crafting an appropriate visualization or presentation structure, the first thing that must be done is to determine which aspects of the data being presented are the most important. While this would seem to be a fairly straightforward exercise, that may not always be the case. Take, for example, an indicator as well known as a research and development spending. Data on these trends are usually captured as a time series and provided in nominal dollar amounts. The first order of visualization of such data would therefore appear to be something as simple as either a line chart showing dollar amounts on the vertical axis and time all of the horizontal axis, or perhaps a bar chart where the bar is simply replace the points on the line. However, it may be that a more important consideration with his data is the change in dollar amounts over time. So rather than see the bars or the line chart, what one would need to present is the differences in funding level from year to year. This might be presented as an index, or it might be equally well represented in terms of a percentage change from year to year, or one could simply graph the nominal dollar amount changes.

Figure 10.5 3-D Bar Chart Example



And it may be that what is needed to properly present the information in a context that provides the best insight is a third dimension on the graph. in this case we might want to add a z-axis so that for any total amount of funding in a given year we would be able to break it down into some component elements that would be represented. This would give us many graphical options. The easiest of these to see would be a series of bars that represent the amounts by component for a given year. This is depicted in Figure 10.5 to the left.

What is readily apparent in this example is that there is a great deal of detail available in the data that is well presented by going to the third dimension. We can readily see that the total amounts have been increasing significantly over time, as has the series represented by the yellow bars. In contrast the purple and blue have done nowhere near as well in both relative and absolute terms. This graphic is useful in that there are a number of trends, facts, events, etc. that are represented. At the same time, the graph also enables an analytic observation, one that would lead one to question what caused the shift in funding priorities that are in evidence in this chart.

As such, one could state that this is an effective graphic. It portrays the data in an interesting way, and also manages to reveal the story behind the data equally effectively. The graphic does not inform as to the decision-making processes that took place to yield the result that is in evidence, but the graphic clearly portrays the fact that there were some significant shifts in funding patterns that were occurring during the time period depicted.

Given that there is a significant array of considerations that must be weighed when it comes to selecting the optimal form of data visualization to best tell the ‘story contained in the numbers,’ perhaps the best watchword for this endeavor is flexibility. The characteristics of the individual data sets determine how best to portray them. However, within those data sets there are always options that are available for the presentation that best suit the particular purpose at hand. What typically happens is a search for the optimal presentation formats -- sorting through both the obvious options and the alternate formats that are less conventional but might prove to be more effective. What is needed to support the purpose of data presentation is flexibility; flexibility both in terms of the data series being employed to reveal the available insights, and flexibility in the presentation tools that are being used to do the actual representation.

There are a number of highly flexible data presentation tools available. Many of these are proprietary types of tools that are provided to the business intelligence customers of the large database software firms, e.g. Oracle and SAP. But there are also a number of these that are available in the public domain, or in the semi-public domain where they are readily available through a low-cost or no-cost licensing basis. Whether proprietary or readily available, these tools all tend to be similar in that they enable the presentation of the data from large databases or data warehouses. They are also frequently quite flexible in terms of the way they handle the multidimensional aspects of the data being presented.

Part of the flexibility lies in the fundamental charting options that are typically employed. By this we mean that charts can be arrayed to represent all manner of numerical values and the axes can also be structured to display whatever values are required. What is also interesting is the ability of these advanced tools to represent data in that depicts four dimensions or more within a series of data sets.

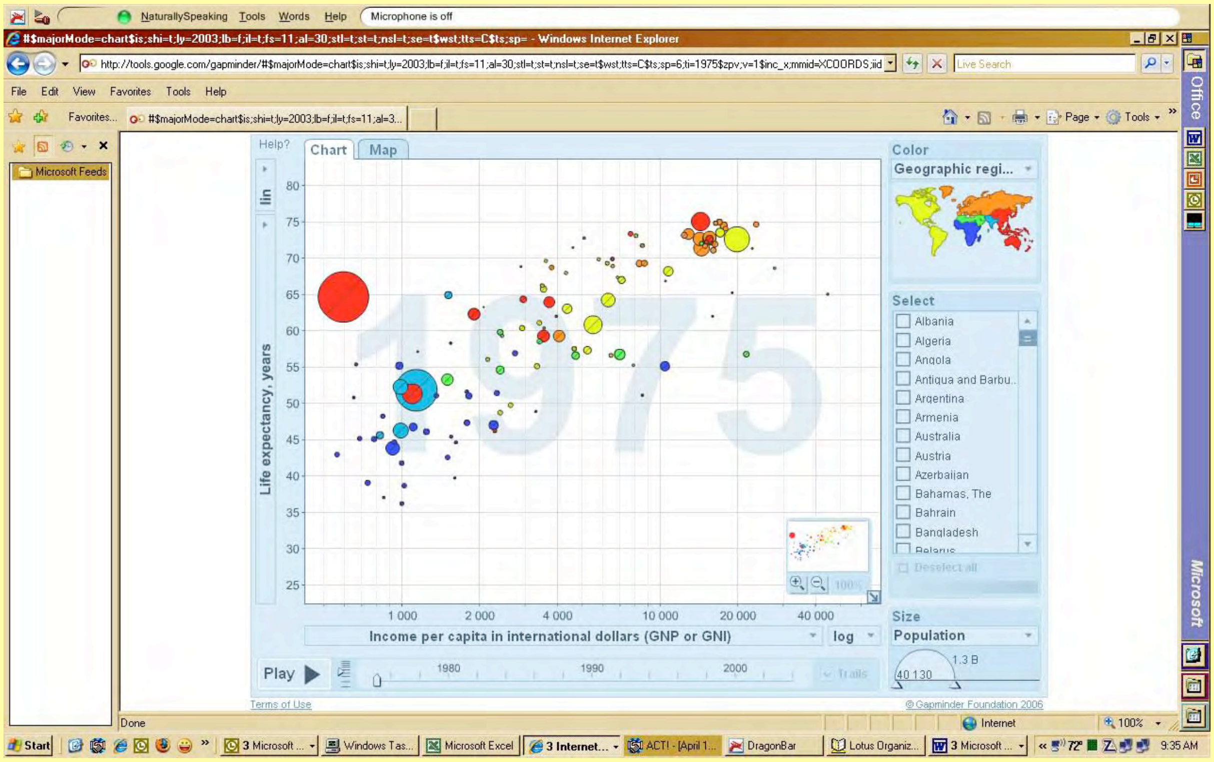
This kind of flexibility is something that most likely would be highly useful in the context of presenting and displaying the innovation vital signs that have been the objective of this project. The thing that becomes readily apparent when looking at the list of potential vital signs is that not only is the raw data of interest, but there may be a number of secondary or tertiary approaches to handling and representing the data that might be most illuminating. While it does seem that most of the data series of interest in the innovation ecosystem are in some way related to time, as there is much interest in trend analysis, the other indicators run the gamut from statistics on educational enrollment and educational achievement to statistics on research funding, to data on venture investment, to data on the migration of skilled workers, to data on infrastructural elements such as the availability of broadband and wireless phone service. The options are, as we have seen, seemingly endless.

This need for flexibility can be met in a variety of ways. Perhaps the best way to reveal the power of flexibility as it contributes to the power of explanation is by presenting a quick example of statistics in action across a four dimensional database. Figure 10.6 below is a screen capture of a database that has been prepared by a firm called GapMinder. This particular application was designed specifically to present information on economic development as it relates to health across the global population. The tool itself is a Flash-based construct that has a structured presentation format coupled to significant flexibility in the data series that can be mapped in the basic tool. Such flexibility is interesting in that it can be quite revealing. It can also be quite non-revealing. This is especially true in the case of GapMinder where the selection of the data series that are mapped in the basic charting framework can easily lead to the construction of charts that are simply one set of numbers portrayed against another. Frequently these potentially randomly selected and portrayed databases reveal nothing. However, with the appropriate selections, the data series can be highly illuminating.

There is also a value in the fact that the flexibility of the basic tool allows considerable leeway for experimentation. The fact that these experiments may prove inconclusive or non-revealing is essentially immaterial. What is relevant is the fact that these comparisons are so easily made and can lead to insight that would not be forthcoming were it not for the ease with which these graphics can be constructed.

Figure 10.6, appearing below, is the starting point for a time series of data for all of the countries that are depicted as either dots or colored circles on the basic grid portrayed. The source of the data is a combination of UN health statistics and economic data that was derived from the OECD. The basic elements of this presentation device are as follows:

Figure 10.6
GapMinder Graph of Life Expectancy vs. GDP per Capita - 1975



- The vertical axis depicts the average life expectancy of a country's population as it was recorded in 1975
- the horizontal axis shows income per capita in nominal dollars
- the circles on the grid depict the relative population size of countries presented
- the color of the circles indicates where on the globe the depicted nations are approximately located
- and finally, the 1975 emblazoned upon the grid indicates that this is data for that year.

These are the basic constructs of the graphical device. There are many other aspects to it that can be described, but the best way to come to a better understanding of the multiple elements of this visualization tool is to view it at the GapMinder site: www.gapminder.org.

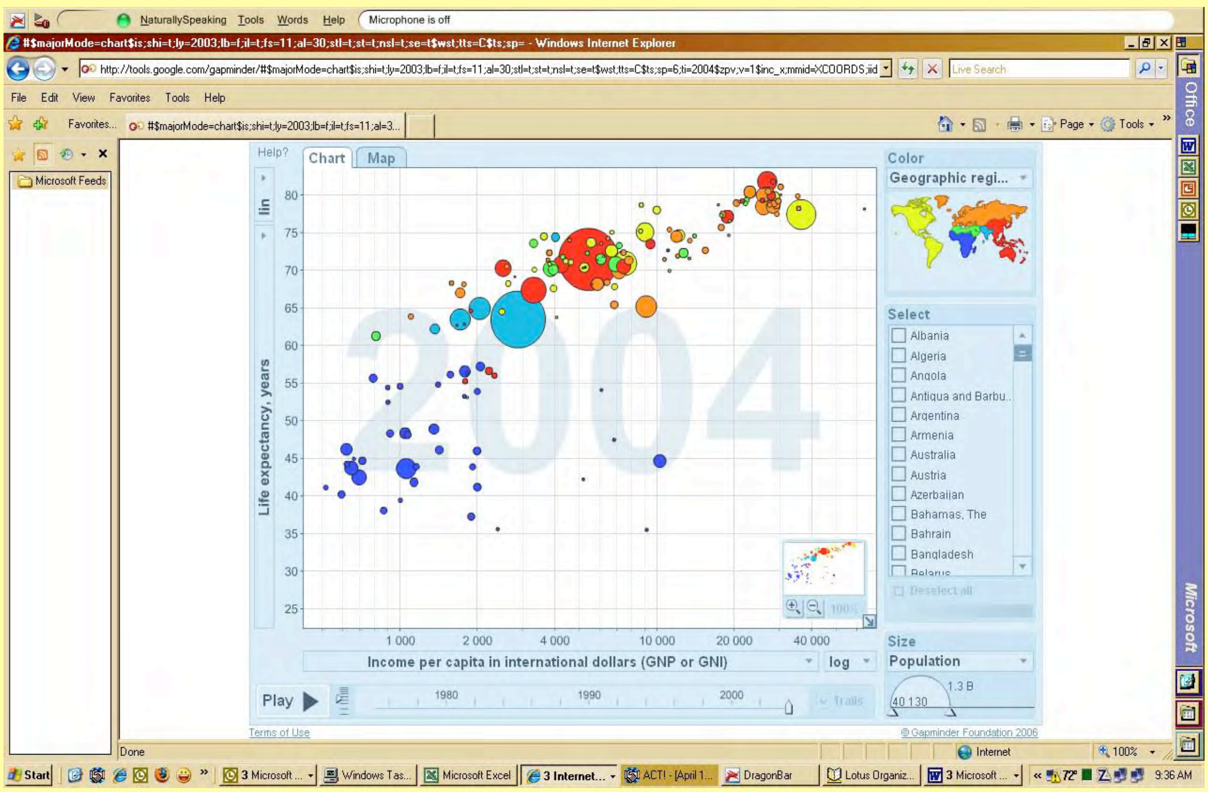
What is readily apparent from even the most cursory examination of the data presented is that there appears to be a strong correlation between life expectancy and income per capita. This is not surprising. One would expect that wealthier nations can afford better health care, a fact that is revealed in a longer expected lifespan. But there are some other details that are also readily apparent. Look, for example, at Africa on the small insert map above the country listing. There one sees that the color code for African nations is dark blue on the grid. One can also readily see that there is a significant clustering of dark blue circles that is at the lower left-hand quadrant of the grid, a clustering that reveals the significant development challenges that Africa faces.

One can also see some interesting apparent anomalies. The large red circle at the middle left off the grid is what in 1975 was referred to as Communist China. The grid reveals that while income levels and China were extremely low, on average lower than those in much of Africa, the Chinese nonetheless experienced a life expectancy that was on the order of 50% longer than most of the African nations depicted. A similar situation occurs in comparing China to India. India is the second largest circle on the grid, one that is aquamarine in color. Here again we see that while India's average per capita income is three to four times that of China, the average life expectancy in China is again about 50% higher than that of India.

This raises a variety of questions. One immediately wonders what it is that the Chinese are doing to maintain such high life expectancy despite being settled with a low level of income. A variety of potential causes and contributing factors can be postulated upon, but clearly there is something unusual happening in China in 1975 that is clearly in evidence on this data visualization tool. As such, this has to be considered a highly effective way of presenting such data.

But this is just the first chapter of the power of the GapMinder tool. Figure 10.b below reveals how the GapMinder tool handles the fourth dimension of data presentation, the element of time. In the screen

Figure 10.7
GapMinder Graph of Life Expectancy vs. GDP per Capita – 2004



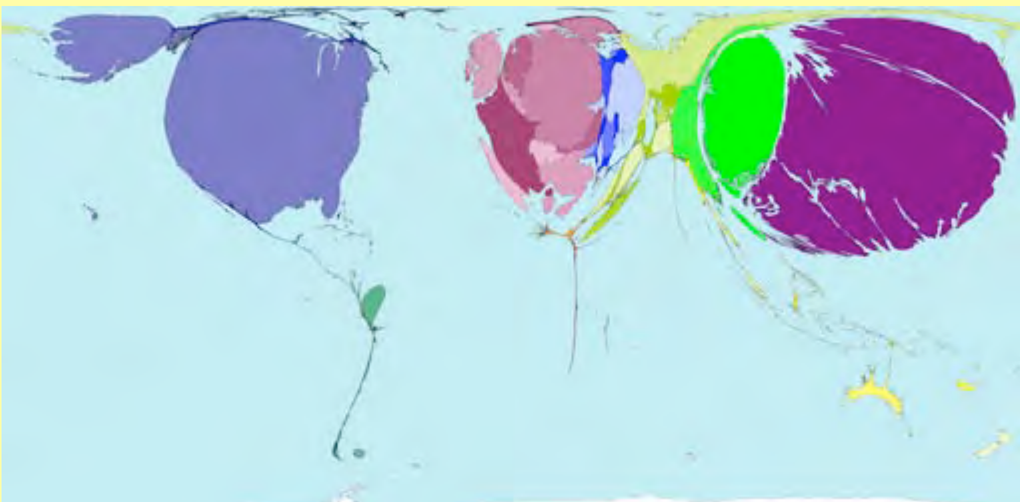
capture presented here, the graphic has been migrated to reveal the same two sets of statistics charted against each other, the difference being that this set of it depicts the world in 2004. It must be mentioned at this point that part of the fascination with a GapMinder tool, and part of its incredible power, is that it has built-in animation that enables the viewer to see the path of movement of the data on a year-to-year basis. In the case of the chart above, one sees that the movement of the various countries is usually upwards and to the right of the overall graph, but one also sees changes in the size of the circles depicted in this is most notable in the case of the large red circle which is China and the large blue circle that represents India.

What is immediately apparent is the fact that China, despite having grown significantly in terms of its population, has an increase in its per capita GDP that has enabled it to move will past India in a span of 30 years. What is also apparent is that China's level of internal health, as represented by life expectancy, has continued to increase. India has also done quite well in terms of its average life expectancy, having increased by approximately 20 years over the time period. What is perhaps the most revealing element of this second visualization is the scattering of blue circles that continues to populate the lower left-hand quadrant of the grid. The story being clearly told is that over this time period, when both China and India were making significant strides in income and apparent health, many African nations remained essentially unchanged.

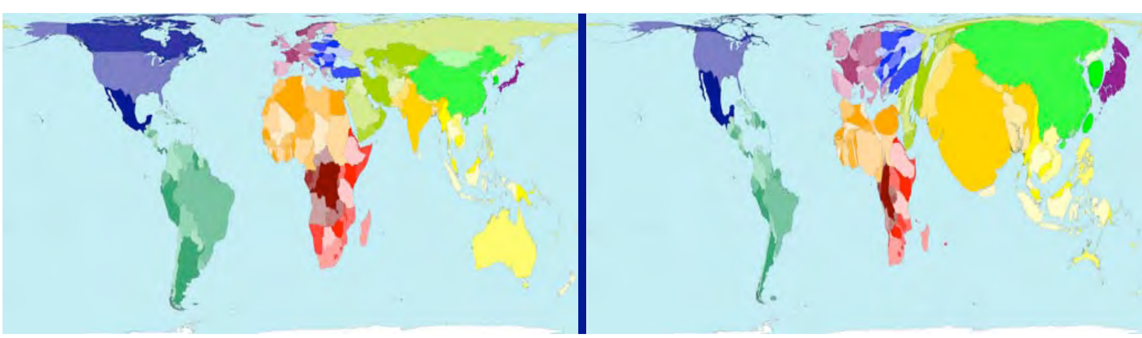
Without necessarily needing to engage in a discussion of the reasons and factors behind these events, even a casual observer of this GapMinder presentation of data would be able to conclude that there is a significant lack of progress on the income and health-related fronts in Africa. From the perspective of a communications tool, there can be no doubt that GapMinder is extremely effective.

Another flexible data visualization tool, though not on the same order as GapMinder, is a tool called Worldmapper. Figure 10.8 below is a product of Worldmapper.

Figure 10.8
International Patents Granted in 2003



Worldmapper is a collection of world maps, using equivalent area cartograms where territories are re-sized on each map according to a particular variable. What makes Worldmapper unique is the scope of the data that it covers and the format that it uses to do the presentation of the particular variables that are under examination.



In the map to the left above, the countries presented are displayed according to the actual physical land area as it is frequently shown on a mercator projection. Such a map is one way or displaying the relative sizes of nations around the globe with reasonable accuracy. The map to the right is a Worldmapper cartogram that has adjusted the relative sizes of the individual nations according to their total population. Densely populated nations therefore stand out significantly. The largest is China, which is bright green. The next largest is India, depicted in orange. What is somewhat surprising is the relative size of Japan, and perhaps that of Indonesia, both of which are much larger than they appear in the original map of the countries geographic sizes.

It is worth noting that population is just one variable that could be mapped this way. Additional maps can be created display other variables – variables that are bounded only by the imagination – and for each of these mappings the size of each nation or territory are displayed in proportion to the value of that particular variable. Every map shows the worldwide distribution of something. If a particular country is larger on one map than another, it follows that it has a higher proportion of the world total of the variable being evaluated.

In order to make it easier see what these visualizations are showing, most cartograms try to preserve the shapes of individual territories, and keep them adjacent to other territories and nearby bodies of water that can be recognized by those viewing the mapping. In the examples given here we are looking at global/international comparisons, but there is no reason that similar comparisons could not be performed for either state or regional bodies. In fact, as long as it can be mapped, even at a city or county level, cartograms can be used to illustrate the key features being analyzed.

In Figure 10.8 above, Worldmapper is used to display the granting of patents worldwide in 2003. In 2003, 312,000 patents were granted around the world. More than a third of these were granted in Japan. Just under a third were granted in the United States. A quarter of all territories had no new patents in 2003, so while they are on the map, their presence is greatly diminished. Examples of this lack of patenting activity are seen in both South America and Africa where both have been reduced in size to merely lines in this representation of the global distribution of patents.

One thing that is missing from a static display such as figure 10.8 is a representation of the dynamism of the patenting process. Whereas GapMinder has a built-in animation feature that shows the status of the variables graphed over time, Worldmapper does not currently have that capability. One would think it would not be that difficult to create this capability, given that the data going back historically is available. There is, however, the question of the complexity of the calculation required to create something like Worldmapper. It may well be that the calculations required to do the proportional expansion of geographic territory is more complex than what could be supported in an on-the-fly web-based delivery paradigm.

Figure 10.9 below is another Worldmapper cartogram. The depiction here is of another variable that would be considered to be relevant to the innovation vital signs. On this chart we have mapped the population of personal computers in use around the globe in 2003. The relevance to innovation is self-evident.

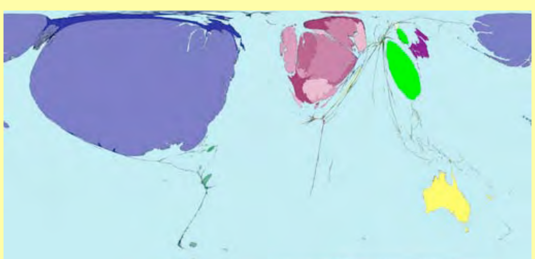
What is notable on this chart is the significant discrepancies between the basic geographic mapping that appears in the base map above and the distribution of personal computers. In 2003 there were almost 600 million such computers in use worldwide; a total that equates to roughly 1 computer for every 10 people. What is clearly shown in the cartogram above is that, in terms of individual countries with the most computers, the United States, Japan, China and Germany are all significantly over-represented. In fact, in 2003 these countries combined were home to more than half of all computers in the world.

Figure 10.9
Personal Computers in Use in 2003

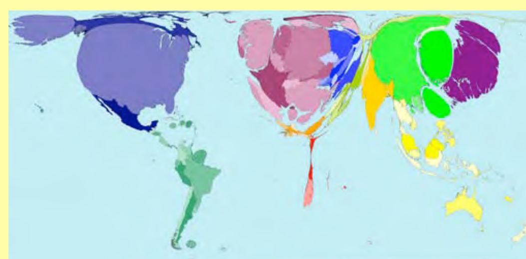
Additionally, the 12 nations with the most personal computers owned just over 75% of the global total. And in what is another display of the applicability of the 80/20 rule *in extremis*, this left the remaining 188 countries with just 25% of the world total of personal computers.

As was the case with the display of patent information in figure 10.8, there is clearly a broader context that could be provided to this data visualization with the addition of animation or some way of showing the changes in the world totals by country over time.

Figure 10.10
Internet Users in 1990 & 2003



1990



2003

The potential for providing incremental insight through animation is very apparent in the two charts and displayed in Figure 10.10 above. The data depicted here is the global population of Internet users beginning in 1990 and closing with the same population 2003. The changes are both radical and revealing. The rest of the world moved quite rapidly into the Internet era, most notably in China and India, but there's also been a significant increase in Internet users in Japan. The endpoints of the timeframe depicted here are interesting, but they do only tell part of the story. One is left to wonder how it was that South America grew substantially, and how India went from being effectively off the map in 1990 to being a major presence in 2003. The ability to display these changes on these cartograms on a year-by-year basis would help to answer some of those questions.

The Worldmapper website offers over 350 of these cartogram's showing the global distribution of some variable. A variety of these variables are quite similar to, if not identical to, the data series that were selected as potential innovation vital signs candidates. As can be seen in the examples in the figures above, a number of these relate to technology or economic variables such as: the use of the Internet, patents, cellular service penetration rates, transportation infrastructure, research and development expenditures, the publication of scientific papers, percentage of population in tertiary education, cable-television subscriptions, and even onto such loosely defined areas as high-tech exports. This is an impressive data series to have collected and made available for conversion into these cartographic visualization devices.

That being said, the drawbacks of cartograms are relatively self-evident. The foremost of these is that the presentation format is essentially fixed. One has a territory or series of territories that are being worked with, and the only change to a given cartogram becomes a function of the value of the particular variable that is being charted. As such, the ability to provide details and deep levels of interpretation and analysis is limited. There might be some options for attempting to provide additional dimensionality to these diagrams, something such as elevation of a country above the base level to indicate annual rates of change for a given variable. While this is possible, one suspects that it may be more difficult to enact in a meaningful way simply because of the complexity of the geographic maps. It's quite possible that large countries with high growth rates would completely overshadow smaller countries' standing in such a representation.

Flexibility in Visualization for the Innovation Vital Signs

In considering the visualization options that are available for the innovation vital signs project, and given the size of task involved in trying to develop optimal visualization schemes across a broad array of data types and configurations, it is not difficult to conclude that no single method is going to be 'the answer' that will meet this broad array of requirements. Instead, what will most likely result is a structure in which those using the innovation vital signs to gauge a state of innovation within the US economy will want to employ different ways to visualize the specific data sets that comprise the vital signs. The right tool and format of visualization will then become a function of what works best for the data being examined. In other words, users will want to employ the visualization that does the best job of portraying the trends and currents in the data across the timeframe, and within that context, that is being examined.

With that as a prerequisite, the implications are clear that the optimal visualization methodology is one that will employ a model that is similar to what is being practiced by both GapMinder and Worldmapper. In both cases, the individuals responsible for the development of the tool have created their visualization schema around a large database structure that includes primarily freely available data. What is interesting and useful in the way they have structured the data is that it has been a raid in a way that enables:

- the storage of entire data series going back as far as is relevant to the data being examined
- capture of a broad array of data series that may or may not be correlated with the analytical context that is presented
- the derivation of secondary and tertiary measures and indices in a structure that permits on-the-fly creation of data series for mapping and analysis.

One issue that always arises in the creation of large databases is how much data is enough for the purpose of the analyses being facilitated. In the case of much of the data for the innovation vital signs, there is a conflict between having data that goes back as far as 50 years or more and having more contemporary data. Actually, for the purposes of studying innovation, one would want the freshest possible data, that being data that becomes available as soon as possible after the events being reported on.

Having the historical data is important in coming to grips with long-term trends, and the events that shaped them that most analysts would be familiar with. However, there is a conflict between the need to understand history and the purpose of the innovation vital signs. The vital signs are largely intended to capture on an as-close-to-contemporary-as possible basis events that are taking place that will have an impact on the nation's current competitive posture as well as its evolving economic health. From that perspective, historical data is useful going back perhaps 10 to 15 years and no more. Anything beyond that is irrelevant. This is the case simply because much of what had been the underlying conditions that created the events of 10 to 15 years ago no longer hold sway. Consider the difference in the competitive landscape relative to China and India in 1990 and today.

A simple technology example is the growth of the IC&T infrastructure and its impact on all aspects of the economy. The application of this technology across all industries has been well documented and studied extensively. The general conclusion at this point is that the most significant impact of technology occurred in a post-1990 to 1995 timeframe. Prior to that, while there was indeed an ongoing revolution in the computer and of the IC&T paradigm, the communications element was an impediment to the broader application computing technologies. That being the case, having statistics available on the application of the technology prior to 1990 is an interesting artifact and little more. The changes that occurred after 1990 were radical enough to make a more extensive history moot.

There is another element of the potential for visualization of the innovation vital signs construct that is most likely also an aspect of the GapMinder and Worldmapper methodologies, but the websites did not indicate that it was a specific concern to their ongoing operations. This second major element is the need to ensure that whatever data series are a part of the “innovation vital signs database" are connected to the sources of data in a way that enables real-time updating and the refreshing of these data series on an automated basis. While this is a task that can be handled by people, it is desirable, indeed preferable, to have this process automated in order to:

- ensure that the data is obtained automatically as soon as it is publicly released
- minimize the potential for data entry errors that might otherwise crop up
- ensure that all relevant internal calculations are carried out automatically in those areas where the database may be creating secondary or tertiary indicators such as indices or ratios
- implement routine data verification procedures to ensure that the data being received falls within the expected bounds of the historical data and ongoing trends -- this is a function that is sometimes assigned to intelligent agent softwares which are capable of doing sophisticated analyses to red flag anomalies that may arise.

With that as a background, using the individual data sets that characterized the vital signs for the purposes of exposition and analysis will most likely become a data-specific task. There are so many different data sets that present themselves as candidates, and within those take considerable array of subsets, of individual items for permanent reporting is a vital sign is probably unlikely. One would expect that one element of the flexibility we have discussed above is the ability to or revise the data series that are considered to be part of the vital signs.

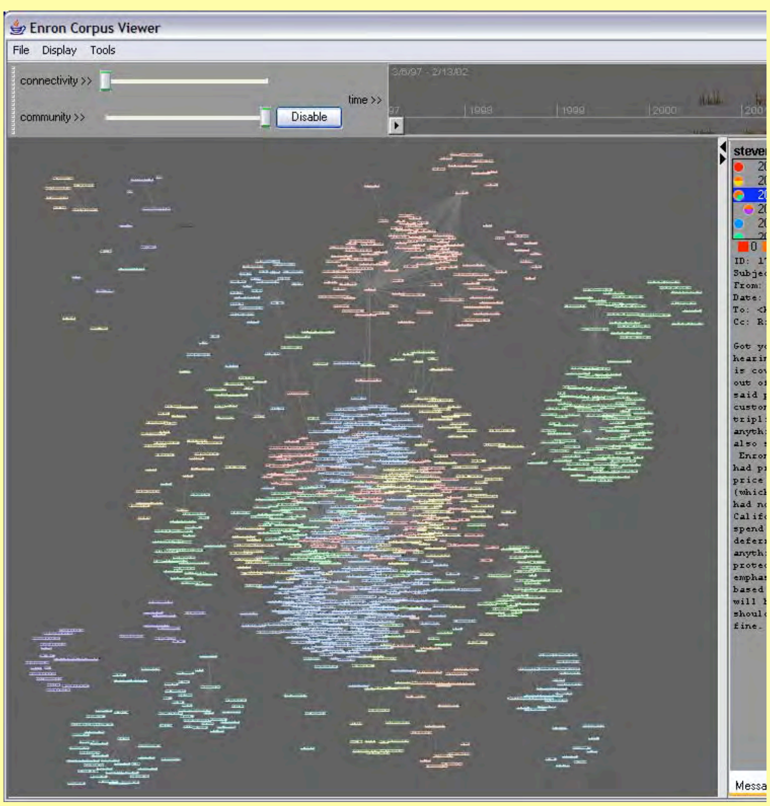
The specifics of how and why this might happen are not important. Instead, having the capability to do so is a critical need. One might even extended this flexibility construct into a perspective in which the vital signs that are employed are not necessarily a fixed set. Rather, the vital signs that are of interest to the financial community might be different from those that would be of interest to the academic community. Similarly, the vital signs that are of interest to manufacturers would have no particular impact in the medical area. In essence, the ideal structure for the vital signs visualization platform would be one in which each person can pick and choose those indicators that they find most relevant to their own specific purposes.

This customization potential is something that is not unlike what is seen in many of the so-called executive dashboards. In these constructs, executives typically have different benchmarks of performance that they choose to monitor. The specific indicators that are displayed upon their personal dashboards would be a function of their role within their respective organizations. The CEO’s dashboard would be different than the dashboard of the CFO. Similarly, a marketing executive’s dashboard may well bear little resemblance to that of the chief operating officer. There may be some commonality where the indicators employed are shared as a communications tool across disciplines, but this is not necessarily a requirement. Instead, if we use this sort of clear functional definition of what constitutes an important indicator, we may be well-served to follow this sort of paradigm for the application of innovation indicators across the many elements of the innovation ecosystem.

The need to maintain flexibility within the visualization scheme of the innovation vital signs is paramount. But this flexibility will tend to differ across data series and across application areas. This is the case simply because the data sources that are available from different sectors of the economy are at very different levels of maturity. In the manufacturing sector, as we have noted earlier, the data is quite extensive and reasonably robust. There are obviously gaps having to do with technology being ahead of the ability of the statisticians to capture and report on the new technologies or the new devices that are new entrants to the market.

However, the status of the manufacturing sector, while it does have some problems, is enormously preferable to that which exists in the services sector of the economy. As was discussed earlier in this report, there are many areas of the service sector in which meaningful statistics are entirely absent. This is especially true in those areas in which we are trying to identify and codify the sources and uses of innovation within the service sector. There is widespread agreement that something needs to be done to address this data gap, but agreement that something needs to be done is far easier than actually assuming the task of doing something in this complex, yet increasingly important, area of the US economy.

Figure 10.11
Connections in a Corporate Network



The best way to present the concept of flexibility within the data reporting and data virtualization structures is through an example or two. One of the things that is readily agreed upon as an innovation indicator is venture investing. The venture investment industry is a discipline that supports the creation of new companies, frequently companies that are based upon the idea of an entrepreneur/technologist who is the founder of the firm. There are a number of data series that are currently available on the investment patterns of venture capitalists, and some of these have been used extensively in reporting on the growth and development of the innovation economy.

What is not as well reported, though, is the structure of venture capital investments in terms of a higher level of granularity of the types of investments made, the technologies being invested in, and the types of people who are recipients of the investment. These are all potentially important characteristics that would help to better define and better understand the venture investing industry in the US and its links to innovation.

One of the things that is frequently reported on in the venture industry are the multiple layers of connection between the various VC firms. This is a mapping that is similar in some respects to a supply chain construct where there are multiple other networks that are known to create the totality of the infrastructure that is known to exist in the VC community. Figure 10.11 above is a depiction of a corporate network mapped through the use of e-mail addresses. What is interesting is that this same type of diagram could also be used to indicate venture investment patterns by VC firms. The colors of the various nodes of the map could represent technologies. The different clusters of e-mail names could represent the network of invested companies belonging to a particular venture firm. At a higher-level drill down, one would be able to read the names of the companies, as well as the name of the investment firm.

This is just one more example of how advanced data visualization is useful in understanding some aspect of this situation and that is not readily self-evident upon cursory examination of the base data. Thinking further about the kinds of things that one would like to see regarding venture capital investments as an innovation indicator – and thinking in the context of a highly flexible database that enables the restructuring and reporting and visualization of large amounts of base data -- the question becomes what are the right things to look at. Is the data depicted in the figure the right things or simply some selection of interesting things? Therein lies one of the more difficult aspects of mapping the connections between innovation indicators and their interactions to create those novel ideas and new concepts that are so prized by the economy.

Among those data items that might be the most useful for review in an analysis of the venture capital world, without necessarily looking at what actually is currently available, one would think that the series of items listed in Table 10.1 would be some of the primary indicators of the vitality and robustness of venture investing. We currently have venture investing data that is compiled by a private sector source. Some of the aggregated data is available for public release through the National Venture Capital Association, but there are other data items that are proprietary and available to members of the NVCA, but not to the general public.

From the perspective of an innovation analyst, the following is a short wish list of the sorts of data items that one would expect to be the most useful from a policy prescription perspective. Some of these indicators already exist. Others suggested below are ones that it might be interesting to see. From a visualization perspective, there are clearly some interesting relationships that it would be useful to map, as well as some clustering that might potentially be revealed through an advanced data visualization construct of some kind.

Table 10.1 Potential Venture Investing Indicators

Deal Count	This is simply the total number of venture investment deals that are completed in a given time period. What would be useful is knowing how many deals are ***not*** funded. This statistic might be as useful to know as the number of investments that are actually made.
Technology Group	This would be a categorization of the type of technologies being financed
Investment Round and Amount	It is important to know whether the funding received is a first round or something beyond first-round. The amount of the investment is always important
Number of Employees in Invested Firm	Venture firms frequently talk about the number of jobs that their investments have created, but firm employment at the time of the investment is not widely tracked.
Education of Founders	It would be interesting to see the level of education of the founders of the typical venture backed firms, both in terms of their concentration by academic topic and in terms of the degrees received, e.g. MBA, Ph.D. etc.
University Attended	We are not aware of anyone recording the University that the founders of invested companies attended. It would be interesting to see if there is any correlation between the university attended and the ultimate success of the

	invested firm, or if there are universities that are hot beds of firm creation.
Linkages to Other Firms Through Board Composition	This would be a networking exercise to see greater detail on how the established technology and capital network of the major venture clusters are cross-linked through boards of directors or boards of advisors. This may be a critical contributor to a firm's ultimate success.
Source of Introduction to Venture Firm by Type	This would be another interesting indicator to map, as the source of the introduction to a potential VC investor may be as important as a well-polished business plan.

Potential visualization exercises related to the above categories are relatively self-evident. The key is the context that the data might be presented in. What might prove most useful to get a sense of the state of the venture investing world would be a mapping of the data series in 3 dimensions or more. Which raises the issue of the intent of the visualization and the need to maintain the flexibility that was mentioned in the discussion above.

The most important factors in gaining an understanding of the impact of venture investing are a function of the objective of the analysis. Are we trying to compare success rates, or are we simply looking to see where the funds are investing? Are we concerned about the underlying IP trends, or are we more interested in seeing which funds are investing in specific sectors? The objective, as with any visualization, is to be able to define the items that we want displayed and then to have them presented in a way that makes analysis and the drawing of conclusions as robust as possible.

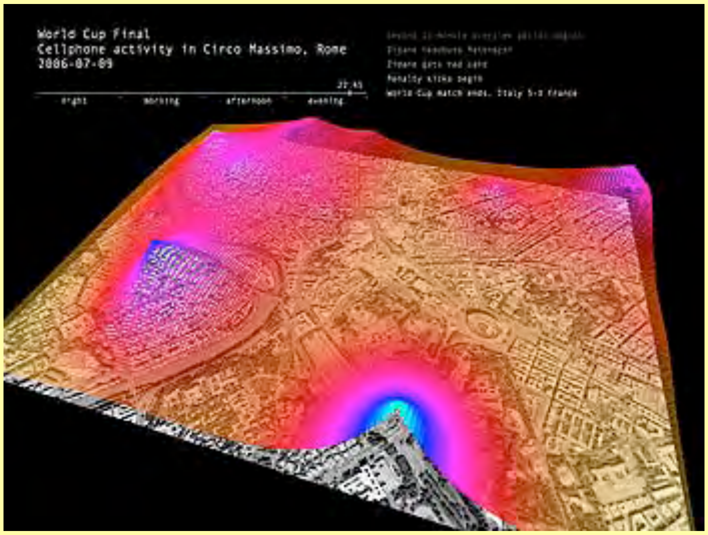
One of the things that is frequently referred to in connection with the topic of innovation is the phenomenon of "clustering." This is a reference to the way in which communities with common interests in industries or specific technologies tend to spring up in a web of interrelationships that can be defined geographically. This is clearly the case for the venture investing community as available statistics on venture investing reveal that a significant amount of total venture capital investing occurs in Silicon Valley in California, around Boston in Massachusetts, and in the Austin, Texas area. But knowing that these clusters exist is really only a small part of the story. What analysts need to find out is what sorts of industries are locating where, and what type of impact these new innovative firms' creation is having on the macroeconomic success of the area in which they are resident.

Trying to capture that kind of information in a single visual is a difficult undertaking. An alternative approach might be to define a visualization geographically and then add in layers of secondary information that can combine to a total. But what is important is that the data is presented in a way that is linked to specific geographies, thereby showing the relative importance of the various clusters to the overall total while also maintaining the ability to drill down into finer levels of granularity.

Figure 10.12 below is an interesting depiction that might serve as an example of how one can show clustering against the geographic area. What is depicted in the graphic is an overlay of cellular phone traffic in a portion of Rome. But what is more interesting is that this cell phone traffic has been graphed during the playing of a World Cup soccer game in Rome's Olympic Stadium. In this visualization cell phone usage is represented vertically over the map's basic geographic features. One can see the impressive spike of cell phone traffic directly over the stadium in the lower right-hand corner, this pattern is significant relative to the ordinary flow of cell phone traffic occurring on the left-hand margin along a major thoroughfare in the city.

So what is the connection to the innovation indicators for venture investing one might ask. The answer lies not so much in what is on this particular visualization as how this format might be employed to depict the sorts of activities that were discussed above.

Figure 10.12
3 Dimensional Plotting Example



If one starts by replacing the small geographic map of Rome with a map of the United States, this creates a baseline for plotting or mapping the venture investing information that we are interested in. Building a compound picture on a sector by sector basis of venturing activity, one that can be combined to present an overall total for the entire country, would rapidly reveal both the clustering phenomenon that is known to exist in the venture industry, and it would also show where venture capitalists are investing on an industry basis.

What we would want is a depiction that enables investment in medical devices as one layer, investment semiconductor technology is another layer, investment in energy technology as another layer, and as many incremental layers as are needed to show the detail that we seek. There might be some cutoff point at which individual or industry investments are no longer tracked and simply summed into an all other category. But overall this sort of a construction, along with the ability to combine and sort through the data components that are used to create the visual, would be a very useful way to rapidly come to understand a significant number of factors that are salient to the venture investing picture in the United States. Again, as was the case in earlier examples, the important component here is good data and the ability to create visuals from the data in a highly flexible manner.

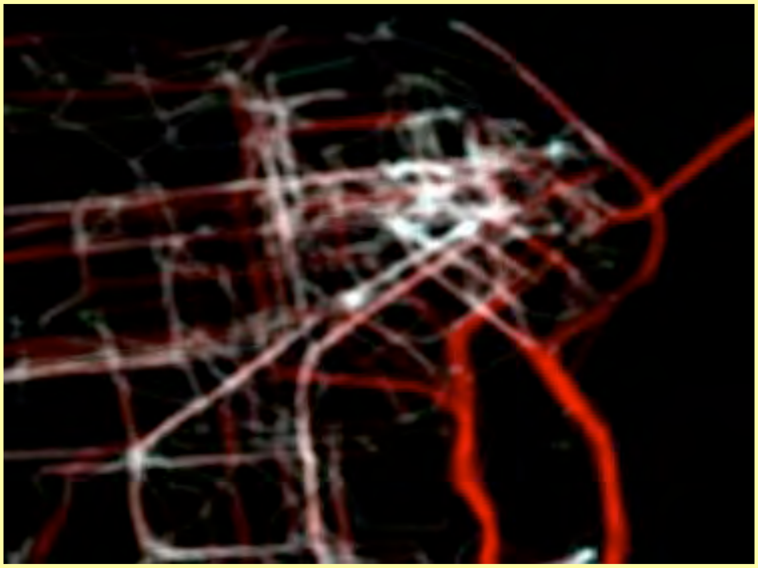
An excellent example of what visualization can do to make raw data comprehensible and revealing is offered in by a project that is currently being carried out by the San Francisco Exploratorium. In a project appropriately called Cabspotting, the Exploratorium cooperated with the local Yellow Cab company to create this very interesting, and very revealing, picture of the ebb and flow of taxicab traffic in the city.

Figure 10.13 below is an overlay of GPS data for cab traffic on a map of the city of San Francisco. The colored lines represent cab traffic flows, in terms of speed and frequency. The red lines represent higher speeds and frequencies of use of specific roadways. An interactive animation of Cabspotting can be accessed at http://cabspotting.org/lines-sf4hr.html.

Cabspotting is designed as a living framework that uses the activity of commercial cabs as a starting point to explore the economic, social, political, and cultural issues that are revealed by the cab traces. Where do cabs go the most? Where do they never turn up? Cab projects such as this are vehicles for researchers to explore these issues in the form of a small experiment, investigation, or observation.

Many cab companies, including San Francisco's Yellow Cab, outfit their cabs with GPS to aid in rapidly dispatching cabs to their customers. Each San Francisco based Yellow Cab vehicle is currently outfitted with a GPS tracking device that is used by dispatchers to efficiently reach customers. The data is transmitted from each cab to a central receiving station, and then delivered in real-time to dispatch computers via a central server. This system broadcasts the cab call number, location, and whether the cab currently has a fare. The cab locations are not stored by Yellow Cab, but only used in real-time to aid dispatch.

Figure 10.13
Cab Spotting in San Francisco



For the purposes of the Exploratorium research, there was a connection established so that the museum computers talked to the Yellow Cab server and stored the data in a database, encoding the call number for privacy. Server-side processors compute the aggregate map at various time intervals (10 minute, 1 hour, 8 hours, etc.) and store these frames as Postscript and bitmap images. These are subsequently combined into animations of traffic flows for an hour, a day, a week, etc. These images and movies can be queried by visitors to the site in order to build a detailed perspective over the time span they wish to see.

What is particularly interesting here is that this is a meaningful and useful tool; the depiction is interesting as well as informative. But more importantly, the use of GPS has benefited the cab company in terms of reduced costs and more efficient customer service. In other words, the visualization enables interpretation and analysis that led to real results. One would hope that visualization is equally useful when combined with the innovation vital signs.

Cabspotting is an interesting visualization, but can this type of exercise be proven to be relevant to innovation and the way in which we might measure and understand it? Once again bringing the imagination to bear on the issue, one might see the virtual map of San Francisco as a prototype for a similar mapping of the innovation ecosystem. Imagine each address on the map as one node in the ecosystem that any participant can stop at to share information and gain insight on potential new ideas, new technologies, new applications, new sources of funding, new participants in the ecosystem, and any other of the myriad points of information that might be contained within the system. Over time, the high traffic – presumably higher value – nodes in the ecosystem will become self-evident and self-reinforcing. As in the Cabspotting exercise, the ecosystem will be self-revealing over time.

The challenge for those looking to gain a better understanding of innovation from the exercise is to determine what the qualifications are to become nodes on the map. There is the potential to have layers imposed on the overall ecosystem that are definable subsets of the entire system – for example, a layer that is devoted to nanotechnology, or a layer that is devoted to alternate energy source technology, or a layer that is focused on applications of new remote sensing technologies to the development of an intelligent transportation and logistics infrastructure. The possibilities are limited only by the collective imaginations of the participants in the tumultuous, entrepreneurially driven innovation economy that is well-recognized but not that well-monitored or understood at this time.

The last two examples discussed lean in the direction of what might be termed a GIS-type visualization structure as a basis for displaying innovation and the data sources that are considered to be the best innovation indicators. And there is a certain attraction to such a system. GIS, or geographic information systems, have been around for many years and have been employed in countless applications, frequently with considerable success. The strength of the GIS type systems is that they engage in precisely the activity that was described above, that being the ability to link multiple layers of data to a specific point on a map. As such, they can show specific elements that can be linked to geography, for example research facilities, educational establishments, population statistics of all kinds, etc.

The weakness of GIS systems, and a factor that makes them problematic for the display of innovation into, is the fact that GIS systems do not necessarily show interrelationships that occur within a defined geography, much less interrelationships that might take place beyond the bounds of a defined geography that do have an impact on the activity being measured. The GIS system will tell us where the university is located. It will also potentially tell us the number of researchers that are active at that university, as well as the fields in which they are active. There could also be layers dealing with funding, layers dealing with the student population, layers dealing with intellectual property development, and layers dealing with economic development activities funded at the University. All of these would be considered to be important in defining the innovation capacity of the institution.

However, what would be missing from the map, and this might be accommodated over time, would be in the linkages of activities at the university to like activities at other institutions of higher learning, or within private research labs, or within the business community. These are the sorts of things that GIS system would be weakest in doing. The GIS system might serve as an excellent repository of data in the types of activities described above, but it most likely would not be the appropriate tool for a high-valued interpretation and analysis of the types of linkages that are known to exist. To gain that capability, one would have to create new structures that invoke secondary and tertiary visualization tools that can and properly present those important linkages that create the cross fertilizations that are such an important part of the innovation ecosystem.

Figure 10.14 Swarm

Figure 10.14 presents another data visualization tool, one called Swarm. Swarm is a graphical map of hundreds of websites, all connecting to each other. It updates itself every second with where people are going and coming from. As sites become more popular, they move towards the center of the swarm.

Website traffic is symbolized with thin lines. Each time a line appears or disappears means someone has moved from one site to the other. It is possible to gauge how many people are swarming around a site based on the number of lines connecting to it.

Swarm is presented as an alternative way of graphically depicting the complexity of the task at hand. The website for Swarm is interesting in that it is virtual and highly visual. Things move from point to point, going toward the center or away from the center. Connecting lines are established, broken, and then reestablished elsewhere for as long as an individual is logged on and actively searching the web. It has much of the dynamism and that one would expect to see in the real world of the innovation ecosystem. It also provides a representative visualization of the level of complexity that we know exists through our efforts to find those indicators and data points that we can genuinely referred to as innovation vital signs.

Which leaves us with the simple conclusion that visualization will be a key component of successfully presenting and representing the data to tell us what is happening in our innovation ecosystem. But that is the easy conclusion to draw. The difficulty of the entire process begins with moving one or two steps away from the basic conclusion that visualization is important. We know that there are many ways to visualize data, a few of which have been presented above. We know that there are some preferred methods for depicting certain kinds of data. And we have seen that flexibility in presentation formats and presentation styles will most likely be important components of a useful visualization of innovation.

The questions that remain to be answered are not so much related to what needs to happen next, but instead relate to how to best go about the task of meaningful presentation of innovation data. Among the top three topics that we have considered that present themselves as potential baselines for visualization are:

- network issues that need to be portrayed - we know that innovation happens in a very messy world, one that has numerous connections that do not necessarily follow established boundaries or established processes for having information flow from individual to individual or group to group
- technology tracks that need to be followed - from an innovation perspective, technology is not a necessary condition for innovation to occur, but we have seen that most of what we recognize as innovation tends to take place within a technology context. This being the case, any robust system of innovation vital signs will need to have strong and demonstrable links to the development and adoption of technology of all kinds across the entire economic spectrum.
- market channels that need to be mapped - we have spent a great deal of time talking about the economics of innovation, but it should be mentioned that innovation is only valued to the extent that it can be understood by, and accommodated to, markets. Successful innovations are those that ultimately lead to financial success, whether as a primary product or as a contributor to secondary and tertiary products — for example, the laser. In the innovation ecosystem the data points that we are tracking within it are only useful to the extent that they enable us to understand the self-sustaining mechanisms of innovation that exist and must be nurtured.

This clearly is not an exhaustive list; rather, it is offered as a guideline for starting point for developing visualizations that are informative, illustrative, and relevant.

The ultimate objective is to create the capability to track and understand the critical success factors that are involved in innovation so that we can monitor and respond to the need to maintain the vitality of the nation’s innovation enterprise. This means that we need to:

1) be able to access as much data as possible that might be related to innovation
2) be able to rapidly and effectively create visualizations of that data in ways that are clear and revealing
3) be able to link the data and the visualizations to some form of analytical understanding that is policy prescriptive.

The bottom line here is one that is not unique to this area of endeavor. There is significant meaning and truth to be derived through visualization of all manner of data. The difficulty in extracting that meaning is that one that needs to be able to recognize the right issues in order to be able to ask the right questions about how to enable the nation to sustain and strengthen the fundamental drivers of innovation that have been so critical to the long-term economic and competitive vitality of the nation.

Table 10.2 below contains a summarization of suggestions for approaching the visualization issue within the context of the intent of this project. These are grouped according to the categories that were established in the IVS conceptual framework. We offer these as suggestions for incorporating visualization as one of the critical ultimate tools for understanding what the innovation vital signs data reveal and the degree to which this understanding is part of a policy analysis and development mechanism for individuals responsible for shaping responses to emerging and emergent corporate, national, or global events.

Table 10.2 Innovation Vital Signs Candidates and Visualization Options

Indicator Type	Visualization Issues and considerations
R&D	Research and development statistics are a combination of close and static pictures of activity. As such, the visualization options for R&D activities will want to focus on defining levels and growth rates, and from them determine ways to express both comparative and absolute positions.
Talent	Education funding, educational achievement, the component of the workforce engaged in research activities are some of the primary talent indicators. Given the long lead times that are required to enact changes in this area, visualization will have to focus on long-term trends and those factors that influence the long-term trends in order to properly portray cause and effect relationships.
Capital	Venture investing, SBIR funding, and capital formation are the leading candidates for selection hasn't innovation vital signs in this category. One would expect that the most important visualizations connected to capital formation are those that provide detail on these subcomponents home the larger categories, with a focus on changes in absolute levels as well as changes in the components over time.
Networks	The networks category refers to both physical and virtual networks. Both types of networks are seen as enablers of innovation. Visualizing the physical networks is an art that is well practiced. Visualizing virtual networks and the interconnections of communities across disciplines and across political boundaries is an area garnering much attention. Visualization of these virtual networks, in order to have value, we will need to depict both the quantity and quality of the network communications that are being established. The tools exist for the quantitative aspects of this visualization. Determining and depicting the qualitative aspects of these rapidly emerging networks is a far more difficult challenge.
Management	Management is one of the categories of the IVS conceptual framework. However actual measures of management activity, the impact of management, and the quality of management are highly elusive. The best proxies we have at this time are measures of entrepreneurship and statistics on the creation of shareholder value. In both cases the visualizations would need to be quantitative in nature, and would seem to have an implicit connection to geography at the national, regional, state or local level.
Product Development	Patents are one measure, process measures are another, and product portfolios are yet a third primary indicator of levels of product development activity. Creating visualizations in this category therefore implies creating items that employ and combine all three in ways that may not be obvious until some experimentation is performed to see how these indicators meld into some insight-providing perspectives.
Efficiency	Efficiency in innovation is a difficult category to describe. At its core it relies on indicators from other categories to construct new measures. There are some direct measures of efficiency that have been suggested, but they are less than robust, making this a category that is in need of better definition and in search of a definitive set of baseline indicators.
Process	Innovation processes are measured here through items such as the speed of new product development, ‘intrapreneurship’ programs, and improvements in business processes that are designed to spur and promulgate innovation. In the diversity of indicators available here creates a visualization problem. There are multiple process perspectives, many of which do not really focused on the same issue or type of concern. That being the case, the appropriate approach in the process area might be to visualize individual components to see if they can be summed up into some form of a composite that would lend itself to better visualization and representation of the multiple data sources being used.

Output

The family of output indicators has much the same problem as the process indicators described above; there are many of them available, and the diversity of activity they represent is problematic. That being said, the fact that these indicators are directly connected to the product of innovation activities means they are extremely important. Here again the best visualization strategy might be one in which clustered subcategories are created or identified. The challenge would then be to both represent activity within a subcategories as well as the interconnections of these categories to each other.

Impact

Measures in the impact category reflect the end product of innovation on the overall economy in terms of job creation, trade in innovation goods, measures of technological competitiveness and other like categories. Visualizing these indicators would appear to be a fairly straightforward exercise in that they are primarily depicting either nominal levels or rates of change of a particular data series over time. These data series are to some degree interconnected as subsets of one another more than they would be expected to be interconnected in a network sense. This makes the visualization task easier to implement.

Macro-Econ

This category contains the standard macroeconomic measures such as GDP growth, per capita income growth rates, and levels of gross private domestic investment. The familiarity that most analysts have with this type of data implies that the visualizations here are a simple task. There is no particular need to employ overly sophisticated graphics as they might tend to be more confusing than edifying in a world where trend lines and bar charts have sufficed for decades in visualizing and presenting these types of data.

Policy

Unlike the macro economic variables in the above category, the policy variables are much more vague in terms of what they are trying to present and explain. The variables that have been developed reflect the status of policy options being practiced – tax rates, measures of trade barriers, IP protection, etc. Visualizing these types of variables will prove difficult in that they are largely binary nature -- they exist or do not exist -- and quantifications of the degree of these kinds of policy options are difficult to display and define.

Infrastructure

The innovation connection to infrastructure is a combination of the physical and the virtual infrastructure – both of which combine to spur innovation. Data sources on the physical side are abundant. The data on the virtual infrastructure is available to a degree, but more problematic in quantifying and depicting. There are methodologies available for quantifying some of these less tangible aspects of the virtual infrastructure, but converting those quantification into meaningful visualizations may prove to be a significant challenge.

Mindset

The final IVS category, mindset, is another ‘soft’ area. It deals with cultural factors such as willingness to embrace change and take risks, and a predilection for pushing the frontiers of scientific and technical knowledge. Quantifying thing such as the mindset in a meaningful way is something that is in the early stages of development. Given that there is some quantification of mindset factors that is emerging, visualization of the results of his quantification can be done. However, there is some question as to the visual and virtual connection to many other innovation indicators that are a function of mindset. Mindset would seem to be something that is best expressed and visualized as an environmental backdrop sort of a factor, and one that might serve comparisons of other, more robust indicators against a visualization of a more or less innovative mindset within the country -- perhaps something as simple as depicting a nation's territory as green for a positive mindset and red for a less positive mindset.

11) Conclusions and Next Steps in the IVS Process

Summing up the work done to date is the best way to get an indication of what needs to be done in the future. At this point, it appears that we have a very good assessment made of the breadth and depth, and variety, of indicators that are available to us. If we were to devote incremental effort to find a more indicators, we would most likely find more, but there is some question as to whether or the effort would yield anything but indicators that are at the margins. There clearly are more private sector indicators that might be discovered by a further mining and refining of the work done to date. But there again, one might reasonably expect that the results of such incremental activity would be interesting, but most likely would yield only a marginal contribution to the base of knowledge built by the project team.

The next challenge to be faced involves going the next step beyond the qualification and scoring exercise we have performed to date. We need to develop a process for the incremental refinement of the 160 plus indicators that we have identified to date as candidates for the innovation vital signs. As noted in the previous section, part of this process will involve reviewing the options around which are the most effective at telling the innovation story. This would involve resolving issues regarding both the quality and the ability of the various indicators to properly, and accurately, tell the innovation story.

We want to be able to utilize indicators that have multiple dimensions to them. By this we mean indicators that are an integral part of the innovation system. Clearly, investment in R&D is a part of the process of innovation. Clearly, the talent pool in technology driven industries is a part of the innovation process. Clearly, the level of university research being performed is a part of the innovation process. Does this mean it would be desirable to find an indicator that captures all three of those activities? If there is no such indicator, would it be possible to construct an indicator driven by all three of these factors? We have not yet put to the test the question of whether "pure" indicators are more desirable than the composites.

Nor have we looked at issues related to what might be termed the derivatives of the indicator set that we have instructed. The vast majority of the indicators we have assembled and evaluated deal with a single point in time for a given value. They are in essence a simple quantification of some activity or population or process. But there is much potential value in looking not only at the absolute values, but in examining the rate of change of these values over time. This is the case in the US economy where we still have the largest R&D enterprise of any economy in the world by a significant amount. However, when one looks at the rate of change of that research investment, it is useful to see that the level of research as a share of total economic activity has not kept pace with its position 15 to 20 years ago.

Does this imply that indicators showing movement are superior to those that show a simple quantification? The answer would have to be no. And that is the essence of this vital signs Project. No single measure can adequately, and comprehensively, be expected to serve as an indication of the health and vitality of innovation within our economy. That is why selection of the appropriate indicators, indicators for the entire spectrum of inputs and outputs and processes of innovation are what need to be sifted from the collection of indicators that we have compiled to date.

Which brings us full circle to a discussion of the next steps in the Innovation Vital Signs Project. When this project was launched, one of the key activities proposed for the overall process from beginning to - conclusion was a mid-project "gathering of eagles" to survey from a very high level the work that we had done to date. These eagles would consist of a combination of data providers and data users with an interest in innovation for their industry, or whatever subset of the economy they work in. It was our intent to have them review the processes we employed on the one hand, but more importantly, our intent was to have them review the work-product to date. It was the mission of this gathering to bring together the collective experience of the group so that they might reflect from their multiple perspectives on both what we have done, and to provide for their insight on future directions for the work going forward.

Having sorted through and compiled our indicators to date confirms the wisdom of our initial proposed activities. While we have created a body of knowledge around these indicators that is perhaps unique within the field, we also have created a significant problem that will require input from individuals whose expertise exceeds our own. This is especially true for the private sector indicators, but is no less true for the analysts of these innovation indicators.

As we knew when we entered into this project, innovation is one of the hottest topic areas with respect to macroeconomic policy in virtually all developed economies. Competitiveness and the economic futures of so many countries and industries are clearly linked to their ability to innovate. As such, in parallel with the rising interest in innovation, there has been a concurrent rise of a class of innovation analysts. These are individuals who have devoted considerable effort to studying the processes of innovation. They have also been doing groundwork, not unlike the work described here, to develop indicators that measure the innovation process and the results of innovation. It was our intent to collaborate with these experts to gather their perspective on the work we have done, hoping their collective wisdom would prove illustrative for the path forward. We were particularly interested in data collection process refinements, refinements to the definition of innovation that extended beyond the framework we have developed, and also in finding out about any progress that has been made in creating new and/or alternate approaches to the quantification and qualification of innovation.

The completion of the workshop enabled us to narrow our focus to those indicators that have survived the scoring and filtering process, as well as focusing in the indicators that the workshop participants felt would be the most valuable in capturing and quantifying innovation. There was also the issue of considering alternate approaches to developing an ongoing process for capturing and reporting these innovation vital signs.

This is embodied in what might best be considered the next phase of work as defined by our original work plan. Much of the effort in this vital component of a follow-up project to our work will need to be devoted to both defining and redefining potential collection mechanisms, and to defining and refining the reporting mechanisms that will be employed.

While we had no expectations that we would be able to, within the scope of work on this project, develop and report a series of innovation vital signs that are carved in stone, we do believe that we have, within the construct of the work done to date, laid a strong foundation for going forward.

We firmly believe we are on the right path. We are equally as convinced that any future work in this area will benefit from our work, both from a perspective of our having narrowed the field of available indicators, and from our having created a process for selection, refinement, and improvement of innovation indicators. As new indicators become available, and as our understanding of the processes and structures of innovation are further investigated and revealed, we expect that the development of a better understanding of innovation will result, as will a better understanding of the mechanisms of data definition and data collection.

In the obverse of the journey of 1000 miles beginning with a single step, in our case the journey to a single set of innovation indicators has begun with a review involving thousands of steps. We believe that the work we have done will prove highly valuable for future follow-on efforts, and we are pleased to have been selected to perform this pioneering function.

12) Listing of Appendices

A) **Summary of Private Sector Indicators Data Base -** name and source, structured according to the approach defined in the text, that being the use of the NAICS as a foundation to analyze industry groups and other sources of data that might be used as innovation indicators, and potentially be qualified to serve as innovation vital signs,

B) **Data Base of Public Sector Indicators** – by name and source, structured according to the components of the conceptual framework developed and reported on in Phase 1.4 of this project. Due to the size of this particular item, this data set is not being printed out for this report. Instead, it is being provided for review in electronic format.

C) **Data Base of Public Sector Innovation Indicators** – ranked and sorted by utility and quality criteria – due to the size of this particular item, this data set is not being printed out for this report. Instead, it is being provided to the client and their authorized representatives in electronic format.

D) **Data Base of Private Sector Indicators** – ranked and sorted by utility and quality criteria

E) **Private Sector Indicators Data Base of Sources and Descriptions** – this is the total of the private sector indicators that were evaluated for inclusion as innovation vital signs.

F) **Scored and Prioritized Database of combined public and private indicators** – ranked and sorted by the IVS team after being scored on the 8-point utility and quality scale described in the text.

G) **Agenda for Innovation Vital Signs Workshop** – This presents the agenda/program for the Innovation Vital Signs workshop that was held on April 26 & 27 as a component of the overall project plan.

H) **Candidate Innovation Vital Signs – by Framework Category** – This appendix presents a detailed listing of the candidate Innovation Vital Signs as structured according to the innovation framework that is presented in the opening sections of this report.

I) **Acknowledgements**

Appendix A – Summary of Private Sector Indicators Data Base

Available Indicators for Evaluation of Vital Signs Applicability - Manufacturing

NAICS Industry	Description	Sector GDP $B in 2004	% of Private Industry	Number of Establishments	Number of Employees
31-33	**Manufacturing**	$4311.6	20.20	350,828	14,966,536
	The Manufacturing sector comprises establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products. The assembling of component parts of manufactured products is considered manufacturing, except in cases where the activity is appropriately classified in Sector 23, Construction.				
Innovation Activities Reported	Manufacturing is a source of considerable innovation in products, processes, inputs, and business practices. Because of the ability to readily identify any of the above listed items as new, measuring innovation in manufacturing is easier than in other sectors, but has nonetheless not been widely adopted due to a variety of difficulties in developing meaningful metrics.				

Private Sector Organizations Monitoring Industry		Innovation Indicator Framework – Potential Innovation Sources				
Name of Organization	**Data Provided/Available**	**R&D**	**Human Capital**	**Finance**	**Management**	**Networks**
SIA	Semiconductor Industry Association – has an extensive global database of proprietary information. Details are provided on the following page.	Yes	Some	Yes	No	Some
AMT	The Association for Manufacturing Technology has a proprietary database of industry specific market information that it collects and provides to members.	No	No	Yes	No	No
SPI	The Society of the Plastics Industry has a sizable proprietary database of industry information that exceeds the level of specificity in gov't. statistics.	Some	No	Yes	No	Some
ACC	The American Chemistry Council provides members and the general public with its US Short Term Indicators, a monthly report providing comprehensive chemical industry data covering shipments, inventories, shipment to inventory ratio, price indices, trade, capacity utilization, industrial production, labor force statistics, rail car loadings and energy. Macro indicators are also included in the areas of building and construction, electronics, metals, packaging, pulp & paper, textiles, apparel & home furnishings, supply chain and more.	Some	No	Yes	No	Some

	NEMA	NEMA provides a forum for the standardization of electrical equipment, enabling consumers to select from a range of safe, effective, and compatible electrical products. NEMA maintains few market statistics, focusing instead on standards issues that have enabled the evolution of the industry over time.	Some	No	Yes	No	Some
		Potential Innovation Vital Signs for Sector					
		The manufacturing sector is unique in the US economy in that it is well defined according to products provided and the industrial/physical inputs required to create them. The entire structure of the NAICS was historically driven by the need to classify activity in the creation of manufactured products during the time when the US was largely a manufacturing and agricultural economy. While this is no longer the case, with the service economy responsible for generating close to 70% of US GDP, the statistical reporting structures instituted during the development of the industrial economy are still in place and are serving well in terms of defining and recording economic activity at high levels of granularity. This is useful when it comes to defining vital signs of innovation in those sectors that are well-documented, but is frequently problematic when it comes to finding the right classification for new products that do not fit within the traditional boundaries, e.g. is an iPod's value created as a product or as a service and is it possible to disaggregate the service value from that of the manufactured product? This factor notwithstanding, there is a robust and structured, governmentally managed system in place for measuring and classifying the output and activities of manufacturing industries. The UC Census Bureau administers this system and provides a series of quarterly and annual data on manufacturing production and other variables within the NAICS structure. Many, if not most, trade groups rely on this data to define activity in the industry they represent, frequently providing statistics on their industry that are reformatted reprints of government data. There are also some industries in which the government data is insufficient to meet the demands of industry participants. In these cases trade groups serve a valuable function for their industry by compiling statistics that are gathered directly from their membership that transcend the boundaries if the NAICS system by incorporating new products at levels of detail far higher than in the NAICS, and also gathering data on market activity in a monthly interval. The discussion below contains a description of the activities of three trade groups that have extensive internal data collection activities that supersede the industry data available from government sources. Of particular interest is how these private data sources in manufactured products might serve as innovation indicators for their industry. Given that these organizations' data, because it has more detail than government sources, might serve to track the patterns of customer acceptance of new technologies. Higher quality data might also be valuable in monitoring trends in product life cycles and the changes in the workforce required to accommodate them. The analysis of manufacturing vital signs potential begins with a review of what we are terming innovation activities of innovative firms.					

		Potential Innovation Vital Signs for Sector
	Name	**Data Provided or Potentially Available**
	New Biz Starts	This is an area in which certain segments of manufacturing are quite active in seeing new businesses established. Examples that are currently quite active are nanotech, energy devices, and medical equipment. While not a string indicator across all of manufacturing, there is most likely some value to be had in finding ways to monitor those sub-sectors in which dynamism exists.
	IP Development	Manufacturing has historically been a source of considerable IP development. The issue for use of this information as an innovation vital sign is where and how to best capture this data, and what the appropriate metric might be.
	Workforce Δ	Workforce development, skills and capabilities, and quality issues are at the top of many manufacturers' list of issues that need to be monitored and addressed as engineering and scientific talent is seeing high demand and shortages of supply. Finding and reporting metrics related to workforce issues would seem to have high potential as an innovation vital sign.
	Bus Models Δ	Convergence of manufacturing and services, the evolution of supply chain dynamics, and the globalization of manufacturing all would seem to indicate that this is an area that would be useful to monitor. The difficulty would be in determining what the measures might be.
	New Products & Services	This is an area that is being tracked by many firms but by relatively few industries. Creating a structure to capture such information would be a valuable and meaningful contribution to the system of statistics and indicators that currently address this through derivative indicators.

		Manufacturing Association Industry Statistics Leaders – Case study 1
	SIA	The SIA is the leading voice for the semiconductor industry representing U.S semiconductor companies since 1977. SIA member companies comprise more than 85% of the U.S. semiconductor industry. Collectively, the chip industry employs a domestic workforce of 225,000 people and is the backbone of the technology industry, as well as the source of product revolution in many manufactured products, from industrial equipment to telecommunications to the entire array of consumer products that incorporate electronics. The SIA supports the compilation and publishing of the World Semiconductor Trade Statistics (WSTS). WSTS is an organization of seventy semiconductor companies from all over the world that provides the industry with accurate and timely indicators of business trends. Participation in this program is available to worldwide semiconductor manufacturers, regardless of size, geographic locations or product line. Companies benefit from WSTS by having the primary source of market data at their disposal. WSTS data is unique in that it is industry driven and highly flexible in terms of the products it reports on. The level of detail is unmatched by any other government or private data sources, and is industry-driven in terms of the statistics provided and the categories of products reported on. The program currently covers 109 product lines for all world regions. Reported data include all monthly net billings (shipments) between semiconductor manufacturers and their end customers, authorized distributors and divisions or subsidiaries that manufacture end products. All billings are reported according to customer shipment location. Actual sales prices (or comparable market prices for internal transfers) are used to value all billings. The SIA also publishes an annual industry DataBook that is developed through a survey of its members and the participants in the WSTS. This is another unique industry data source. It is organized into five sections, with most containing data and graphs that date back to the first edition of the DataBook that was published in 1978. The following is a brief outline of the trends covered in the DataBook. Section 1: Worldwide Sales and Regional Markets Section 2: Operating Expenses Section 3: Investments and R&D Section 4: Employment Section 5: Productivity and Profitability From this listing one can see that the DataBook expands its coverage of the industry to provide key indicators of corporate activity in operations, workforce trends, R&D, and investment. Turning one's perspective to the usefulness of such data as innovation vital signs, clearly the SIA is well ahead of most other trade organizations in providing members valuable data on their markets and the operations of firms within the industry. The issue for further analysis is determining which of the multiple indicators that are available through the SIA might be included as a measure of industry vitality and health. Another consideration is whether the industry would be willing to provide data for the construction of a system of national innovation vital signs. Given the breadth and depth of the information that it already has on hand, and its continued ability to adjust its data to meet market and industry needs, there is little incentive for the SIA to provide such data if it has the potential to be taken out of context and/or misused by analysts and the media.

		Manufacturing Association Industry Statistics Leaders – Case study 2
	AMT	AMT - The Association For Manufacturing Technology represents and promotes the interests of American providers of manufacturing machinery and equipment, with a focus on the manufacture of machine tools and related equipment. Its goal is to promote technological advancements and improvements in the design, manufacture and sale of members' products in those markets and act as an industry advocate on trade matters to governments and trade organizations throughout the world. In 1988 the AMT broadened its membership scope to include all of the elements of manufacturing - design, automation, material removal, material forming, assembly, inspection and testing, and communications and control. These changes reflect the worldwide evolution in the technologies of the manufacturing process and signify the AMT stepping forward to maintain a market information program that is vital and meaningful to members who are competing in a global market. The AMT focuses its efforts primarily on developing and implementing programs that benefit its membership, and provide support and assistance in domestic and global markets for its members' products. One way of doing this is through an extensive industry statistics program that it supports. The program is similar to that of the SIA in that it is based on the NAICS system, but provides market information at a higher level of detail and with greater frequency than do government sources. The proprietary data that AMT maintains is reported on a monthly basis for most product categories and is available exclusively to firms – member and non-member – that provide their company's data to be aggregated for reporting. The majority of this information is available in the US Machine Tool Consumption program run by the AMT and the American Machine Tool Distributors' Association (AMTDA) to provide the most up-to-date statistics on the U.S., Mexican, and Canadian machine tool market. Participants in the USMTC program have access to the most current and comprehensive machine tool market information. Participants in the program have the ability to zero in on market conditions for the products they manufacture or carry. Statistical reports segment the manufacturing technology market by several product statistics classifications and reports time series by geography, and by end users. Product classifications include Metal Cutting and Metal Forming machine tools such as boring and drilling machines, grinding machines, honing & lapping, laser cutting, lathes, milling, machining centers, station type machines, sawing and cutoff, EDM, broaching, press brakes, presses, and bending & rolling equipment. Other manufacturing technology reported on includes, assembly, inspection equipment, software and CAD/CAM, filtration & cleaning, punching & shearing, and material handling machinery. The AMT also produces the Economic Handbook of the Manufacturing Technology Industry that provides an expanded array of data on the U.S. and international manufacturing technology industry. The Handbook includes detailed information on U.S. production and trade, orders and shipments, manufacturing technology in use, and the financial condition of the industry. Also included is a section presenting machine tool data from 31 countries. It provides a global snapshot of the industry and the state of competition with machine tool and manufacturing technology providers from other leading industrial economies. The US market data in the Handbook does not include data that is in the AMT's proprietary market statistics database. Instead, it compiles and presents the state of the industry as reported by the Census Bureau and its annual survey of manufacturing activity. The AMT clearly is another example of a trade group that has a significant investment in its data. The question for the purposes of trying to find innovation vital signs among these indicators is whether manufacturing technology market activity as defined by AMT is even relevant to an economy that is rapidly moving in the direction of an even larger focus on services. This is tacitly acknowledged by the inclusion of 'software and CAD/CAM' among the other manufacturing technologies monitored by the AMT. The question for further analysis is determining which of the multiple indicators that are available through the AMT might be included as contributors to US economic vitality and health. There are measures of innovation buried within the AMT data – items such as the growth of the market in computer controlled machinery, and the implicit efficiency of newer machinery relative to that supplied to manufacturers even ten years ago. But it is indeterminate as to whether the US economy needs to consider manufacturing industry measures as basic as machine tools as part of a system of innovation vital signs.

		Manufacturing Association Industry Statistics Leaders – Case study 3
	SPI	Founded in 1937, The Society of the Plastics Industry is the trade association representing one of the largest manufacturing industries in the United States. SPI's members represent the entire plastics industry supply chain, including processors, machinery and equipment manufacturers, and raw material suppliers. The U.S. plastics industry employs more than 1.3 million workers and provides more than $345 billion in annual shipments. The mission of SPI is to be a world-class trade association representing the entire plastics industry. SPI accomplishes its objectives through a variety of programs, including representing the industry before federal and state government bodies, informing members about important legislative and regulatory policy developments, identifying trends and emerging issues of concern, and communicating the value of the plastics industry and its products to key audiences. SPI serves as a resource for members needing statistical information through its economic and research function. The SPI is akin to the AMT in that it also offers an extensive array of statistics on the industry and its products. What is different about the SPI is that a large share of what it reports is essentially repackaged Census data. SPI's Size and Impact of the Plastics Industry on the U.S. Economy report contains information in a variety of categories. The current edition the report, released in January 2006, provides 2004 data on establishments, employees, value added, shipments, capital expenditures and equivalent 2003 data on a county level basis. Data are broken for 18 NAICS codes including: Plastics Materials and Resins Plastics Product Manufacturing Plastics Pipe & Pipe Fitting Manufacturing Polystyrene Foam Product Manufacturing Plastic Bottle Manufacturing Resilient Floor Covering Manufacturing Industrial Injection-Type Molds Made of Metals for Plastics Custom Compounding of Purchased Resin Unsupported Plastics Bag Manufacturing Laminated Plastics Plate, Sheet, & Shape Manufacturing Urethane and Other Foam Product (Except Polystyrene) Manufacturing Plastics Plumbing Fixture Manufacturing Plastics Working Machinery SPI also publishes an annual and quarterly Plastics Machinery and Equipment Report that provides data on equipment shipments for the year as well as quarterly. The report also contains relevant economic indicators, plastics equipment trends, and a forecast. This report is proprietary and is an important industry tool for examining and understanding the U.S. plastics machinery and equipment industry. Companies that manufacture or import injection, extrusion, blow molding, auxiliary and component equipment that are not currently participating in the SPI Committee on Equipment Statistics may be eligible to participate in the program. Participants receive detailed monthly or quarterly reports on shipments in these plastics equipment sectors. The SPI also compiles and publishes two other data series that are proprietary to the organization and participants in the surveys performed for the reports. These are the Financial & Operating Ratios Survey of Plastics Processing Companies and its annual Labor Survey of Plastics Processing Companies. The former takes the financial pulse of plastics processing companies and presents results in the form of composite operating statements, balance sheets and statistical data for the purposes of benchmarking. The Labor Survey provides hourly rates of pay for 61 job classifications in the plastics processing industry. Plant, bonus and overtime pay statistics, union representation, and other wage policies are included. The most recent report contained data for 63 companies reported data and 78 plants. As is the case with the extensive dataset available from the AMT, the question for the SPI information is whether the indicators that are available might warrant inclusion as indicators of US economic vitality. The SPI data appears to offer less in the way of potential vital signs as its proprietary information is limited to equipment sales information, and to information about firm operations in this sector. Neither of these would seem to qualify as significant in terms of the criteria that we have presented as potential key contributors to innovation. As is the case for the AMT data, the ability of the SPI' extensive industry data to serve as either a direct or indirect indicator of innovation in the plastics industry is indeterminate.

Available Indicators for Evaluation of Vital Signs Applicability - Wholesale Trade

	NAICS Industry	Description		Sector GDP $B in 2004	% of Private Industry	Number of Establishments	Number of Employees
	42	**Wholesale Trade**		$1023.0	4.79%	435,521	5,878,405
		The Wholesale trade sector comprises establishments engaged in wholesaling merchandise, generally without transformation, and rendering services incidental to the sale of merchandise.					
	Innovation Activities Reported	There has been some innovation in this sector, though much is unknown as there are few meaningful statistics about industry activity, much less so statistics on innovation. The challenges to wholesalers are to keep up with innovations in retail to maintain their position of adding value to the overall distribution and supply chain. Wholesalers are therefore becoming more active in their use of IT to augment customer service, and in developing a more sophisticated intermediation function.					
	Private Sector Organizations Monitoring Industry		Innovation Indicator Framework – Potential Innovation Source Indicators				
	Name of Organization	**Data Provided/Available**	**R&D**	**Human Capital**	**Finance**	**Management**	**Networks**
	NAW	The National Association of Wholesaler-Distributors (NAW) is the Washington, DC-based trade association that represents the wholesale distribution industry. NAW is active in these areas: government relations and political action; research and education; and group purchasing. NAW's membership encompasses: over 80 national line-of-trade associations, representing virtually all products that move to market via wholesaler-distributors; approximately 30 regional, state, and local wholesale distribution associations; approximately 40,000 wholesale distribution companies, and 85,000 wholesale distribution company personnel. NAW's Distribution Research and Education Foundation, a not-for-profit educational foundation, was established in 1967. DREF has worked with academia and the distribution consulting community to advance the state of knowledge in wholesale distribution. The core of DREF's work is the sponsorship of primary research on strategic industry issues. Most notable among DREF's research efforts is the industry trends report, *Facing the Forces of Change*. To date, six editions of *Facing the Forces of Change* have been published (one every three years), documenting emerging and developing trends impacting wholesaler-distributors.	Few	Few	No	Some	Few

	PTDA	The Power Transmission Distributors Association (PTDA) is the leading association for the industrial power transmission/motion control distribution channel. PTDA is dedicated to providing targeted education, relevant information and leading-edge business tools to help distributors and manufacturers meet marketplace demands competitively and profitably. PTDA conducts ongoing research on the needs and buying habits of customers of industrial power transmission products. Among the data collected are PTDA's monthly Market Outlook Report which offers: • timely and meaningful information on evolving industry trends • month-to-month and year-to-year changes in sales, inventory-to-sales ratios and accounts receivables for U.S. and Canadian distributors, as well as a general confidence indicator • U.S. and Canadian manufacturer sales, orders and inventory-to-sales information for key PT/MC products, as well as a confidence index.	No	No	Yes	No	No
	AWMA	The American Wholesale Marketers Association (AWMA) is the only international trade organization working on behalf of convenience distributors in the United States. Its distributor members represent more than $85 billion in U.S. convenience product sales. Typical products purchased and sold by convenience distributors include candy, tobacco, snacks, beverages, health and beauty care items, general merchandise, foodservice and groceries. In addition to convenience stores - their largest customer segment, convenience distributors also service grocery stores, drug stores, tobacco shops, mass merchants, newsstands, concession stands, gift shops, fundraising groups, restaurants, institutions and much more. Sponsored by Hershey Foods, the Hershey Industry Performance Analysis (HIPA) Report measures several key benchmarks among convenience wholesalers, including sales per employee, gross margin, return on investment, inventory turnover, salaries, and much more. The HIPA survey is mailed to AWMA distributors annually and comprises a unique resource for the industry.	No	Few	Yes	No	No
	ADMA	Aviation Distributors and Manufacturers Association strives to further the development of the aviation marketplace through the services and products produced and distributed by members.. Members obtain knowledge, and a long-term,	Some	No	Yes	No	Some

		business relationship for distributors and manufacturers through the promotion of service and strategies consistent with the dynamic and ever changing aviation marketplace. ADMA provides the opportunity for executive management to discuss pertinent business issues in a setting conducive to learning and information exchange. .					
·	**IMDA**	IMDA is an association of entrepreneurial sales, marketing and distribution organizations that specialize in bringing innovative medical technologies to market. The association raises the awareness of others in the health care community as to the value its members bring them, and helps its members improve their businesses through education and networking opportunities. IMDA provides its members a monthly e-mail newsletter with information about important trends affecting manufacturers of innovative medical technologies	No	No	Yes	No	Some

		Potential Innovation Vital Signs for Sector
	Name	**Data Provided or Potentially Available**
	New Biz Starts	This is not an industry in which there is a significant amount of new business creation. As such, an alternate indicator of innovation might be one related to existing firms entering new product lines or creating subsidiaries to take advantage of their existing business networks and their underlying capabilities and infrastructure.
	IP Development	There is not a significant body of IP that resides in this industry. Innovations seem to evolve from the application of existing technologies to this industry, and as such, typically fall into the trade secrets category, as first to market is more important to innovating firms than patent protection.
	Workforce Δ	The industry tracks total employment and maintains an interest in cost control, but it does not promote technical training and workforce development as a source of competitive advantage. This has been changing in recent years as the industry is being asked to take on a supply chain role and needs more people with specialized skills to meet this need.
	Bus Models Δ	Changes in business models are not being tracked by this industry on a macro basis, but there are some interesting changes ongoing due to the above-mentioned supply chain requirement. There has also been a trend toward the development of ‘hybrid’ firms that combine traditional wholesaling activities with new models based in on-line businesses and the potential to create virtual global businesses through the application of IT and e-commerce business practices.
	New Products & Services	This is not being tracked by the industry on a formal basis through any of the above trade groups or others who track the industry. That is not to say that this sector is not offering its customers new products and services. Innovations in the amount and use of information and information technology have led to evolutionary change in this sector. A look back to common practices now relative to what was being offered as recently as ten years ago is a telling indicator of how much the industry has changed and will continue to change going forward.

Survey of Indicators for Innovation Vital Signs Applicability - by Industry - Retail Trade

	NAICS Industry	Description	Sector GDP $B in 2004	% of Private Industry	Number of Establishments	Number of Employees
	44 - 45	**Retail Trade**	$1231.4	5.77%	1,114,637	14,647,675
		The Retail Trade sector (sector 44-45) comprises establishments engaged in retailing merchandise, generally without transformation, and rendering services incidental to the sale of merchandise.				
	Innovation Activities Reported	Innovation in retail is widespread but disaggregated across a wide variety of retail markets. The advent and continued growth of e-commerce is just one indicator of innovation. Many retailers are also finding that they are now required to grow their level of capability in supply chain management and customer research in order to meet financial goals. Much retail innovation relates to IT and communications applications, but significant shifts that have also occurred in business models and practices.				

	Private Sector Organizations Monitoring Industry		Innovation Indicator Framework – Potential Innovation Source Indicators				
	Name of Organization	**Data Provided/Available**	**R&D**	**Human Capital**	**Finance**	**Management**	**Networks**
	NRF	The National Retail Federation is the world's largest retail trade association, with a membership comprise of all retail formats and channels of distribution including department, specialty, discount, catalog, Internet, independent stores, chain restaurants, drug stores and grocery stores as well as the industry's key trading partners of retail goods and services. NRF represents an industry with more than 1.6 million U.S. retail establishments, more than 24 million employees and 2005 sales of $4.4 trillion. As the industry umbrella group, NRF also represents more than 100 state, national and international retail associations. NRF Foundation recently launched its fourth annual *Retail Horizons* survey. *Retail Horizons*: *Benchmarks 2006 – Forecasts 2007* is the definitive source of benchmarking information and in-depth analysis for retailers. It provides fundamental retail metrics on industry statistics such as sales and distribution channels, annual payroll, advertising and public relations efforts, inventory controls, employee benefits, and information technology. The survey is organized in nine different sections: General/Financial, Store Operations, Supply Chain, Merchandising, Customer Insight and Focus, Marketing and Advertising, On-Line Presence, Information Technology, and Human Capital. Some of these may serve as proxies for innovation and innovative practices.	Few	Some	Yes	Some	Some

	FMI	Food Marketing Institute (FMI) conducts programs inresearch, education, industry relations and public affairs on behalf of its 1,500 member companies - food retailers and wholesalers - in the United States and around the world. FMI's U.S. members operate approximately 26,000 retail food stores with a combined annual sales volume of $340 billion - three-quarters of all retail food store sales in the United States. FMI's retail membership is composed of large multi-store chains, regional firms and independent supermarkets. Its international membership includes 200 companies from 50 countries. FMI members report to a private database that provides statistics on items such as: weekly sales by square foot, sales by square foot of selling area, percentage of selling space in the total store, and transactions by checkout.	No	No	Yes	Some	Some
	RBA	Retail Benchmarking Association is currently a free association dedicated to the exchange of specific data related to retail performance. The RBA conducts benchmarking studies to identify best practices and improve member effectiveness. RBA™ Mission is to identify "Best in Class" business processes, which, when implemented, will lead member companies to exceptional performance as perceived by their customers. RBA research focuses on a variety of primarily operational topics, with innovation not being among the topics studied.	No	Some	Yes	Some	Some
	NACDS	The National Association of Chain Drug Stores (NACDS) membership base operates more than 36,000 retail community pharmacies with annual sales totaling over $650 billion, including $221 billion in sales for prescription medicines, over-the-counter medications, and health and beauty aids (HBA). Chain-operated community retail pharmacies fill over 71% of the prescriptions dispensed annually in the United States. The NACDS publishes an industry profile report for members to assist in maintaining their awareness of the operational issues surrounding the industry. Published by the NACDS Foundation, the Industry Profile contains statistics that serve as a basis for comparison of operational performance of retail pharmacies.	No	Some	Yes	Some	No
	NACS	The National Association of Convenience Stores (NACS) is an international trade association representing more than 2,200 retail and 1,800 supplier company members. The U.S. convenience store industry, with 140,655 stores across the U.S., posted $495.3 billion in total sales for 2005, with $344.2 billion	No	No	Yes	Some	Some

		in motor fuels sales. NACS has been an advocate for the convenience retailing industry providing industry information, knowledge and connections to ensure the competitive viability of our members' businesses. The diversity of NACS membership reflects the diversity of the convenience store and petroleum marketing industry.					
	NGA	The National Grocers Association (N.G.A.) is the national trade association representing the retail and wholesale grocers that comprise the independent sector of the food distribution industry. Along with affiliated associations, manufacturers, service suppliers as well as other entrepreneurial companies that support NGA's philosophy and mission. As defined by the NGA, an independent retailer is a privately owned or controlled food retail company operating a variety of formats. A few are publicly traded, but with controlling shares held by the family, and others are employee owned. Independents are the true "entrepreneurs" of the grocery/ food industry and are dedicated to their customers, associates, and communities. The NGA supports best practices and innovation in its industry through its Education and Research Centers program that are operated by the Grocers Research and Education Foundation.	No	Some	Yes	Some	Some
	NHFA	The National Home Furnishings Association (NHFA) is the nation's largest organization devoted specifically to the needs and interests of home furnishings retailers. NHFA's membership is comprised of over 2000 corporate entities representing 10,000 stores in all 50 states and several foreign countries. NHFA' is committed to helping home furnishings retailers operate profitable businesses that provide an exceptional level of service to consumers by providing members with the information, education, products and services they need to remain successful. The association publishes and annual *Industry Performance Report* that is a guide to measuring the productivity and profitability of member companies. Statistics included comparisons by sales volume, geographic region and product. Another section of the report includes compensation data for fifteen job titles common throughout the home furnishings industry.	No	No	Yes	Some	No
	ERA	The Electronic Retailing Association is the trade association for companies who use direct response to sell goods and services to the public on television and online. ERA serves multi-channel marketers by monitoring government initiatives and regulations	No	No	Few	No	No

		designed to protect its members' bottom line.					
	DMA	The Direct Marketing Association is the leading global trade association of business and nonprofit organizations using and supporting direct marketing tools and techniques. DMA advocates industry standards for responsible marketing, promotes relevance as the key to reaching consumers with desirable offers, and provides cutting-edge research, education, and networking opportunities. DMA today has more than 4,800 corporate, affiliate, and chapter members from the US and 46 other nations, including 55 companies listed on the Fortune 100. The DMA has an active publications function that includes the DMA Statistical Fact Book, which offers a concise overview of direct marketing vital statistics.	No	Some	Yes	Some	Some
		Potential Innovation Vital Signs for Sector					
	Name	**Data Provided or Potentially Available**					
	New Biz Starts	The retail industry has low barriers to entry but this does not imply that new businesses are necessarily innovative. The clearest indicator of innovation being used in retail is the burgeoning on-line retail and e-Bay entrepreneur sector.					
	IP Development	The retail sector does not concern itself with IP development. Instead, it is focused on customer development and customer satisfaction and the likelihood of repeat business.					
	Workforce ∆	The industry's larger participants monitor workforce trends and the changing composition of people and skills required to be competitive. Demographics and other population factors are a concern to the industry, rather than concern over workers' ability to successfully migrate to a more complex business model or processes.					
	Bus Models ∆	The industry's biggest changes are in the move to on-line retailing and the continual evolution of 'big box' stores in most major lines of business. Changes are not monitored in publicly available data, though there are some private studies by consulting firms that benchmark all manner of changes in the business and the processes used to satisfy existing and potential customer demand.					
	New Products & Services	Here again, there are many changes ongoing, but the majority of the indicators associated with changes in product and service mix are kept by private data sources, though there are numerous benchmarking activities to enable retailers to determine how they compare to the rest of the industry. There are also private consultants who track trends and the evolution of new services and approaches to the business. As is the case with many service sector industries, innovation is frequently tied to enabling IT infrastructures. Examples that have developed in the past 10 years or less would include firms such as Amazon.com and Priceline.com, both of which used an innovative business model combined with IT to offer new-to-market capabilities.					

Available Indicators for Evaluation of Vital Signs Applicability - Information

	NAICS Industry	Description		Sector GDP $B in 2004	% of Private Industry	Number of Establishments	Number of Employees
	51	**Information**		$1,107.0	5.19%	137,678	3,736,061
		The Information sector comprises establishments engaged in the following processes: (a) producing and distributing information and cultural products, (b) providing the means to transmit or distribute these products as well as data or communications, and (c) processing data.					
	Innovation Activities Reported	This sector is witnessing significant innovation in most of its constituent parts. Most notable among these are the telecommunications – including wireless – industry, the publishing industry - including the software publishing industry, and the motion picture and music recording industry. Wireless telecomms Is a hotbed of innovation, with the continual development of new products tied to an array of services, e.g. the Blackberry. Similarly, the book publishing industry has been transformed by the advent of the internet and e-publishing. The motion picture industry and the music sectors have also seen significant change and innovation both in terms of how their products are created and in terms of the methods used to provide those products to consumers.					
	Private Sector Organizations Monitoring Industry		Innovation Indicator Framework – Potential Innovation Source Indicators				
	Name of Organization	**Data Provided/Available**	**R&D**	**Human Capital**	**Finance**	**Management**	**Networks**
	CTIA	Cellular industry reports on proliferation and diffusion of use and the technologies being employed	Yes	Some	Yes	Yes	Some
	NAB	National Association of Broadcasters reports Nielson and Arbitron data for the industry. It does not track innovation within the industry.	No	No	Minimal	No	No
	SIIA	Software and Information Industry Association – tracks broad industry developments but does not maintain a proprietary database of activity.	Some	Some	Yes	Some	Some
	MPIA	Motion Picture Association of America – reports on attendance in theaters and costs of movie production.	No	No	Minimal	No	No
	TIA	TIA's Telecommunications Market Review and Forecast provides a statistical breakdown and analysis of markets and trends, including advances in mobile wireless, optical networking, voice-over-IP and broadband networks.	Yes	Some	Yes	Some	Some

			Potential Innovation Vital Signs for Sector				
	Name	**Data Provided/Available**	**R&D**	**Human Capital**	**Finance**	**Management**	**Networks**
	NCTA	National Cable Television Association - The association provides historical background describing the cable television industry and related industries including cable programmers and relates fields.	Some	No	Yes	No	No
	NAA	Newspaper Association of America represents newspaper publishers across the nation. Has an annual PRESSTIME Innovative Operations (I.O.) Award presented to NAA-member newspaper employees who have implemented a plan, program, procedure or technological innovation that resulted in safer, more effective or more efficient newspaper production.	Some	Some	Yes	Some	No
	OPA	Online Publishers Association - the OPA is committed to producing groundbreaking research into online advertising and media consumption with the goal of advancing the online publishing industry. Through credible research and ongoing communications, the OPA seeks to establish and promote the Internet as an effective advertising medium for marketers	No	Some	Yes	Some	Some
	US Telecom	USTelecom focuses on three broad categories of membership: Carrier, Suppliers and International. Carrier members, the core of the association, consists of facilities-based telecommunication companies. Supplier members are companies who provide services, hardware, software, or technology for the telecom industry.	Some	Some	Yes	Some	Few

		Potential Innovation Vital Signs for Sector
	Name	**Data Provided or Potentially Available**
·	**New Biz Starts**	This industry is one that, including software, is awash in new business start-ups, typically ones that are at an early stage of development. Information on these is available, though not from the data sources listed above. The ebb and flow of new business starts in this industry should serve as a useful proxy for innovation activities. The same can be said for the telecom and publishing sub-sets of this industry, as there are many new investor-backed firms providing new technologies and new products and services in these markets.

	IP Development	With the robust wave of change and technology development in IT and telecoms, there is a good potential to use the public and private data to track the issuance of new patents, copyrights, trademarks, etc. in this field. However, the organizations identified and summarized above do not maintain a regular set of industry data in the IP area. Instead, compiling this innovation relevant data is left to either government sources and/or private sector research firms who have built businesses based on tracking IP across companies and industries. There may be a potential to work with either these associations or the private sector compilers of the data to develop summary statistics that could be used as 'innovation vital signs' in this industry.
	Workforce Δ	Given the high levels of technology and the specialized skill sets that are required to participate in the information revolution, there is interest in this sector in tracking workforce changes as they impact the industry's ability to grow and develop. However, as is the case with the IP issue, workforce changes are not tracked on a consistent basis by any of the sources cited above. The common practice is to rely on BLS data for total employment and changes in employment. There are some efforts at keeping abreast of the quality of the workforce, but that is done primarily through statistics on the hiring and availability of engineers in IT and other technical specialists in the telecoms industry. These data typically come from either academic sources and/or private consulting firms who specialize in labor force issues and trends. Given the importance of a highly skilled and technologically up-to-date workforce to this sector, efforts to develop better measures of workforce quality and capabilities should meet with a positive reception.
	Bus Models Δ	Business model changes are an ongoing fact of life in this sector as old models and business processes are obviated by on-line businesses that are offering new ways of turning information into revenue. Examples of business model changes abound. In publishing, the basic print industry model has been replaced by virtual and electronic media. In the telecoms sector business models based on time of use have been supplanted by ones in which providers with the most features and add-on capabilities are market leaders. In software the paradigm of purchased software with a follow-on revenue stream based on updates and maintenance is giving way to the 'software as a service' paradigm. Because of their revolutionary, as well as evolutionary nature, there is no ongoing effort to routinely track business model changes in this sector, despite the seeming importance of keeping abreast of such changes. This dearth of data may present an opportunity to develop an innovation vital sign in this sector that would be unique and valuable to industry participants.
	New Products & Services	This highly dynamic sector is continually awash in a sea of new products and services, but the associations serving the industry do not routinely track these changes. The difficulties in doing so are obvious, but one would expect that a structured research and data gathering effort could do much to contribute to filling this void. Having such data available would serve as a proxy for the level of dynamism in the industry relative to a benchmark, where changes would serve as an telling indicator of the health of the industry. These associations should be interested in providing such data to their members as there is considerable market interest in monitoring the pace of change and the inputs to it.

Available Indicators for Evaluation of Vital Signs Applicability - Finance and Insurance

	NAICS Industry	Description		Sector GDP $B in 2004	% of Private Industry	Number of Establishments	Number of Employees
	52	**Finance and Insurance**		$1541.8	7.22%	440,268	6,578,817
		The Finance and Insurance sector comprises establishments primarily engaged in financial transactions (transactions involving the creation, liquidation, or change in ownership of financial assets) and/or in facilitating financial transactions. Three principal types of activities are identified:					
	Innovation Activities Reported	This industry group is not usually seen as a hotbed of innovation, but it can argued that there has been as much innovation here as there has been in manufacturing. The difference is that the innovation here has been product and service driven with a heavy layer of enabling IT systems and processes to thank. Significant innovations in finance would be items such as the growth of on-line brokerage services for anything from bonds to equities to loans and mortgages. In the insurance sector there has been a similar revolution in products offered on-line, and there is a similar growth in back office support services and products that make the retail aspect possible.					
	Private Sector Organizations Monitoring Industry		Innovation Indicator Framework – Potential Innovation Source Indicators				
	Name of Organization	**Data Provided/Available**	**R&D**	**Human Capital**	**Finance**	**Management**	**Networks**
	AFSA	American Financial Services Association is the national trade association for the consumer credit and finance industry. Founded in 1916, AFSA has a broad membership, ranging from large national financial services firms to single office, independently owned consumer finance companies.	No	Some	Yes	Some	No
	AFA	The American Finance Association was planned at a meeting in December 1939. The Journal of Finance was first published in August 1946. The AFA sponsors an annual meeting and papers which cover the gamut of financial topics. The Journal of Finance publishes leading research across all the major fields of financial research. It is one of the most widely cited academic journals on finance. Each issue of the journal reaches over 8,000 academics, finance professionals, libraries, government and financial institutions.	Some	Some	Yes	Yes	Some
	ABA	The American Bankers Association represents banks of all sizes on issues for financial institutions and their customers. The ABA brings together all categories of banking institutions to best represent the interests of this rapidly changing industry. Its membership -- which includes community, regional and money center banks and holding companies, as well as savings associations, trust companies and savings banks -- makes ABA the largest banking trade association in	No	Yes	Yes	Yes	No

		the country. The ABA conducts industry research and maintains an extensive reporting structure of Benchmarking and Survey Research. Its comprehensive industry survey reports are designed to help member determine how their bank compares to its peers—measured by asset size, location, portfolio composition, and many more criteria. These programs are designed to facilitate the exchange of information and sharing of best practices among ABA member banks.					
	MBA	The Mortgage Bankers Association (MBA) is the national association representing the real estate finance industry, an industry that employs more than 500,000 people in virtually every community in the country. MBA members invest in communities across the nation by ensuring the continued strength of the nation's residential and commercial real estate markets; expanding homeownership and extending access to affordable housing; and supporting financial literacy efforts. The MBA's research and economics group provides current and comprehensive data and benchmarking tools for short- and long-term strategic planning. These products and surveys cover all real estate business areas - economic forecasting, residential, commercial and multifamily.	Some	Yes	Yes	Some	Some
	NVCA	The National Venture Capital Association (NVCA) is a trade association that represents the U.S. venture capital industry. It is a member-based organization, which consists of venture capital firms that manage pools of risk equity capital to be invested in high growth companies. NVCA's mission is to foster greater understanding of the importance of venture capital to the U.S. economy, and support entrepreneurial activity and innovation. The NVCA represents the public policy interests of the venture capital community and provides reliable industry data. The American Entrepreneurs for Economic Growth (AEEG) is an affiliate organization of the NVCA representing over 14,000 CEO's of emerging growth companies and rapidly growing enterprises.	No	Some	Yes	Some	Some
	ARIA	Founded in 1932, the ARIA is comprised of academics, individual insurance industry representatives, and institutional sponsors. ARIA emphasizes research relevant to the operational concerns and functions of insurance professionals, and provides resources, information and support on important insurance issues. ARIA provides information and support through publications such as The Journal of Risk and	Some	Yes	Yes	Some	No

		Insurance, the Risk Management and Insurance Review, ARIA's Annual Meeting, and the annual Risk Theory Seminar.					
	PCIAA	PCIAA (Property Casualty Insurers Assn of America) is the nation's premier insurer trade association, representing over 1,000 companies that write 40.7 percent of the nation's automobile, homeowners, business, and workers compensation insurance. The association serves as the voice of the property/casualty insurance industry before state and federal policymakers; state and federal courts; key insurance industry, governmental, and business groups; the news media; and the public. The association maintains a proprietary database of industry loss experience and related financial indicators.	No	Some	Yes	Yes	No
	SIFMA	The Securities Industry and Financial Markets Association (SIFMA), is the result of the merger between The Securities Industry Association and The Bond Market Association. The organization represents more than 650 member firms in financial markets in the U.S. and around the world. The association provides member and educational services, and educational resources for the professionals in the industry. The association maintains the Securities Industry DataBank that is a comprehensive database providing aggregated financial and employment data contained in the reports filed by all NYSE broker-dealers dealing with the public.	Some	Yes	Yes	Some	No
	ICI	The Investment Company Institute (ICI) is the national association of U.S. investment companies. Founded in 1940, its membership includes 8,798 mutual funds, 655 closed-end funds, 254 exchange-traded funds, and four sponsors of unit investment trusts. Its mutual fund members serve 93.9 million individual shareholders and manage $9.610 trillion in investor assets. The Institute is the primary source for statistical data on the investment company industry. Institute members represent 95 percent of the total investment company industry's assets. Many ICI statistical releases include not only ICI member data, but also nonmember data from the remaining 5 percent of investment company industry assets. Institute research examines such topics as shareholder demographics, trends in shareholder ownership costs, the industry's role in foreign markets, and analyses of the retirement market.	Yes	Yes	Yes	Some	No

		Potential Innovation Vital Signs for Sector – Process or Output data availability
	Name	**Data Provided or Potentially Available**
	New Biz Starts	This type of data is not tracked by the organizations listed above as this is an industry in which the bias appears to be in the opposite direction, continued consolidation rather than new firms springing up. As such, this is not a good candidate as a vital sign of innovation in the finance and insurance sector. Even in the case of what appears to be a new entrant, for example E-surance.com, the firm is actually an operating arm of a large, publicly-listed insurance holding company.
	IP Development	This industry is characterized by significant breakthroughs and innovation in developing IP that enables the development of new financial products or new insurance products. These are usually the result of the 'rocket scientists' that work to develop the financial and risk management algorithms that drive the new products. As such, most of this work is not patented or copyrighted, as it is firmly in the realm of trade secrets and company confidential.
	Workforce Δ	Workforce change is a topic of considerable interest to the industry, but there does not appear to be a significant effort among the associations listed above to track the quality and quantity of its workers. There are significant programs focused in education and skills development at all levels of the industry, but there does not appear to be an effort ongoing to capture the innovation impact of these activities. The ABA is very active in training and maintaining workforce quality in the banking industry. On the finance side of this sector, the NASD (the National Association of Securities Dealers) also plays a large role in workforce development and quality. NASD, in conjunction with other self-regulatory organizations and the Securities Industry/Regulatory Council on Continuing Education, administers a two-part mandatory Continuing Education Program. This program is required for industry members to keep their licenses. However, neither the ABA or the NASD program would be considered to be models for tracking workforce factors leading to innovation.
	Biz Models Δ	There has been considerable upheaval in both the finance and the insurance sectors resulting from changes in business models that were innovative and significantly disruptive to the established order. On-line businesses in both of these sectors rapidly took a bite out of old models revenues, and are continuing to cause re-thinking of the way in which firms can make money in this industry. That being said, there is no ongoing industry think tank or association that monitors these sorts of shifts. There are some academic sources of such data, but these are primarily one-time studies that are not intended to be the foundation of an ongoing effort to capture innovation within this large and diverse industry group. The opportunity would appear to exist to employ research into business models as an indicator of a vital and healthy industry.
	New Products & Services	Given that this industry is driven by the retail aspects of its operations, i.e. selling insurance and financial products to customers, tracking new product and service offerings would seem to be important to the industry. However, none of the organizations listed above have a structured program that monitors new product and service development practices and success. There are numerous examples of new financial and insurance products that have been developed, notably on-line brokerage, on-line banking, on-line insurance offerings, and even innovative firms such as PayPal that was built in response to a need based on the development of e-Bay as a viable business. Efforts to include new product and service monitoring would seem to be an innovation indicator that the industry would be interested in seeing and supporting.

Available Indicators for Evaluation of Vital Signs Applicability - Real Estate & Rental and Leasing

	NAICS Industry	Description	Sector GDP $B in 2004	% of Private Industry	Number of Establishments	Number of Employees
	53	**Real Estate & Rental and Leasing**	$2078.2	9.74%	322,815	1,948,657
		The Real Estate and Rental and Leasing sector comprises establishments primarily engaged in renting, leasing, or otherwise allowing the use of tangible or intangible assets, and establishments providing related services. The major portion of this sector comprises establishments that rent, lease, or otherwise allow the use of their own assets by others. The assets may be tangible, as is the case of real estate and equipment, or intangible, as is the case with patents and trademarks.				
	Innovation Activities Reported	This industry effectively reduces to two prime sub-sectors: the real estate related industry, and the equipment related component. Innovation in both of these is reported by participants to be minimal. Most of the innovation is viewed as being related to the introduction of new business processes and the application of new technologies that are provided by outside sources. In both sectors, most noteworthy would be the continuing proliferation of IT and IT-related products and services that enable revised and novel business processes and practices.				
	Private Sector Organizations Monitoring Industry		Innovation Indicator Framework – Potential Innovation Sources Reporting			
	Name of Organization	**Data Provided/Available**	**R&D**	**Human Capital**	**Finance**	**Management**	**Networks**
	NAR	National Association of Realtors - NAR's Research Division analyzes the economic, policy and structural effects of changes in the real estate industry. NAR produces studies and statistics on topics affecting the practice of real estate and the ownership and management of real estate firms. NAR's "existing home sales series" is the benchmark measurement of the health of the residential real estate market. This includes statistics on the number of existing home sales transactions as well as median sales prices of existing single-family homes.	No	Some	Yes	No	Minimal
	MHI	Manufactured Housing Institute represents all segments of the factory-built housing industry. MHI provides industry research dealing with the volume of monthly shipments at a state-by-state level.	No	No	Yes	No	No
	BOMA	BOMA International (Building Owners and Managers Association) is a primary source of information on office building development, leasing, building operating costs, energy consumption patterns, local and national building codes, legislation, occupancy statistics and technological developments.	Some	No	Yes	Some	Minimal

	NAIOP	The National Association of Industrial and Office Properties (NAIOP) is leading trade association for developers, owners, investors, asset managers and other professionals in industrial, office and mixed-use commercial real estate. Founded in 1967, NAIOP comprises 13,000+ members in 50 North American chapters. It provides research on trends and innovations through NAIOP's sister organization, the NAIOP Research Foundation. The Research Foundation is a think tank dedicated to conducting research assessing the trends, economic viability and needs of the built environment.	Some	No	Some	No	No
	ELA	Organized in 1961, the Equipment Leasing Association (ELA) is a non-profit association that represents companies involved equipment leasing and finance to the business community, government and media. ELA provides its members with research on industry facts through studies such as a Monthly Leasing Index (MLI:25), the Survey of Industry Activity, Market Segment Studies, and Compensation Studies. The ELA established the Equipment Leasing and Finance Foundation as a separate organization to provide future-oriented, in-depth, independent research for the equipment leasing industry.	Some	No	Yes	Some	No
	NAHB	The National Association of Home Builder's mission is to enhance the climate for housing and the building industry. As "the voice of America's housing industry," NAHB helps promote policies that will keep housing a national priority. The NAHB Research Center, a subsidiary of the NAHB, is dedicated to advancing housing technology and enhancing housing affordability for the benefit of all Americans.	Some	Minimal	Some	No	Some

		Potential Innovation Vital Signs for Sector – Process or Output data availability
	Type	**Data Provided or Potentially Available**
	New Biz Starts	This industry is one that is populated by a mix of large and small firms, but new business start-ups are not an indicator that is widely followed as one that is significant. More telling to most observers is the rate of business failures in economic downturns.
	IP Development	Discussions with industry experts indicate that IP development in this industry is minimal. This is not to say that there is no introduction of new technologies in either of the prime subsectors, real estate and the equipment leasing industry. Instead, innovative products are introduced by the suppliers to the industry. The industry, in turn, introduces these innovations to its customers. Examples might be the in the aircraft leasing business where new products and product refinements are provided by the aircraft manufacturers as a result of the need to meet the demands of their customers. The leasing firm is simply a financial intermediary without any real interest in the innovation stream. Similarly, in the residential and commercial real estate industry innovations in building processes and structural systems and materials come from outside the industry – through the contractors and those supplying to them. New building energy efficiency systems and the like are not being driven to widespread use by the realtors, who are like the leasing agents, intermediaries in the transaction with no long term stake in the product being sold.
	Workforce ∆	Workforce changes are another aspect of the real estate and rental industries that are considered important at the macro level but not in terms of quality indicators. Much of the work done in real estate is done by experienced professionals who learned through on the job training. The rental industry is not known for the high level of training required of its employees. As is the case described in IP development, industry observers offer that much of the innovative talent and workforce development that is evident in this industry comes through suppliers to these industries. These might be product or service specialists who do the training of the industry workforce for the adoption and proliferation of new technologies – items such as IT systems connected to building management, or sophisticated new items such as jet engines or specialized equipment of all types.
	Bus Models ∆	This is one aspect of this industry in which there has been something of a revolution in the past few years. Real estate has been significantly impacted by the development of REITs and other types of innovative financial structures (e.g. time shares) that enable smoother transactions and enhance the availability of capital to a wider range of ventures than had been the case in the past. In the equipment leasing industry there also has been a degree of innovation in which the lessors have modified their business models to one in which customers no longer lease the equipment. Instead, it can be said that the leasing entity actually purchases the services of the equipment in question and the lessor is responsible for all aspects of the service and maintenance of the item being used. These kinds of business model changes are at the heart of innovation in this industry and represent something that should be tracked for this sector over time. Whether there is interest in doing so is an unknown.
	New Products & Services	Industry sources are the first to emphasize the relative lack of innovation in this industry. This is due to a variety of factors, but the same sources indicate that the industry could be far more active in promoting the adoption of the new technologies and processes that become available to it from its suppliers. Further investigation with a broader array of industry participants and experts might be required to definitively answer questions as to whether new products and services offerings might be a valid indicator of the vitality of this industry and its component sectors.

Available Indicators for Evaluation of Vital Signs Applicability - Professional, Scientific, and Technical Services

	NAICS Industry	Description		Sector GDP $B in 2004	% of Private Industry	Number of Establishments	Number of Employees
	54	**Professional, Scientific, and Technical Services**		$1269.7	5.95%	771,305	7,243,505
		The Professional, Scientific, and Technical Services sector comprises establishments that specialize in performing professional, scientific, and technical activities for others. These activities require a high degree of expertise and training. The establishments in this sector specialize according to expertise and provide these services to clients in a variety of industries and, in some cases, to households. Activities performed include: legal advice and representation; accounting, bookkeeping, and payroll services; architectural, engineering, and specialized design services; computer services; consulting services; research services; advertising services; photographic services; translation and interpretation services; veterinary services; and other professional, scientific, and technical services.					
	Innovation Activities Reported	Innovation in this sector comes in many forms. Clearly, the architectural and engineering communities have done much to innovate through the use of new technologies in their basic value adding processes through the use of IT. They have also seen significant changes occurring as a result of the introduction of new materials and processes. In other sectors, such as the legal and accounting professions, there have been similar evolutions of products and services that are enabled by innovation in the support infrastructures based on new IT. Other elements of this sector have also experienced innovation in business models and in the services being offered. Veterinarians are applying the same novel technologies to the care of animals that are being applied with humans. Marketing and advertising services have undergone a revolution due to the development of the Internet and the creation of entirely new categories of business that resulted.					
	Private Sector Organizations Monitoring Industry		Innovation Indicator Framework – Potential Innovation Sources Reporting				
	Name of Organization	**Data Provided/Available**	**R&D**	**Human Capital**	**Finance**	**Management**	**Networks**
	AIA	The AIA represents the professional interests of America's architects. As AIA members, over 77,000 licensed architects, emerging professionals, and allied partners express their commitment to excellence in design and livability in buildings and communities. Members adhere to a code of ethics and professional conduct that assures the client, the public, and colleagues of an AIA-member architect's dedication to the highest standards in professional practice. AIA provides members with a best practices education service that is limited only by the collective knowledge of AIA members. This service benchmarks and reports on a wide array of innovation in architects' professional practice—including design, marketing, business management, information technology, project management, public outreach, and community service.	Some	Yes	Some	Yes	Minimal

	ABA	The American Bar Association, with more than 400,000 members, provides law school accreditation, continuing legal education, information about the law, programs to assist lawyers and judges in their work, and initiatives to improve the legal system for the public. The association monitors changes in the industry and innovations in legal technology. The ABA's Legal Technology Resource Center provides technology information for legal professionals by educating about and monitoring the legal profession's use of technology and emerging trends. The association also surveys and monitors marketing information about the industry. The ABA's Market Research Department (MRD for short) serves the ABA, lawyers, and the general public by: • compiling statistics about lawyers and the legal profession. • advising and consult individual ABA entities, such as the sections and divisions, who desire more informed guidance or direction. • spearheading large-scale research studies about lawyers, which then help the ABA deliver products and services to its members.	No	Some	Yes	Some	No
	NSA	The National Society of Accountants (NSA) is the preeminent organization for professionals who provide accounting, tax and related financial services to individuals and small businesses. The mission of the National Society of Accountants is to foster the free enterprise system and serve NSA members, and thereby the public, by providing members with information, resources and representation. The NSA engages in the following activities: • protecting the right to practice of licensed and unlicensed members; • promulgating and enforcing a code of ethics; • providing high quality education; • assisting members in obtaining professional credentials; • disseminating technological information; and • cooperating with other organizations on matters of mutual interest.	No	Some	Minimal	No	Some

	AICPA	The American Institute of Certified Public Accountants is the national, professional organization for all Certified Public Accountants. Its mission is to provide members with the resources, information, and leadership that enable them to provide valuable services in the highest professional manner to benefit the public as well as employers and clients. The AICPA works with state CPA organizations and gives priority to those areas where public reliance on CPA skills is most significant.	No	Yes	Some	Some	No
	AVMA	The American Veterinary Medical Association (AVMA) is a not-for-profit association representing more than 74,000 veterinarians working in private and corporate practice, government, industry, academia, and uniformed services. The AVMA acts as a collective voice for its membership and for the profession. AVMA compiles the annual Economic Report on Veterinarians & Veterinary Practices Report which provides data on professional income and veterinary office practice items such as: • Personnel statistics and salaries • Key practice operating expenses and ratios • Distribution of total revenue and total expense to various business categories • Break-down of client transactions per species • Mean and median values pertaining to: practice revenue, practice expense, return to capital, net revenue per owner, return to labor and management per owner, salary per owner, etc.	Some	Yes	Yes	Some	Some
	NACCB	The National Association of Computer Consultant Businesses (NACCB) is the only national trade association representing relationships between companies that specialize in providing highly skilled computer professionals to clients in need of technical support and/or IT services/solutions. In the past 18 years, NACCB membership has grown to almost 300 companies with more than 1,000 offices and billions in combined annual revenue. Compiles and publishes the NACCB Operating Practices Report (OPR) that provides members detailed industry metrics in the following categories: • Return on Investment • Income Statement • Balance Sheet • Financial Ratios • Cash Sufficiency Ratios • Distribution of Revenue • Operations Profiles • Employee Productivity Ratios	No	Some	Yes	Some	No

	DBIA	The Design-Build Institute of America (DBIA) is a membership organization founded in 1993 to advocate and advance single source project delivery within the design and construction community. The design-build method of project delivery embraces architecture/ engineering and construction services under a single contract, thereby re-integrating the roles of designer and constructor. DBIA members include practitioners from all project phases, plus public- and private-sector project owners. DBIA focuses its efforts on increasing the successful use of innovative design-build teams on non-residential building, civil infrastructure and process industry projects.	No	Yes	Some	No	No
		Potential Innovation Vital Signs for Sector – Process or Output data availability					
	Name	**Data Provided or Potentially Available**					
	New Biz Starts	This widely divergent industry does not track business starts in any of the organizations listed above. This may be a function of their focus on member education and customer service, but it may also reflect the fact that the professional services sector runs the gamut from very large global firms to single proprietorships. As such, business start ups may not be a significant indicator of anything other than the dynamism of the market for these services and the way in which they are provided to a broad array of customers.					
	IP Development	Patentable technologies and ideas may be an important factor in the contract research and engineering technical services components of this industry, but most other elements (e.g. legal and accounting) do little to drive and secure IP creation. This being the case, it is unlikely that IP development is a good indicator for innovation activities across this diverse industry group. This is not to dismiss it out of hand as perhaps a very valid indicator for innovation in the technology driven segment of these businesses. None of the organizations listed above track IP for their industry.					
	Workforce ∆	Being a services industry, where customers are paying for the service of skilled professionals, there is surprisingly little in the way of workforce change data interest in this sector. Clearly, professional certifications are important for the legal and accounting industries, and for engineering, but there is no organization that is focused in the maintenance and improvement of the talent pool, and its quality and capability. This should be a valid vital sign for the industry, but it may be problematic to develop and collect this data from industry firms and practitioners.					
	Biz Model ∆	This is not an industry in which business models have changed significantly. The industry still appears to be dominated by the billable hours of services model. There are some aspects of this industry in which some novel approaches are being tried, but these are significantly the exception. With this background, business model changes are not a good candidate for consideration as an innovation indicator in this portion of the services industry.					
	New Products & Services	With the wide expanse of services that this industry covers, it is natural that there are indeed a significant array of new products and services being offered by industry participants. Many of these are driven and enabled by the application of new technologies and new business processes that result from the use of IT. This is the case in accounting, and in legal services where new IT has made it possible to offer information-based services that were not possible without IT platforms and capabilities. Similarly, engineering and architectural firms have availed themselves of the opportunity to be the conduit for the					

		application of new materials and devices to their customers. In all of these cases it seems that the development of new products and services would be a valid indicator of the state of innovation within the industry and its component subsectors. There do not appear to be any statistics gathered by any organization at this time that tracks this variable.

Available Indicators for Evaluation of Vital Signs Applicability - Health Care and Social Assistance

	NAICS Industry	Description		Sector GDP $B in 2004	% of Private Industry	Number of Establishments	Number of Employees
	62	**Health Care and Social Assistance**		$1298.3	6.08%	704,526	15,052,255
		The Health Care and Social Assistance sector comprises establishments providing health care and social assistance for individuals. The sector includes both health care and social assistance because it is sometimes difficult to distinguish between the boundaries of these two activities. The industries in this sector are arranged on a continuum starting with those establishments providing medical care exclusively, continuing with those providing health care and social assistance, and finally finishing with those providing only social assistance. The services provided by establishments in this sector are delivered by trained professionals. All industries in the sector share this commonality of process, namely, labor inputs of health practitioners or social workers with the requisite expertise. Many of the industries in the sector are defined based on the educational degree held by the practitioners included in the industry.					
	Innovation Activities Reported	This sector has experienced significant innovation resulting from the need to control costs and the introduction of new technologies and processes that enable efficiency, as well as new services and products. In the medical field there have been breakthroughs running the gamut from sub-molecular to high-end devices providing new types of imaging. There have also been significant shifts in patient record keeping and quality/process controls that have permitted better care and follow-up while reducing the likelihood of errors in services, many enabled by IT and related networked and automated systems.					
	Private Sector Organizations Monitoring Industry		Innovation Indicator Framework – Potential Innovation Sources Reporting				
	Name of Organization	**Data Provided/Available**	**R&D**	**Human Capital**	**Finance**	**Management**	**Networks**
	AHCA	The American Health Care Association (AHCA) is a non-profit federation of affiliated state health organizations, together representing more than 10,000 non-profit and for-profit assisted living, nursing facility, developmentally-disabled, and subacute care providers. AHCA serves as a force for change within the long term care field, providing information, education, and administrative tools that enhance quality at every level. AHCA maintains the Online Survey, Certification and Reporting (OSCAR) system for the Centers for Medicare and Medicaid Services (CMS) in cooperation surveying agencies. OSCAR is a compilation of all the data elements gathered during the inspection survey conducted at nursing facilities for the participation in the Medicare and Medicaid programs. OSCAR is the most comprehensive source of facility level information census and regulatory compliance of nursing facilities.	Some	Minimal	Minimal	Some	No

	AMA	The American Medical Association's mission is to promote the art and science of medicine for the betterment of public health. The AMA is an essential part of the profession by uniting physicians nationwide to work on the most important professional and public health issues. The AMA has a long history of collecting and maintaining data and is the single most comprehensive source for physician-related data. Physicians' records are subject to change and are updated continually through the extensive data collection activities	No	Some	Minimal	Some	Some
	ADA	The American Dental Association has more than 153,000 members 53 constituent (state-territorial) and 545 component (local) dental societies. It is the largest and oldest national dental association in the world. The Association's 11 councils serve as policy recommending agencies. Each council is assigned to study issues relating to its special area of interest and to make recommendations on those matters. The Association's official publication is The Journal of the American Dental Association. Other publications include the ADA News and the ADA Guide to Dental Therapeutics. The ADA Foundation provides grants for dental research, education, and scholarships.	Some	Yes	Yes	Some	Some
	AHA	The American Hospital Association (AHA) is the national organization that represents and serves all types of hospitals, health care networks, and their patients and communities. Close to 5,000 hospitals, health care systems, networks, other providers of care and 37,000 individual members have joined forces under the banner of the AHA. AHA provides an annual series of reports that provide up to date information on both health and hospital trends. Data from various sources including the AHA Annual Survey is compiled and made available through its TrendWatch Chartbook. Other reports and surveys of hospital leaders are released throughout the year and provide a snapshot of issues like the workforce shortage, health care costs, disaster preparedness and other topics of interest to hospital members, policy makers and industry analysts.	Some	Some	Yes	Minimal	Some
	ATA	The American Telemedicine Association (ATA) is a leader in promoting access to medical care for consumers and health professionals via telecommunications technology. ATA seeks to bring together diverse groups from traditional medicine, academic medical centers, technology and telecommunications companies, e-health, medical	Some	Yes	No	No	Some

		societies, government and others to overcome barriers to the advancement of telemedicine. ATA promotes better understanding of this emerging field by working closely with private industry market research resources, including links to various industry research firms and other organizations that provide market intelligence and information services regarding telemedicine.					
	META	The Medical Equipment & Technology Association is an organization for professionals that service and support equipment in the healthcare industry. The primary purpose of META is to contribute to the improvement of healthcare delivery through the development and improvement of the personnel, processes and techniques related to the management and support of healthcare technology.	No	Yes	No	No	No
	SHEA	The Society for Healthcare Epidemiology of America (SHEA), was founded in 1980 to advance the application of the science of healthcare epidemiology. SHEA works to maintain the quality of patient care and healthcare worker safety in all healthcare settings. Its success is reflected in its high success rate in infection control and prevention, while applying epidemiologic principles and prevention strategies to a wide range of quality-of-care issues. SHEA is a growing organization, strengthened by its active membership in all branches of medicine, public health, and healthcare epidemiology. The organization performs a periodic *Healthcare Epidemiology Resources and Compensation Survey* that provides meaningful, representative data on the role of healthcare epidemiologists and related infection control staff in a variety of healthcare settings.	Yes	Yes	No	Minimal	Minimal
	ANA	The American Nurses Association is the full-service professional organization representing the nation's 2.9 million registered nurses (RNs) through its 54 constituent member associations. The ANA advances the nursing profession by promoting standards of nursing practice, promoting the economic and general welfare of nurses in the workplace, and through advocacy with the Congress and regulatory agencies on health care issues affecting nurses and the public.	No	Yes	No	No	Some

		Potential Innovation Vital Signs for Sector
	Name	**Data Provided or Potentially Available**
	New Biz Starts	New business starts in this industry group are primarily the province of the health care services side of the coin rather than the social services component. As is the case in the other industries reviewed, much of the new business starts are technology driven. Perhaps the best example of this is the introduction of 'imaging centers' to the health care services spectrum. These are businesses that employ new imaging technologies to provide patient services to doctors in an effort to maximize the potential use of the equipment while minimizing the associated costs. Beyond that, new business starts in this sector are primarily the normal churn of practitioners moving or retiring, or simple practitioners opening up a practice to meet assumed demand in a given area. With the exception of technology driven businesses, it would seem that new business starts are not a good potential innovation vital sign indicator for this industry.
	IP Development	There is little comment about the development of IP in the closely defined health services industry. The research done to serve the health industry is typically performed by or on behalf of other industries and the resultant IP resides there. IP would not appear to be a valid innovation indicator for this industry.
	Workforce Δ	The review of industry organizations above yields little in the way of statistics that support the workforce development activities of this industry. While life-long learning and related continual training and refreshers are a normal part of maintaining expertise in healthcare, the industries attention appears to be focused on ensuring that medical practitioners are offered a wide array of such opportunities rather than measuring the share of the population that takes advantage of such offerings. There would seem to be an opportunity here to develop metrics on workforce skills and the breadth and depth of participation in continuing education. However, finding the right partner and the right methodologies and metrics might prove difficult.
	Biz Model Δ	This is probably the area of the most significant innovation in this sector, but there is no tracking of such data in the industry at this time, at least not from the perspective of publicly available data. There may be some consulting specialists who monitor these changes and report on them to industry executives, but such information is not readily apparent in our scan. Interestingly, the introduction of HMOs, and their subset PPOs and the like, are perhaps the single most significant change in this sector. And these are strictly a business model change combining healthcare and insurance. Similarly, specialized surgical centers and other like organizations promise to have a significant impact on the future of this industry. However, for the purposes of finding innovation vital signs, business models are a good candidate, but one that would be hard to design and implement.
	New Products & Services	Technology enabled products are the key to this area in the health care market, many of which are tied to the adoption of new IT systems for quality control and information management. Much of the innovation occurring here is related to improved diagnostics driving better treatment and a higher level of service with better potential outcomes for patients. Doctors and others in the services chain are mostly dealing with the same sets of diseases and health care issues. They are not truly providing new services, but the services they are providing are better and more effective. This being the case, it is doubtful that new products and services development would serve as a mainstream innovation indicator for healthcare. There is, however, the possibility that, applied in conjunction with the business model variable, that such an indicator could provide consistent and valuable insight on the state of innovation in health care.

Available Indicators for Evaluation of Vital Signs Applicability - Privately Produced Indicators and Statistics

	Other Sources by Industry	Description	Sector GDP $B in 2004	% of Private Industry	Number of Establishments	Number of Employees
	Privately Produced indicators and statistics	Below is a listing of innovation indicators that are developed and maintained by private industry sources that do this on a prepaid subscription or a for-hire basis. Most of these indicators are related to market activity and shares of market determined by product type rather than industry of production.	N.A.	N.A.	N.A.	N.A.
	Innovation Activities Reported	There are numerous private sector providers of information related to industry activity, usually market information and statistics, that might serve as either an innovation indicator or as an input to a derivative indicator, e.g. some number divided by another. The section below is a brief summarization of some of the larger, more well-known providers of such data and the information or statistics they have that might contribute to the development of innovation vital signs.				
	Private Sector Organizations Monitoring Industry					
	Name of Organization					
		Potential Innovation Vital Signs for Areas Covered				

	Name	Data Provided or Potentially Available	Vital Signs Indicator Contributor Potential
	Gartner Group	The Gartner Group provides technology-related research for clients. Gartner serves 10,000 organizations, including chief information officers and other senior IT executives in corporations and government agencies, as well as in technology companies and the investment community. The company consists of Gartner Research, Gartner Consulting and Gartner Events. Gartner products tangential to innovation include Gartner Dataquest. This long running data series provides in-depth market forecast and share data together with analysis of trends, competitors and customer requirements in 37 key technology markets. These markets include software, hardware, IT services, communications, semiconductors, and business and industry strategies. Dataquest Qstats provide quarterly shipments, market spend and vendor share for PCs, Workstations, Servers, Printers, Semiconductor Devices.	Access to the DataQuest time series might be useful in the development of cross correlated or derivative indicators of technology diffusion across industries and the impact this has had on overall sector innovation performance.
	Thomson Financial	The Thomson Corporation is a leading global provider of integrated information-based solutions to business and professional customers. Thomson provides value-added information, with software tools and applications. Thomson serves information users in the fields of law, tax, accounting, higher education, reference information, corporate e-learning and assessment, financial services, scientific research and healthcare. Thomson products include information products for the legal, financial services, tax and accounting, scientific, educational, and healthcare industries. The majority of these are information management products intended to enable users to access industry background information and trends. An example is CenterWatch that tracks ongoing clinical trials and their	Thomson's focus appears to be more on services rather than on maintaining and reporting statistics. There are some examples, such as CenterWatch that offer interesting potential as an indicator of innovation.

		latest published results.	
	The Conference Board	The Conference Board a business membership and research organization best known for the Consumer Confidence Index and the Leading Economic Indicators. The Conference Board has, for almost 90 years, provided members practical knowledge through issues-oriented research and senior executive peer-to-peer meetings. Examples if CB products include the economics program which serves the interests of Conference Board Associates and other corporate executives through economic briefings, an extensive publishing program and a growing body of research on timely topics. This program is part of a long tradition of research and education stretching back to the compilation of the first continuous measure of the cost of living in the United States in 1919. The Economics Program publishes widely watched economic indicators, supplemented by concise commentary and analysis on a wide range of issues. These include: • The Consumer Confidence • Help-Wanted Advertising index • The index of U.S. Leading Economic Indicators	The Conference Board data appears to be at too high a level of aggregation to provide meaningful statistical evidence of innovation. However, the audience that the Board serves might be an interesting one to approach to determine interest in developing and maintaining innovation indicators.
	IDC	IDC is the premier global provider of market intelligence, advisory services, and events for the information technology, telecommunications, and consumer technology markets. IDC helps IT professionals, business executives, and the investment community make fact-based decisions on technology purchases and business strategy. IDC analysts in 50 countries provide global, regional, and local expertise on technology industry opportunities and trends. IDC offers clients a variety of products and services. The most widely used are its research reports and its Continuous Intelligence Service (CIS) programs. The research reports provide market forecasts, competitive analysis, vendor profiles, and information on customer requirements and buying patterns across a wide spectrum of technology markets and subjects. The Continuous Intelligence Service (CIS) programs are designed for IT professionals and form a core market intelligence data set that provides answers, solutions, and insights on demand, and trends in the use of IT in global applications markets.	The CIS program might offer an interesting foundation on which to build innovation metrics, especially in the context of global application markets for IT and the impact of the use of IT on business success through improved processes and business models.
	Venture One	VentureOne is the world's leading venture capital research firm, offering investors, service providers, and entrepreneurs the most comprehensive, accurate, and timely information on the venture capital industry. VentureOne's products and services help venture capital firms, corporate investors, investment banks, and accounting and law firms identify private investment opportunities, perform due diligence, and evaluate market trends, including company valuations and industry preferences. VentureOne compiles and makes available on a subscription basis its VentureSource database. This is a continuously updated source of venture capital activity, including complete business information on investors and venture-backed companies, venture financing transactions, valuation information, and key executives and board members of funds and their portfolio companies.	To the extent that financing is a critical variable in the development of innovative companies and markets, gaining access to selected elements of the VentureSource database would theoretically be an important contributor to the development of meaningful innovation metrics.
	Forrester Research	Forrester Research is an independent technology and market research company that provides research and consulting about technology's impact on business and consumers. Since its founding in 1983, Forrester has grown into a thought leader with a global client base of customers who rely on its research, consulting, events, and peer-to-peer executive programs to	Forrester’s WholeView platform might serve as the basis for building innovation metrics on an industry specific and forward looking basis. Further

		understand their markets and develop winning strategies on the basis of Forrester's insights. Forrester focuses on the business implications of technology change. Its products include its trademarked WholeView 2™ Research platform that is intended to provide a holistic perspective of business, technology, and customer demands. WholeView 2™ Research helps clients understand the interplay of business demands and technology capabilities to yield a perspective on market trends from deep IT issues to broad business goals.	investigation of the component elements of this platform and how it might integrate with other indices is required to make a determination of applicability.
	McGraw-Hill	The businesses that comprise the McGraw-Hill Information & Media group provide the information and insight professionals in business and government need to remain competitive in their fields and in the global economy. McGraw Hill's flagship publication is BusinessWeek, one of the world's most widely read business magazine. The firm is also a leader in providing information to the aviation and aerospace industry through its Aviation Week Group, to the energy sector through its Platts Energy unit, and in the construction industry through its McGraw-Hill Construction publications and information division. McGraw Hill is also the corporate parent to JD Power and Associates. This firm is noted for its independent and unbiased surveys of customer satisfaction, product quality and buyer behavior. The firm's services include industry-wide syndicated studies; proprietary (commissioned) tracking studies; media studies; forecasting; and training services, as well as business operations analyses, and consultancies on customer satisfaction trends. Taken as a whole, these various business units comprise an information platform that monitors activities in a variety of industries and also maintains statistical databases in several of them.	McGraw-Hill data appear initially to be not a good fit for innovation metrics as they are connected more to broad industry trends – items such as sales and employment information – that may or may not be useful in defining innovation within the industries covered. Further investigation might be warranted, but some of the other sources cited here appear to offer better prospects.
	IRI	Information Resources, Inc. (IRI) is the world's leading provider of enterprise market information solutions and services, enabling its clients to grow their business profitably through the use of timely and unique market information at the retail product level. IRI provides a combination of real-time market content (retail scanner data), advanced analytics, enterprise performance management software, and professional services to drive the transformation of the consumer packaged goods (CPG), retail, and healthcare industries. The company's portfolio of services, solutions, and technology enable leading retailers and their suppliers around the globe to see market developments as they are happening, respond quickly with greater confidence and win at the shelf. Ninety-five percent of the FORTUNE Global 500 in CPG and retail use IRI data in their business decision-making. Examples of IRI retail products include: InfoScan is a scanner-based tracking service that provides you with high quality datasets to fuel your business analyses and decision making InfoScan Reviews is the industry's leading syndicated retail tracking service used extensively by CPG manufacturers and retailers IRI also provides services to assist manufacturers in their new product introduction efforts. These include: IntroCast Launch Forecasting - a suite of applications that leverages a robust database of category-specific benchmarks to assist in new product goal-setting and trial and repeat forecasting New Product Performance - a solution that provides the ability to see and analyze true	IRI's data and retail solutions provide extensive contemporary hard data points that should be useful in developing and monitoring the impacts of innovation across a variety of business and geographic settings. Further investigation and development of potential indices is warranted.

		performance of new products as they are launched in the market Price and Promo Performance - an enterprise software application that offers state-of-the-art price and promotion analytics and planning capabilities.	
	Aberdeen Group	Aberdeen Group is one of the leading providers of fact-based research focused on the global technology-driven value chain. Aberdeen's mission is to provide technology answers for the global value chain by providing a service called "Educating Buyers to Action." Aberdeen's fact-based research educates technology buyers with the facts they need to act on business and technology decisions. Aberdeen's portfolio of fact-based research services addresses key go to market issues facing marketing executives in technology industries. Aberdeen's approach involves conducting probing research studies across all aspects of business and technology. Hundreds of companies participate in each research study to assure research depth and quality. The research is context rich and provides specific insight by industry sector, company size, and geography, as well as by business process and technology. Aberdeen's research process requires that it maintains and supports a research community of industry knowledgeable resources. Among Aberdeen's assets are: - a registered research community of over 25,000 executives - a publication and media research network that reaches over 14 million business and technology practitioners around the globe - a knowledge base of over one hundred studies performed in the last year - performed benchmarking activities with over 25,000 enterprise decision makers over the past two years - more than 90% of the Software 500 as clients and research participants.	The availability of extensive benchmark data and capabilities is intriguing in terms of developing innovation metrics and other indicators of industry performance and vitality. It appears that Aberdeen has the potential to assist in the development of innovation vital signs, but more investigation is required to determine where and under what industries would Aberdeen's capabilities be best able to contribute.

Appendix B – Public Sector Innovation Indicators Data Base

The following series of tables summarizes all of the data sources that were used to compile and evaluate all of the indicators are employed in this analysis. Rather than prepare a printed listing of the over 3100 individual indicators we evaluated, we have chosen to provide the sources of the data in the tabular listing below. Given that this would be a daunting series of pages were it printed out, we have instead chosen to provide the data series in electronic format that will accompany this report.

Instead, the tables below will demonstrate the breadth and depth of the data series that were employed in the analysis. They also show the broad spectrum of data types and data sources that we used to compile the overall mapping of available indicators.

Series 1 - Global

GLOBAL INNOVATION INDICATORS SOURCES	Source Code
OCED Science, Technology & Industry Scoreboard 2006	OECD STI
European Innovation Scoreboard 2005 Database	EIS
OECD Main Science and Technology Indicators (electronic) 2006	MSTI Elec
Main Science and Technology Indicators Report 2006/1 OECD	MSTI OECD
Oslo Innovation Scorecard 2004	OSLO Innov
IMD World Competitiveness Yearbook 2006	IMD
Global Competitiveness Index 2006	GCI Indx
World Bank Knowledge Assessment Methodology (KAM)	WB Kam
Economic Freedom World Index 2006	Econ Freedm
Science and Technology Priorities of OECD Countries	S&T Prior
World Bank Doing Business Indicators 2006	WB Do Bus
Global Entrepreneurship Monitor 2004-5	GEM Monitr
Capital Access Index 2005 -- Milken Institute	CapAcc
OECD Education at a Glance 2005	OECD Educ
Industrial Development Report	IndDev Rep
Trend Chart report: Innovation in Services	TrndServ
UN World Investment Report	UN Inv Rep
Benchmarking Innovation Policy & Innovation Framework Conditions FORA 2004	InnovPolFora
OCED Science, Technology & Industry Scoreboard 2006	OECD STI
European Innovation Scoreboard 2005 Database	EIS
OECD Main Science and Technology Indicators (electronic) 2006	MSTI Elec
Main Science and Technology Indicators Report 2006/1 OECD	MSTI OECD
Oslo Innovation Scorecard 2004	OSLO Innov
IMD World Competitiveness Yearbook 2006	IMD
Global Competitiveness Index 2006	GCI Indx
World Bank Knowledge Assessment Methodology (KAM)	WB Kam

Series 2 - National

NATIONAL INNOVATION INDICATORS SOURCES	Source Code
NSF Science and Engineering Indicators 2006	NSF S&T
CEA Economic Indicators	CEA
BLS National Productivity	BLS
BEA/NSF R&D Satellite Account	BEA/NSF
UK Productivity and Competitiveness Indicators 2006	UK Comp
Norway Science and Technology Indicators 2005	Norw S&T
EU Regional Benchmarking--Mutual Learning Platform	Reg MLP
New Zealand Economic Development Indicators 2005	NZ Indic
Australia Public Science and Technology Report 2006	AuS&T
Canada Performance and Potential 2005-06	CanPerf

Series 3 - Regional

REGIONAL INNOVATION INDICATORS SOURCES	Source Code
ASTRA State Level Science and Technology Indicators 2005	ASTRA
Washington State Index of Innovation and Technology 2006	Wash Indx
Index of Silicon Valley 2006	SilcVal Indx
Philadelphia Life Sciences Cluster 2005	Phil LifeSc
Arkansas Position in the Knowledge Based Economy 2005	ArkKnow
State New Economy Index	StNewEc
State Science and Technology Index 2004 Milken	StateMilk
Index of the Massachusetts Innovation Economy 2006-5	MassInnov
Southern Innovation Index	S. Innov Indx
Region Lazio Innovation Scorecard 2005	Lazio Reg
State and Territory Based Assessment of Australian Research	AU Res
Southern Community Index	South Comm
Hong Kong Creativity Index	HKCreativy
Toronto Cultural Index and Plan	Tor Cul Plan
Wired Top Ten Geek Cities	Wired

Series 4 – Enterprise

ENTERPRISE INNOVATION INDICATORS SOURCES	Source Code
Index of Corporate Innovation -- Canada	CanCorpIndx
Fujitsu Innovation Index 2006	FujitIndx
Balanced Scorecard	BalScore
Danish Intellectual Capital Statement	DE IntCap
EU Benchmarking Enterprise	EU Benmk Enter
Converting Intangibles to Tangibles Kaplan & Norton	KapNorTang
Entrepreneurial Indicators FORA Denmark	DKFora
European Community Intangible Assets Repository	EC Intang
Innovation in New Zealand	NZ Innov

Appendix C – Public Sector Innovation Indicators

This appendix contains the Data Base of Public Sector Indicators that are ranked and sorted by utility and quality criteria. Due to the size of this particular data compilation, this data is not being printed out for this report. Instead, it is being provided to the client in electronic format. The graphic below is for illustrative purposes, showing the layout of the data base and the format employed in evaluating and compiling the data.

Innovation Vital Signs Project

Innovation Indicator Scoring Sheet

			UTILITY of Indicator					QUALITY of Indicator					U	Q
Input Type	Global Talent Indicators v.4.2 12-30-2006	Source of Indicator	Significance	Relevance	Clarity	Acceptance	Utility Sum	Accuracy	Timeliness	Comparability	Accessibility	Quality Sum	Graph Plot Point	
	B.1. Flows of university graduates.	OECD STI	3	3	3	3	12	3	3	3	3	12	12	12
	B.2. International mobility of doctoral students	OECD STI	3	3	3	2	11	2	3	3	3	11	11	11
	B.3. S&E doctorates and post doctorates to foreign citizens in the United States	OECD STI	2	2	3	2	9	3	3	3	3	12	9	12
	B.4. Employment of tertiary-level graduates	OECD STI	3	3	3	2	11	3	3	3	3	12	11	12
	B.5. Human resources in science and technology	OECD STI	2	2	3	2	9	2	3	3	3	11	9	11
	B.6. International mobility of the highly skilled	OECD STI	2	2	3	2	9	2	3	3	3	11	9	11
	B.7. R&D personnel .	OECD STI	3	2	3	2	10	3	3	3	3	12	10	12
	B.8. Researchers	OECD STI	2	2	3	2	9	3	3	3	3	12	9	12
	B.9. Foreign scholars in the United States .	OECD STI	3	2	3	2	10	3	3	3	3	12	10	12
	B.10. Human resources in S&T in non-OECD economies.	OECD STI	1	2	3	2	8	3	3	3	3	12	8	12
	D.2. ICT occupations and skills	OECD STI	2	2	3	2	9	2	3	3	3	11	9	11
	S&E graduates per 1000 population aged 20-29	EIS	3	3	2	3	11	4	3	3	3	13	11	13
	Population with tertiary education per 100 population aged 25-64	EIS	3	3	2	3	11	4	3	3	3	13	11	13
	Participation in life-long learning per 100 population aged 25-64	EIS	3	3	2	3	11	2	3	3	3	11	11	11
	Youth education attainment level (% of population aged 20-24 having completed at least upper seconc	EIS	3	2	2	3	10	2	3	3	3	11	10	11
	7. Total researchers (FTE)	MSTI Elec	3	3	4	2	12	4	2	2	3	11	12	11
	7.a. Total researchers -- Compound annual growth rate	MSTI Elec	2	2	4	2	10	4	2	2	3	11	10	11
	8. Total researchers per thousand total employment	MSTI Elec	2	2	4	2	10	4	2	2	3	11	10	11
	8.a. Total researchers per thousand labour force	MSTI Elec	2	2	4	2	10	4	2	2	3	11	10	11
	9. Total R&D personnel (FTE)	MSTI Elec	3	3	4	2	12	4	2	2	3	11	12	11
	9.a. Total R&D personnel -- Compound annual growth rate	MSTI Elec	2	3	4	2	11	4	2	2	3	11	11	11
	10. Total R&D personnel per thousand total employment	MSTI Elec	3	3	4	2	12	4	2	2	3	11	12	11
	10.a. Total R&D personnel per thousand labour force	MSTI Elec	2	3	4	2	11	4	2	2	3	11	11	11
	21. Total researchers (headcount)	MSTI Elec	2	3	4	2	11	4	2	2	3	11	11	11
	21.a. Women researchers (headcount)	MSTI Elec	1	3	4	2	10	4	2	2	3	11	10	11
	22. Women researchers as a percentage of total researchers (based on headcount)	MSTI Elec	1	3	4	2	10	4	2	2	3	11	10	11
	22.a. Business Enterprise Sector: Total researchers (headcount)	MSTI Elec	2	3	4	2	11	4	2	2	3	11	11	11
	22.b. Business Enterprise Sector: Women researchers (headcount)	MSTI Elec	1	3	4	2	10	4	2	2	3	11	10	11
	22.c. Business Enterprise Sector: Women researchers as a percentage of total researchers (based (	MSTI Elec	1	3	4	2	10	4	2	2	3	11	10	11
	22.d. Government Sector: Total researchers (headcount)	MSTI Elec	2	3	4	2	11	4	2	2	3	11	11	11
	22.e. Government Sector: Women researchers (headcount)	MSTI Elec	1	3	4	2	10	4	2	2	3	11	10	11
	22.f. Government Sector: Women researchers as a percentage of total researchers (based on headc	MSTI Elec	1	3	4	2	10	4	2	2	3	11	10	11
	22.g. Higher Education sector: Total researchers (headcount)	MSTI Elec	2	3	4	2	11	4	2	2	3	11	11	11
	22.h. Higher Education sector: Women researchers (headcount)	MSTI Elec	1	3	4	2	10	4	2	2	3	11	10	11
	22.i. Higher Education sector: Women researchers as a percentage of total researchers (based on h	MSTI Elec	1	3	4	2	10	4	2	2	3	11	10	11
	Business Enterprise R&D Personnel (FTE):	MSTI Elec	0	0	0	0	0	0	0	0	0	0	0	0
	27. Business Enterprise researchers (FTE)	MSTI Elec	3	3	4	3	13	3	3	3	3	12	13	12
	27.a. Business Enterprise researchers -- Compound annual growth rate	MSTI Elec	2	2	4	3	11	3	3	3	3	12	11	12
	28. Business Enterprise researchers as a percentage of national total	MSTI Elec	2	2	4	3	11	3	3	3	3	12	11	12
	29. Business Enterprise researchers per thousand employment in industry	MSTI Elec	2	2	4	3	11	3	3	3	3	12	11	12

Appendix D - Private Sector Indicators Score Sheet

Innovation Vital Signs Project

Innovation Measures Score Sheet

Private Sector Indicators and Sources

		Utility Measures Score					Quality Measures Score							
	Indicator Name	Significance	Relevance	Clarity	Acceptance	Quality Sum	Accuacy	Timeliness	Comparability	Accessibility	Utility Sum	Graph Plot Point		Source of Indicator/Data Series
1	Engineering College Profiles and Statistics - Engineering and	5	4	5	3	17	4	3	2	5	14	17	14	ASEE - American Society for Engineering Education
2	Venture Capital Yearbook - Industry statistics for the past tw	4	5	5	5	19	5	4	4	2	15	19	15	NVCA National Venture Capital Association
3	World Semiconductor Trade Statistics (WSTS) - Semiconduc	3	3	5	5	16	5	4	5	3	17	16	17	SIA - Semiconductor Industry Association
4	Economic Handbook of the Manufacturing Technology Indust	1	2	4	5	12	5	3	4	3	15	12	15	AMT - the Association for Manufacturing Technology
5	Plastics Machinery and Equipment Statistics Annual and Qu	3	2	5	5	15	5	5	2	1	13	15	13	SPI - Society for the Plastics Industry
6	Chemical Economics Handbook; Business of Chemistry: Sit	2	3	5	4	14	5	3	3	1	12	14	12	ACC - American Chemistry Council
7	Electroindustry Business Confidence Index	2	2	3	4	11	4	4	5	1	14	11	14	NEMA - National Electrical Manufacturers Assn.
8	HDMA Factbook	3	2	4	3	12	4	2	3	1	10	12	10	HDMA - Healthcare Distribution Management Association
9	Hershey Industry Performance Analysis (HIPA) Report meas	2	1	4	4	11	4	1	3	1	9	11	9	AWMA - American Wholesale Marketers Association
10	Geneva Risk and Insurance Review	3	3	1	2	9	3	1	1	1	6	9	6	Geneva Association
11	PTDA Market Outlook Report - monthly	2	1	4	4	11	4	5	3	2	14	11	14	PTDA - Power Transmission Distributors Association
12	Retail Industry Indicators	3	1	3	3	10	4	2	4	3	13	10	13	NRF - National Retail Federation
13	Technology Review Highlights & SUPERMARKET Facts - Inc	2	3	3	5	13	4	2	2	1	9	13	9	FMI - Food Marketing Institute
14	Series of ongoing client sponsored Benchmarking projects	2	4	5	2	13	3	1	1	1	6	13	6	RBA - Retail Benchmarking Association
15	Pharmacy Activity Cost and Productivity Study	3	4	3	2	12	4	1	1	1	7	12	7	NACDS - National Association of Chain Drug Stores
16	No statistics but some potential to data mine with the Univer	0	0	0	0	0	0	0	0	0	0	0	0	NGA - Natonal Grocers Association
17	Publish the NHFA's 2006 Retail Performance Report - bench	2	3	3	2	10	4	4	3	3	14	10	14	NHFA - National Home Furnishings Association
18	Publish the 2005 Direct Marketing Statistical Fact Book - grc	2	2	3	3	10	4	3	3	2	12	10	12	ERA - Electronic Retailing Association
19	Publish the DMA 2006 Statistical Fact Book: The Definitive S	3	3	3	2	11	4	4	4	3	15	11	15	DMA - Direct Marketing Association
20	Publishes the Wireless Industry Indices Report, the most coi	3	2	3	2	10	4	4	4	3	15	10	15	CTIA - Cellular Telephone Industry Association
21	Sponsor academic and analyst research into industry topics	3	1	4	1	9	1	1	3	4	9	9	9	NAB - National Association of Broadcasters
22	Maintains no statistical data base. Is issue and policy orient	0	0	0	0	0	0	0	0	0	0	0	0	SIIA - Software and Information Industry Association
23	Publishes MPA Worldwide Market Research & Analysis	3	2	4	2	11	4	4	4	3	15	11	15	MPIA - Motion Picture Industry Association
24	TIA's 2007 Telecommunications Market Review and Forecast	4	3	4	3	14	4	4	4	4	16	14	16	TIA - Telecommunications Industry Association
25	2005 AAP Industry Statistics Report	3	3	4	2	12	4	4	4	3	15	12	15	AAP - Association of American Publishers
26	Publish Industry Statistics - investment, subscribers, broadb	4	3	4	3	14	4	4	4	3	15	14	15	NCTA - National Cable & Telecommunications Association
27	Publishes The Source: Newspapers by the Numbers -- a quic	3	3	4	3	13	4	4	4	3	15	13	15	NAA - Newspaper Association of America
28	Has a series of topical studies and a time series on Busines	2	3	2	2	9	3	4	2	4	13	9	13	OPA - Online Publishers Association
29	Publishes Phone Facts Plus Telecom Trends 2005 - compila	3	3	2	3	11	4	3	3	4	14	11	14	US Telecom
30	Does not gather, compile, or publish any industry data	0	0	0	0	0	0	0	0	0	0	0	0	AFSA - American Financial Services Association
31	Does not gather, compile, or publish any industry reports. D	0	0	0	0	0	0	0	0	0	0	0	0	AFA - American Finance Association
32	ABA Benchmarking and Survey Research	3	2	4	2	11	4	4	5	3	16	11	16	ABA - American Bankers Association
33	Industry Market Research Products and Survey	3	2	4	3	12	4	4	4	3	15	12	15	MBA - Mortgage Bankers Association
34	ARIA publishes two journals, *Journal of Risk and Insurance*	0	0	0	0	0	0	0	0	0	0	0	0	ARIA - American Risk and Insurance Association
35	Offers Fast Trak Plus through ISS - and external resource prc	3	1	4	1	9	4	5	5	2	16	9	16	PCIAA - Property Casualty Insurance Assn of America
36	Securities Industry DataBank and other private research resu	2	3	4	2	11	4	5	4	3	16	11	16	SIFMA - Securities Industry and Financial Markets Association

Appendix D - Private Sector Indicators Score Sheet – page 2

Innovation Vital Signs Project

Innovation Measures Score Sheet

Private Sector Indicators and Sources

		Utility Measures Score					Quality Measures Score					Graph Plot Point		
	Indicator Name	Significance	Relevance	Clarity	Acceptance	Quality Sum	Accuacy	Timeliness	Comparability	Accessibility	Utility Sum			Source of Indicator/Data Series
37	Publishes the Mutual Fund Fact Book - as well as the montl	4	2	4	2	12	4	5	5	3	17	12	17	ICI - Investment Company Institute
38	In March of 2005, NAR began producing the Pending Home S	2	2	4	1	9	4	5	4	3	16	9	16	NAR - National Association of Realtors
39	Publishes - Monthly Industry Statistics	2	2	4	1	9	4	5	5	3	17	9	17	MHI - Manufactured Housing Institute
40	Experience Exchange Report - annual	4	3	4	2	13	4	3	3	4	14	13	14	BOMA - Building Owners and Managers Association
41	Commercial Real Estate in a Flat World: The Implications of	3	3	4	3	13	3	3	2	3	11	13	11	NAIOP - National Association of Industrial and Office Properties
42	Monthly Leasing Index	3	3	3	3	12	3	5	5	3	16	12	16	ELA - Equipment Leasing Association
43	Publishes the Home Builders Forecast, Housing Market Stat	3	3	4	2	12	4	5	3	3	15	12	15	NAHB - National Association of Home Builders
44	Publish Firm Survey Report, as well as Work-on-the-Boards,	2	3	4	2	11	4	5	3	4	16	11	16	AIA - American Institute of Architects
45	Publish a variety of statistics in all manner of legal topics - e.	2	2	3	3	10	3	3	3	2	11	10	11	ABA - American Bar Association
46	Plublishes the NPA magazine that tracks industry developme	2	2	2	2	8	3	3	2	3	11	8	11	NSA - National Society of Accountants
47	CPA Vision Process	2	2	2	3	9	3	2	3	4	12	9	12	AICPA - American Institute of Certified Public Accountants
48	Economic report on veterinarians & veterinary practices	2	2	4	3	11	3	2	3	3	11	11	11	AVMA - American Veterinary Medical Association
49	NACCB Operating Practices Report	2	3	4	2	11	3	2	3	3	11	11	11	NACCB - National Association of Computer Consultant Businesses
50	Design-Build Project Database	1	1	2	2	6	2	1	2	2	7	6	7	DBIA - Design-Build Institute of America
51	OSCAR Data Reports (Online Survey Certification And Repor	2	3	4	3	12	4	2	3	3	12	12	12	AHCA - American Health Care Association
52	Publishes -- Census of physicians, Census of medical group:	2	2	4	4	12	4	2	4	3	13	12	13	AMA _ American Medical Association
53	Researches and publishes on Workforce Issues, Educationa	3	3	4	3	13	4	2	3	3	12	13	12	ADA - American Dental Association
54	Trendwatch Chartbook	3	3	4	3	13	3	2	2	3	10	13	10	AHA - American Hospital Association
55	Telemedicine and e-Health Journal	2	2	2	3	9	3	2	2	3	10	9	10	ATA - American Telemedicine Association
56	In process of developing statistics	0	0	0	0	0	0	0	0	0	0	0	0	META - Medical Equipment & Technology Association
57	SHEA Healthcare Epidemiology Resources and Compensati	2	3	4	3	12	3	3	2	3	11	12	11	SHEA - Society for Healthcare Epidemiology of America
58	National Database of Nursing Quality Indicators (NDNQI®).	3	3	3	3	12	3	2	3	3	11	12	11	ANA - American Nurses Association
59	VentureSource	3	3	4	4	14	4	5	4	3	16	14	16	Venture One
60	Baby Boomers Report, Builders Suite, Consumer Decision M	2	3	4	3	12	5	5	5	2	17	12	17	IRI
61	Consumer Confidence, Help-Wanted Advertising, Help-Wante	3	3	5	4	15	5	5	5	4	19	15	19	The Conference Board
62	Quarterlly 'Tracker' reports on technology markets and trends	2	2	5	3	12	4	3	4	3	14	12	14	IDC
63	Hardware Technology Spending Survey: North America And E	3	2	4	4	13	4	4	4	3	15	13	15	Forrester Research
64	Thomson features solutions in the form of information on the	3	3	4	4	14	4	4	4	3	15	14	15	Thomson Financial
65	Dataquest	2	3	4	4	13	4	5	5	3	17	13	17	Gartner Group
66	Point-of-sale (POS) and consumer panel market research	3	2	5	3	13	4	5	4	3	16	13	16	NPD
67	Key Performance Indicators, Metrics and Benchmarks are av	3	3	4	3	13	4	3	2	3	12	13	12	Aberdeen Group
68	JD Power Index reports across many products and industries	2	1	3	3	9	3	3	3	4	13	9	13	McGraw-Hill
69	Journal of Product Innovation Management (JPIM) and Comp:	2	3	4	3	12	3	4	2	2	11	12	11	PDMA - Product Development Management Association
70	Optoelectronics Industry Market Data and Forecast Report	3	3	4	4	14	3	4	4	2	13	14	13	OIDA - OptpElectronics Industry Development Association
71	Privacy Policy Trends Report	3	3	4	2	12	4	2	2	2	10	12	10	ISA - Internet Security Alliance
72	Growing The Nation's Biotech Sector: State Bioscience Initia	3	3	3	4	13	3	2	2	4	11	13	11	BIO - Biotechnology Industry Organization

Appendix D - Private Sector Indicators Score Sheet – page 3

Innovation Vital Signs Project

Innovation Measures Score Sheet

Private Sector Indicators and Sources

#	Indicator Name	Utility Measures Score					Quality Measures Score					Graph Plot Point		Source of Indicator/Data Series
		Significance	Relevance	Clarity	Acceptance	Quality Sum	Accuacy	Timeliness	Comparability	Accessibility	Utility Sum			
73	Nanotechnology White Paper Library	2	3	3	4	12	2	2	2	4	10	12	10	Nanotechnology Business Alliance
74	State of IT Services Business	3	3	4	3	13	4	3	4	3	14	13	14	CompTIA - Computing Technology Industry Association
75	Federal Technology Transfer	2	3	4	3	12	2	3	2	4	11	12	11	FLCTT
76	Masters of Logistics Study	2	2	4	3	11	3	2	3	3	11	11	11	Logistics Management
77	Essential Facts About the Computer and Video Game Indust	3	2	4	3	12	4	3	2	3	12	12	12	ESA - Entertainment Software Association
78	Statistics at a Glance	3	3	4	3	13	4	3	3	3	13	13	13	AIP - American Institute for Physics
79	Michael Render Census Information	2	3	4	3	12	3	3	4	3	13	12	13	FTTH - Fiber to the Home Council
80	Quarterly Robotics Industry Statistics	3	3	4	3	13	4	4	4	3	15	13	15	RIA - Robotics Industry Assocaition
81	Monthly Petroleum Facts at a Glance, Monthly Statistical Re	2	3	4	3	12	4	4	4	3	15	12	15	API - American Petroleum Institute
82	Wind Power Weekly, Global Wind Energy Market Report	3	3	4	3	13	3	5	3	3	14	13	14	AWEA - American Wind Energy Association
83	AAMVA Online Surveys	2	3	3	2	10	4	2	2	3	11	10	11	AAMVA - American Association of Motor Vehicle Administrators
84	CRA Taulbee Survey	3	4	4	4	15	4	3	4	4	15	15	15	CRA - Computing Research Association
85	Publishes Industry Data - Current PCB Book-to-Bill Ratio	3	2	4	3	12	4	4	4	3	15	12	15	IPC - Association Connecting Electronics Industries
86	Financial and Operating Review	2	2	4	2	10	4	3	4	4	15	10	15	EEI - Edison Electric Institute
87	Quarterly Cost Index: U.S. Passenger Airlines - and multiple	2	4	4	2	12	4	4	4	3	15	12	15	ATA - Air Transport Association
88	Trucking Activity Report	2	2	4	3	11	4	4	4	4	16	11	16	ATA - American Trucking Associations
89	Cross-Industry Comparison of Standard Benchmarks	3	3	4	3	13	4	3	3	3	13	13	13	CAPS: Center for Strategic Supply Research
90	OGJ Energy Database - Haverdata	3	2	4	2	11	4	4	4	3	15	11	15	Pennwell - Oil and Gas Journal
91	National Recycling Economic Information Project	2	3	3	2	10	3	2	2	4	11	10	11	NRC - National Recycling Coalition
92	Industry Statistics	2	3	3	2	10	3	1	2	3	9	10	9	ARA - Automotive Recyclers Association
93	ETDE World Energy Base	2	3	4	3	12	4	2	3	2	11	12	11	ETDE - Energy Technology Data Exchange
94	Market Research Program for Manufacturers	3	2	3	2	10	3	3	3	2	11	10	11	ESTA - Entertainment Services and Technology Association
95	Ethanol Industry Outlook	3	3	3	2	11	3	2	3	2	10	11	10	RFA - Renewable Fuels Association

Appendix E - Private Sector Indicators Data Base of Sources with Descriptions – page 1

Summary of Private Sector Innovation Vital Signs Candidates			
	Source	**Indicator Description**	**Links**
1	**ASEE**	College enrollments, degrees awarded, faculty headcounts, and research expenditures at the undergraduate and graduate levels for engineering and undergraduate level for engineering technology	http://www.asee.org/publications/profiles/index.cfm
2	**NVCA**	2006 Venture Capital Yearbook - This report details the state of the venture capital industry and detailed industry statistics for the past twenty years, including commitments, disbursements, IPOs, acquisitions and performance. Also publish Venture Impacts - stat compendium of impacts of VC. Also publish Venture Impacts - stat compendium of impacts of VC	http://www.nvca.org/ffax.html
3	**SPI**	Republish government statistics on feedstock and plastics production by NAICS industry sectors. Also compile and publish the Financial Management Surveys for Plastics Processing Companies. This is intended to provide performance benchmarking capabilities.	http://www.plasticsdatasource.org/
4	**AMT**	Monthly, quarterly and annual shipments of capital equipment, mostly metalworking. Much is published, much is proprietary. Also do financial and operating ratio report for industry.	http://www.amtonline.org/section_display.cfm?section_id=5
5	**SIA**	World Semiconductor Trade Statistics: The WSTS is an organization of seventy semiconductor companies from all over the world that provides the industry with accurate and timely indicators of business trends.	http://www.sia-online.org/pre_statistics.cfm
6	**ACC**	Republish some Gov't stats and also do occasional topical research at their division level - Maintain weekly and monthly regional and global production statistics by product family. Also have American Chemistry Council Economic Survey.	http://www.americanchemistry.com/s_acc/sec_statistics.asp?CID=637&DID=2514
7	**NEMA**	NEMA members have the ability to participate in customized research in the following areas - Economic Forecasts & Market Research, Survey Services that focus on specific products, industrial relations topics, financial compilations of the industry and sub-sectors, and statistics related to government and regulatory body mandates.	http://www.nema.org/econ/members/

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8	NAW	Six editions of Facing the Forces of Change have been published documenting emerging and developing trends in wholesale industry. Also publish 2006 Wholesale Distribution Economic Reports—that supply detailed channel benchmarking data, including revenue and employment growth trends, the number and size distribution of companies, gross margins, wages, and many other operating statistics. Each individual Report includes economic analyses of one of the 18 major wholesale distribution sectors	http://www.naw.org/Content/ContentGroups/Publications/new_economicrep.htm
9	AWMA	Hershey Industry Performance Analysis (HIPA) Report measures several key benchmarks among convenience wholesalers, including sales per employee, gross margin, return on investment, inventory turnover, salaries, and much more	http://www.naw.org/Content/ContentGroups/Publications/new_economicrep.htm
10	Geneva	The Geneva Association is a global non-profit organization formed by CEOs of leading insurers in America, Asia, Africa and Australia. Its mission is to research the growing economic importance of insurance activities in the major sectors of the economy.	http://www.genevaassociation.org/research_programmes.htm
11	PTDA	PTDA's monthly Market Outlook Report offers unique insight into the state of the U.S. and Canadian power transmission/motion control (PT/MC) industry	http://www.ptda.org/Content/NavigationMenu/MarketTrends/MarketOutlookReport/default.htm
12	NRF	Retail Industry Indicators - a yearly publication from the NRF Foundation, this is a collection of statistics describing retail industry indicators such as: sales, employment, profitability etc. at the national and state level.	http://www.nrf.com/content/default.asp?folder=member/retailDispIns&file=rd_surveyStudy.htm
13	FMI	Publish SUPERMARKET - Industry Overview 2005 is a compilation of information from the U.S. Department of Labor, U.S. Department of Agriculture, Progressive Grocer magazine, U.S. Census Bureau, and the Food Marketing Institute. The reported data represent average performance based on data from a cross-section of FMI members.	http://www.fmi.org/facts_figs/superfact.htm
14	RBA	Retail Benchmarking Association is a free association dedicated to the exchange of specific data related to retail performance. RBA conducts benchmarking studies on a multi-participant basis to identify and implement best practices.	http://home.flash.net/~benchmar/rba.html#objectives
15	NACDS	Arthur Andersen LLP conducted the Pharmacy Activity Cost and Productivity Study during July-August, 1999, pursuant to a grant from the NACDS Education Foundation	http://www.nacds.org/wmspage.cfm?parm1=609
16	NGA	Current initiatives being pursued by the University Food Industry Coalition include: Identifying new research initiatives to address industry issues.	http://www.nationalgrocers.org/UniverCoalition/University%20Coalition.html

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17	NHFA	Allows members to compare own figures to industry averages for productivity and profitability	http://www.nhfa.org/publicationsRPR.asp
18	ERA	ERA provides its members with cutting edge research through an exclusive agreement with Forrester. ERA releases a new report every other week	http://www.retailing.org/new_site/memresources/research_resources.htm
19	DMA	DMA's Research and Market Intelligence Department is the world's premier center for direct marketing research in the following areas: Benchmarking, best practices, public policy, economic research, consumer research, and emerging trends.	http://www.the-dma.org/research/
20	CTIA	Wireless Industry Indices Report: An in-depth analysis of the CTIA semi-annual data survey results. The Wireless Industry Indices Report is the most comprehensive periodic report on the wireless industry. Rather than a sampling, it is the actual data for over 90 percent of the industry on subjects such as numbers of subscribers, revenues, cell sites, and the average monthly bill for consumers	http://www.ctia.org/research_statistics/index.cfm
21	NAB	Have a series of reports sponsored by two committees. These are - Committee on Local Television Audience Measurement and COLRAM (for Radio)	http://www.nab.org/AM/Template.cfm?Section=Reports2&Template=/TaggedPage/TaggedPageDisplay.cfm&TPLID=50&ContentID=3538
22	SIIA	Publishes a compilation of useful data about the software industry, compiled by SIIA Research and the Software Division from primarily private sources such as Gartner and IDC. Overall revenue and growth numbers and other data are provided and refreshed as they become available.	http://www.siia.net/software/pubs/statpage_q104.pdf
23	MPIA	Has a series of market information reports that may be able to be used to develop second order innovation indicators. Details the domestic performance of the motion picture industry by media, comparing year over year changes and comparisons to historical data.	http://www.mpaa.org/researchStatistics.asp
24	TIA	TIA's Telecommunications Market Review and Forecast helps members and others anticipate market changes. Packed with facts and figures.	http://www.tiaonline.org/business/research/
25	AAP	The sales figures in this report are based on year-to-date data in the AAP 2005 December Monthly Sales Report, and other statistical data. Also contains operating information for the industry.	http://www.publishers.org/industry/index.cfm

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26	NCTA	Publish a series of industry statistics on subscribers, companies, revenue from subs, and revenue from advertisers - these are sourced from Kagan Research LLC, AC Nielson Media, Warren Communications News, and some are their own.	http://www.ncta.com/ContentView.aspx?contentId=66
27	NAA	Publishes data on demographic reach, circulation, ad revenues, new media migration, environmental impact of industry, and also some information on Canada.	http://www.naa.org/thesource/
28	OPA	Publishes a series of studies in various topic including - Internet Usage and Media Consumption, Online Journalism and Use of News and Information Sites, Online Advertising, Paid Content, Politics and the Internet, Other Research of Interest	http://www.online-publishers.org/?pg=opa_rsrch&dt=all
29	US Telecom	This best-selling USTelecom publication pulls together the latest information on the telecom industry and will help you succeed in today's highly competitive communications marketplace. You'll find the most current data available on everything from ILECs to CLECs, broadband to wireless and more. Filled with 103 pages of industry information from the FCC and leading industry analysts, it is easy to see why Phone Facts Plus Telecom Trends 2005	http://www.ustelecom.org/index.php?urh=home.news.telecom_resources
30	AFA	Do not have any ongoing data series, as such. Instead, there is significant research reported on in the Journal of Finance. There are also a series of accompanying data sets that might server as a foundation for research into innovation in the finance industry.	http://www.afajof.org/journal/supplements_datasets.asp
31	AFSA	American Financial Services Association (AFSA), based in Washington D.C., is the national trade association for the consumer credit and finance industry.	http://www.afsaonline.org/sitepages/membership_publications2.cfm
32	ABA	Offers ABA Benchmarking and Survey Research - a series of industry survey reports designed to enable comparisons by asset size, location, portfolio composition, and other criteria. Also sponsors custom reseach to enable information sharing of best practices among ABA member banks.	http://www.aba.com/Surveys+and+Statistics/default.htm
33	MBA	The MBA research and economics group provides the most current and comprehensive data and benchmarking tools that make a difference in short- and long-term strategic planning. Products and surveys cover all real estate business areas - economic forecasting, residential, commercial and multifamily.	http://www.mbaa.org/ResearchandForecasts
34	ARIA	ARIA publishes two journals, Journal of Risk and Insurance and Risk Management and Insurance Review. Information on industry innovation is contained in the editorial content but is not reported or monitored explicitly.	http://www.blackwell-synergy.com/loi/jori?cookieSet=1

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35	PCIAA	Uses the Independent Statistical Service, Inc. (ISS) as its statistical agent, ISS offers Fast Track Plus™, a quarterly publication of private passenger automobile and homeowners loss experience. The target of this data is not innovation, but there may be ways to use for innovation derivatives.	http://www.iss-statistical.net/iss/web/home.nsf/lcallcontent/8?opendocument
36	SIFMA	Securities Industry Data Bank – Data provided in the new Expanded Securities Industry DataBank will assist securities analysts, brokerage house senior management, and government officials in analyzing and tracking trends in the financial performance of the entire U.S. securities industry. Approximately each month, Research Reports features a selection of articles on the securities industry, securities markets, operational issues and managerial topics of interest to industry senior management, along with a statistical review of monthly activity in the US primary and secondary capital markets.	http://www.sia.com/research/html/research_reports.html
37	ICI	The Institute is the primary source for statistical data on the investment company industry. Institute staff compile and release a wide range of statistics on mutual funds, exchange-traded funds, closed-end funds, and unit investment trust sponsors	http://www.ici.org/stats/latest/index.html#TopOfPage
38	NAR	In March of 2005, NAR began producing the Pending Home Sales Index, also have National Center for Real Estate Research (NCRER) that supports original research that contributes to a greater understanding of the real estate industry, housing, and homeownership.	http://www.realtor.org/research/index.html
39	MHI	The latest industry shipments and data are published routinely, but also compiles MHI Quarterly Economic Report Detailed data series and analysis of macro- and micro-economic trends affecting the manufactured housing industry.	http://www.manufacturedhousing.org/statistics/default.asp
40	BOMA	Experience Exchange Report (EER) is the most detailed and reputable benchmarking source for the commercial real estate industry. It includes income and expense figures from over 5,000 buildings across the US and Canada and represents over one billion square feet of office space. The EER has more than 560 pages. Special studies sections including agency managed, all-electric, corporate facilities, financial, medical, and single purpose have been included.	http://www.boma.org/Research/
41	NAIOP	Nation's leading trade association for developers, owners, investors, asset managers and other professionals in industrial, office and mixed-use commercial real estate. Has subsid organization called NAIOP Foundation – sponsors custom research such as – Commercial Real Estate in a Flat World: The Implications of Economic Globalization for Industrial, Office and Mixed-Use Real Estate in North America	http://www.naiop.org/foundation/inprogressresearch.cfm

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42	ELA	Quarterly Performance Indicators Report (PIR) The PIR preceded, and was replaced by, the MLI. The PIR tracked the performance of prominent leasing organizations in six key areas. Because the same companies were tracked, the PIR provides fairly reliable trend analysis. This was replaced by the Monthly Leasing and Finance Index of equipment leasing and finance activity showing monthly commercial equipment lease and loan activity	http://www.elfaonline.org/research/
43	NAHB	NAHB produces in-depth economic analyses of the home building industry based on private and government data. The Economics Group surveys builders, homebuyers, and renters to gain insight into the issues and trends driving the industry. NAHB also hosts the Construction Forecast Conference.	http://www.nahb.org/generic.aspx?sectionID=140&genericContentID=26009
44	AIA	AIA conducts monthly and periodic surveys to track business conditions and provide our members with useful and timely analysis. We also work with data from other institutions to compile information on market dynamics of the architecture business.	http://www.aia.org/econ_default
45	ABA	The LTRC regularly performs survey research to assess the use of technology in the legal community. Numerous resources for research and statistics about lawyers and the legal profession are readily available. These cover a variety of issues and practices in the legal profession.	http://www.abanet.org/lawyer.html
46	NSA	Each issue focuses on a timely theme and includes a technology roundup, case studies, special features, and views from a variety of columnists.	https://www.nsacct.org/npa_issues.asp?id=532
47	AICPA	Sponsors the CPA Vision Process to create a comprehensive and integrated vision of the profession's future. Focus on changing nature of the profession	http://www.cpavision.org/search.htm
48	AVMA	The profession's primary financial performance and employment survey, provides detailed statistics for private practice and public/corporate employment. Report focuses on professional earnings, practice financial returns and ratios, cash operating expenses, gross revenues, personnel and wages, and employment benefits. Breakdowns include type of practice, region, gender, hours worked, years of experience, and size of practice.	http://www.avma.org/products/resource/economic.asp
49	NACCB	The NACCB Operating Practices Report provides benchmarking information covering every aspect of an IT services firm's operations. With 110 firms participating in 2006, it is the most comprehensive report of its kind in the industry.	http://www.naccb.org/resources/opr.cfm

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50	DBIA	Sponsors Foundation for Integrated Services - funds research to stimulate the development of new knowledge, information, programs, and products addressing future trends in integrated design and construction processes.	http://www.dbia.org/fr_publications.html
51	AHCA	The Health Services Research and Evaluation group provides impact assessments of current and proposed public policy, supports the profession's need for standardized quantitative measures of quality, and provides statistics that describe the long term care sector.	http://www.ahca.org/research/index.html
52	AMA	The AMA has a long history of collecting and maintaining data and is the single most comprehensive source for physician-related data. Physicians' records are subject to change and are updated continually through the extensive data collection activities.	http://www.ama-assn.org/ama/pub/category/2674.html
53	ADA	The Health Policy Resources Center's Survey Center has an excellent historical database, going back over decades for certain subjects. Many reports on dental education, workforce and economics are published as a series; some are available back to the 1950s. Custom research and consulting services are available at a reasonable charge.	http://www.ada.org/ada/prod/survey/index.asp
54	AHA	Through its affiliation with the American Hospital Association, HRET (health research education trust) accesses valuable resources, data and thought leadership. Also, AHA releases a series of reports that provide up to date information on health and hospital trends. Data from various sources including the AHA Annual Survey are compiled and made available trough our TrendWatch Chartbook.	http://www.aha.org/aha/research-and-trends/index.html
55	ATA	Promotes research and education including the sponsorship of the Telemedicine and e-Health Journal. Organization also spearheads the development of clinical and industry policies and standards.	http://www.atmeda.org/about/aboutH.htm
56	META	The Medical Equipment & Technology Association is an organization for professionals that service and support equipment in the healthcare industry. To develop a model set of educational outcomes for college-level biomedical equipment technology programs.	http://www.mymeta.org/education/education.html
57	SHEA	The SHEA Survey Task Force researches and compiles the SHEA Healthcare Epidemiology Resources and Compensation Survey.	http://www.shea-nline.org /news/shea_news_index.cfv
58	ANA	In 1998, ANA established the National Database of Nursing Quality Indicators (NDNQI®). Participation in NDNQI has grown from the original 30 hospitals to over 1,000 facilities.	http://nursingworld.org/books/pdescr.cfm?cnum=11#07NDNQ

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59	**Venture One**	CompensationPro is U.S.'s most robust database of compensation data for privately held companies, VentureSource gives you the accurate, timely information you need to succeed in one efficient tool: Valuations, Top investors, Company profiles, Funds and fundraising activity, Returns, Partners.	http://venturecapital.dowjones.com/products/prod_vsource.html
60	**IRI**	IRI provides consumer information based on bar code scanner date to assist retailers determine market drivers, preferences, loyalties, habits and concerns. Business managers use the data in understanding of consumer behavior and structuring business models to accommodate.	http://us.infores.com/page/manufacturers/manufacturers_overview
61	**The Conference Board**	The Conference Board is the world's preeminent business membership and research organization. Best known for the Consumer Confidence Index and the Leading Economic Indicators.	http://www.conference-board.org/economics/indicators.cfm
62	**Forrester Research**	Forrester's Business Technographics® research surveys business and IT executives at small and medium-size businesses and enterprises in North America, Europe, and Asia Pacific. Surveys uncover the health of technology budgets, technologies currently deployed, intended future purchases, and processes used in making technology	http://www.forrester.com/Products/MarketResearch/Business
63	**IDC**	IDC delivers dependable, high-impact intelligence and advice on the future of technology, e-business, and the Internet. Using a combination of rigorous primary research and in-depth competitive analysis, IDC forecasts worldwide markets and trends and analyze business strategies, technologies, and vendors.	http://www.idc.com/prodserv/subservices.jsp?v=4
64	**Thomson Financial**	Thomson has an extensive database of information across multiple industry groups and clusters. Use of these as innovation indicators will require analysis at the individual product level.	http://www.thomson.com/solutions/scientific/
65	**Gartner Group**	Gartner Dataquest has helped technology vendors grow by collecting and interpreting critical IT and telecom market data For more than 30 years - Gartner also has data on best practices benchmarks for various IT functions.	http://www.gartner.com/it/products/research/research_services.jsp#data
66	**Aberdeen Group**	Aberdeen conducts probing research studies across all aspects of business and technology with 100s of companies participating in each research study. Aberdeen's research depth is context rich and provides specific insight by industry sector, company size, and geography, as well as by business process and technology.	http://www.aberdeen.com/access/KPI/

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67	**McGraw-Hill**	McGraw Hill is the parent firm of J. D. Power and Associates which provides a series of awards are based on responses from consumers and business-to-business customers who have used the products and services being rated. The methodology is applicable to innovation and the determination of a variety of innovation metrics	http://www.jdpower.com/corporate/awards/about/index.asp
68	**NPD**	NPD provides original market research on music, film & video, PC games, and video games in the physical, digital, and mobile realms. Point-of-sale (POS) and consumer panel market research products and services uncover emerging needs and consumer behaviors.	http://www.npd.com/corpServlet?nextpage=entertainment-categories_s.html
69	**PDMA**	The Journal of Product Innovation Management is an academic journal devoted to research, theory, and practice in new product and service development. It is published six times a year, and takes a multifunctional, multi-disciplinary, international approach issues. Presents research from academics, consultants, practicing managers, economists, scientists, lawyers, sociologists - articles are based on empirical research, observations of management experience, and reviews of issues and theoretical developments. Also sponsors PDMA Foundation that publishes the Comparative Performance Assessment Study (CPAS) - a longitudinal study on best practices and their impact on corporate results.	http://www.pdma.org/journal/?PHPSESSID=fb36eca8b18dfccd00a2526c539e657f -- also http://www.pdma.org/cpas.php
70	**OIDA**	This report includes over 400 pages of market data and forecasts, including chapters on solar cells, sensors, displays, LEDs, communications, and medical applications.	http://www.oida.org/pdfs/market2006_excerpt.pdf
71	**ISA**	ISAlliance develops quarterly deliverables on cutting edge information security topics in conjunction with our partners at Carnegie Mellon University CyLab. These deliverables may be in the form of white papers, such as the Privacy Policy Trends, assessment tools, or other material designed for operational improvements in corporate security.	http://www.isalliance.org/content/view/41/126/
72	**BIO**	This organization collects and publishes multiple one-off studies and research reports such as State Bioscience Initiatives. The SBI report presents updated data, examines growth trends, and identifies metropolitan areas with the largest and most concentrated employment in each of the bioscience sub sectors identified in the 2004 report. These include agricultural feedstock and chemicals; drugs and pharmaceuticals; medical devices and equipment; and research, testing and medical laboratories.	http://www.bio.org/local/battelle2006/
73	**NanoBusiness Alliance**	The NanoBusiness Alliance's Nanotechnology White Paper Library is a collection of links to more than 500 nanotechnology white papers, presentations and reports. As such, it comprises a portal to the nano industry as well as an indicator of trends and events in nano in its own right.	http://www.nanobusiness.org/

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74	**CompTIA**	CompTIA performs major research and frequent web-based surveys to inform members of industry trends. CompTIA research is primarily comprised of one-off surveys, some of which are repeated to establish some time series data sets.	http://www.comptia.org/sections/research/default.aspx
75	**FLCTT**	The Federal Labs Consortium for Technology Transfer reports annually on its progress in moving its 'inventories' of technology from Federal labs to the private sector. The report contains some data on the value of such transfers and future potential benefits. More anecdotal than statistical.	http://www.federallabs.org/pdf/Federal_T2_2006.pdf
76	**Logistics Management**	Logistics Management from Reed Business Information is a monthly magazine for supply chain professionals that offer industry news and analysis on the major forms of freight transportation, plus information on products, technologies, government regulations and international logistics. Reed's *Masters of Logistics* study has identified emerging trends in the field of logistics and provided benchmarking data on transportation and distribution.	http://www.logisticsmgmt.com/article/CA6373394.html
77	**ESA**	Entertainment Software Association publishes privately sourced date on sales and user profiles.	www.theesa.com/files/2005EssentialFacts.pdf -
78	**AIP**	The Statistical Research Center is the source of data on education and employment in physics, astronomy and allied fields. Examples of data collected include: 2005 Roster of Physics Departments, Roster of Astronomy Departments, Enrollments and Degrees Report, Latest Physics Trends, Women Physicists, and a Society Profile.	http://www.aip.org/statistics/
79	**FTTH Council**	FTTH has commissioned a private source to perform a census of North American fiber-to-the-home deployments for the past five years. Fiber-to-the-Home Council is a market development organization whose mission is to educate, promote, and accelerate FTTH.	http://www.ftthcouncil.org/?t=143&||web_records::_R_CategoryID=2
80	**RIA**	Established in 1974, RIA is the only trade group in North America organized exclusively to promote the use of robotics. The Association collects and reports market statistics each quarter based on actual totals provided confidentially by RIA member companies, which is estimated to represent more than 90% of the robotics market activity in North America.	http://www.roboticsonline.com/public/articles/articles.cfm?cat=201
81	**API**	ACCESS*API™ is an online subscription service that provides industry statistics to both API members and non-members. Highlights include: a weekly bulletin of refinery inputs, production, imports and inventories; a monthly inventory report of natural gas liquids; current and historical environmental data; and an annual report which is the only long-term source of details on U.S. drilling expenditures.	http://accessapi.api.org/accessapi/index.html

Appendix E - Private Sector Indicators Data Base of Sources with Descriptions – page 11

89	CAPS	CAPS: Center for Strategic Supply Research has developed core benchmarking information for a series of basic key performance indicators. It does this by maintaining links to industry groups to collect fresh information and data for analysis and publication in its Cross-Industry Benchmarking Report. CAPS captures enough information to report out twenty (20) cross-industry benchmarks on a regular basis. CAPS Research is a non-profit organization whose mission is to help organizations achieve competitive advantage by providing them with leading-edge research and benchmarking information to support the evolution of strategic purchasing and supply management.	http://www.capsresearch.org/benchmarking/crossindustry.htm
90	OGJ - Haverdata	The OGJ Energy Database was developed and is maintained by the staff of the Oil & Gas Journal Energy Database and is offered in conjunction with Haver Analytics. The Database includes information in the following major categories: Drilling and exploration, Production, Reserves, Refining, Demand/consumption, Financial and investment, Transportation, and Offshore energy.	http://www.pennwellpetroleumgroup.com/resourcecenter/haver.cfm
91	NRC	The National Recycling Coalition has conducted a groundbreaking study of the nation's recycling and reuse industry. The study provides information to understand the importance of the recycling and reuse industry to the US economy. Also supports the Electronics Recycling Initiative.	http://www.nrc-recycle.org/resources/rei/studyresults.htm
92	ARA	Most recent ARA statistical data regarding the automotive recycling industry. Data compiled from a 1997 survey by the private consulting firm, Axiom Research Company and Automotive Recycling: Your Car's Afterlife (2-13-2006).	http://www.a-r-a.org/content.asp?pl=505&contentid=436
93	ETDE	ETDE World Energy Base is an Internet tool for disseminating the energy research and technology information that is collected by the International Energy Administration. It offers the ability to search through close to 400k research papers on energy on a topical basis. As such, it enables the study of innovation in energy through direct and indirect means. ETDE is a quango funded by the European Community.	http://www.etde.org/
94	ESTA	Now in its sixth year, the Market Research Program for Manufacturers collects quarterly sales data which is designed to provide manufacturers around the world with accurate market information they can use in business planning, product development, charting trends, obtaining financing, and valuing their business.	http://www.esta.org/research/marketResearch.html

Appendix E - Private Sector Indicators Data Base of Sources with Descriptions – page 12

95	RFA	Organized in 1981, RFA serves as the voice of the ethanol industry, providing important industry data. Compiles and Publishes Ethanol industry statistics including: Historic U.S. Fuel Ethanol Production, Ethanol Industry Overview, 2006 Monthly U.S. Fuel Ethanol Production/Demand, U.S. Fuel Ethanol Industry Plants and Production Capacity, U.S. Fuel Ethanol Demand, Fuel Ethanol Use By State, Annual World Ethanol Production by Country, U.S. Fuel Ethanol Imports by Country, Ethanol Prices.	http://www.ethanolrfa.org/industry/statistics/

Appendix F - Scored and Prioritized Database of Combined Public and Private Indicators - ranked and sorted by IVS team

Global and National Indicators – Page 1

	Innovation Vital Signs Project			Innovation Vital Signs Project	
	Innovation Indicator Scoring Sheet				
	Consolidated Project Team Scores			Consolidated Project Team Scores	
Sub-Category Type	GLOBAL Indicator Family	Source of Indicators	Sub-Category Type	NATIONAL Indicator Family	Source of Indicators
	GLOBAL Indicators - highest ranked within those examined			NATIONAL Indicators - highest ranked within those examined	
	R&D	257		**R&D**	358
RDExp	4.3.01 Total expenditure on R&D	IMD	RDExp	U.S. R&D expenditures, by performing sector and source of funds: 1953–2004	NSF S&T
RDExp	4.3.04 Business expenditure on R&D	IMD	RDExp	U.S. basic research expenditures, by performing sector and source of funds: 19	NSF S&T
			RDExp	R&D expenditures by source of funds: 1990–2004	NSF S&T
			RDExp	Gross domestic expenditure on R&D	UK Comp
	Talent	213		**Talent**	422
SciEng	7 Total researchers (FTE) and percapita (IMD)	MSTI OECD	LabFor	Percentage of the population with higher education	Norw S&T
SciEng	8 Total researchers per thousand total employment	MSTI OECD	LabFor	Population with tertiary education (% of 25-64 age class)	Reg MLP
			LabFor	FIGURE 58: Adult population aged 25–64 years by highest education (tertiary),	NZ Indic
			SciEng	R&D full time equivalent per 1 000 capita	Norw S&T
			SciEng	R&D employees (full-time equivalent per 1 000 employees)	Reg MLP
			SciEng	Researchers per 1000 labor force	CanPerf
	Capital	250		**Capital**	48
BusInv	Gross Capital Formation as % of GDP (Average), 1995-2004 (DDP) World Ba	WB Kam	VenCap	Federal Small Business Innovation Research funds, by phase: 1990–2003	NSF S&T
BusInv	D.1. Investment in ICT equipment and software .	OECD STI	VenCap	Venture capital disbursements, by stage of financing: 1994–2004	NSF S&T
BusInv	ICT Expenditure (%GDP)	EIS	VenCap	SBIR awards and funding: 1983–2003	NSF S&T
VenCap	A.15. Venture capital and (IMD)	OECD STI	VenCap	U.S. venture capital disbursements, by industry: 1999–2004	NSF S&T
VenCap	Early-stage venture capital (% of GDP)	EIS			
Equity	3.3.10 Stock markets	IMD			
FinAsset	3.3.05 Investment risk	IMD			
	Networks	51		**Networks**	35
Collab	Innovative SMEs co-operating with others (% of all SMEs)	EIS	Collab	New international technology alliances by membership: 1980–2003	NSF S&T
Commun	Broadband penetration rate (number of broadband lines per 100 population)	EIS	Collab	Industrial technology alliances registered under National Cooperative Research	NSF S&T
Computer	4.2.08 Computers per capita	IMD	Collab	Worldwide industrial technology alliances and those with at least one U.S.-own	NSF S&T
Internet	D.9. Internet use by businesses .	OECD STI	Collab	Federal laboratory CRADAs: FY 1987–2003	NSF S&T
Internet	Internet users: Internet users are people with access to the worldwide network.	IndDev Rep			
Internet	4.2.10 Internet costs	IMD			
Internet	4.2.12 Broadband costs	IMD			

Appendix F - Global and National Indicators – Page 2

	Innovation Vital Signs Project			**Innovation Vital Signs Project**	
	Innovation Indicator Scoring Sheet				
	Consolidated Project Team Scores			Consolidated Project Team Scores	
Sub-Category Type	**GLOBAL Indicator Family**	Source of Indicators	Sub-Category Type	**NATIONAL Indicator Family**	Source of Indicators
	GLOBAL Indicators - highest ranked within those examined			**NATIONAL Indicators - highest ranked within those examined**	
	Management	12		**Management**	1
Manage	3.4.06 Shareholder value	IMD	Manage	Business executive perceptions of quality of management	UK Comp
Manage	3.4.07 Customer satisfaction	IMD			
Manage	3.4.08 Entrepreneurship	IMD			
	Product Development	1		**Product Development**	0
ProdDev	Firm-level technology absorption	GCI Indx			
	Efficiency	2		**Efficiency**	4
			Supply	FIGURE 66: Availability of competent senior manager	NZ Indic
	Process	69		**Process**	77
Organiz	iii) Number of companies with co-operation arrangements on innovation activities	InnovPolFora	Supply	Table 10 Use of Knowledge Obtained From R&D Carried Out Overseas	NZ Innov
OthrProc	Figure 1: Early-Stage Entrepreneurial Activity by Country and GDP	GEM Monitr	Supply	Table 11 R&D and Innovation Expenditure	NZ Innov
OthrProc	Figure 5: U.S. Entrepreneurial Trends	GEM Monitr	Supply	Table 12 Intensity of Investment in Innovation	NZ Innov
OthrProc	(2) Business' assessment of the quality of research. WEF (2001).	InnovPolFora			
Production	(2) Business' Assessment of the quality of collaboration with Universities in R&D	InnovPolFora			
	Output	51		**Output**	26
Rev	Sales of new-to-market products (% of total turnover)	EIS	NewProd	5.07 Number of Innovative Products or Services, by Industry	NZ Innov
Rev	Sales of new-to-firm not new-to-market products (% of total turnover)	EIS	NewProd	Table 2 Number of Innovations Introduced	NZ Innov
Rev	Royalty and License Fees Payments, $ millions, 2004 (DDP)	WB Kam	NewProd	Proportion of Total Sales from Innovations Introduced	NZ Innov
Productivity	3.1.01 Overall productivity (PPP)	IMD	OthrOutpt	9.01 Outcomes of Innovation Activity	NZ Innov
			OthrOutpt	9.02 Outcomes of Innovation Activity, by Sector	NZ Innov
	Impact	113		**Impact**	89
Employ	Exports of high technology products as a share of total exports	EIS	Employ	Employment in high-technology establishments as share of total employment, I	NSF S&T
Employ	Employment in medium-high and high-tech manufacturing (% total workforce)	EIS	Employ	Science and technology employment: 1950–2000	NSF S&T
OthImp	9. Share of innovative enterprises (percent of all manufacturing enterprises)	OSLO Innov	OthImp	Leading indicators of technological competitiveness: 2005	NSF S&T
OthImp	10. Share of innovative enterprises (percent of all services enterprises)	OSLO Innov	Trade	U.S. trade in advanced technology products: 2000–04	NSF S&T

Appendix F - Global and National Indicators – Page 3

Sub-Category Type	Innovation Vital Signs Project Innovation Indicator Scoring Sheet Consolidated Project Team Scores GLOBAL Indicator Family	Source of Indicators	Sub-Category Type	Innovation Vital Signs Project Consolidated Project Team Scores NATIONAL Indicator Family	Source of Indicators
	GLOBAL Indicators - highest ranked within those examined			**NATIONAL Indicators - highest ranked within those examined**	
	Macroeconomy	**87**		**Macroeconomy**	**63**
Fiscal	1.1.12 Real GDP Growth	IMD	Employ	FIGURE 7: Real median and average hourly earnings	NZ Indic
GDP	A. Gross Domestic Product (million current PPP $)	MSTI OECD	GDP	FIGURE 3: Real GDP per capita, 2003	NZ Indic
GDP	Gross Domestic Product (GDP) Per Capita, 2005 (international current PPP $) (	WB Kam	GDP	FIGURE 4: Gross national income per capita, 2003	NZ Indic
Inflat	C. Recent inflation rate	Econ Freedm	GDP	FIGURE 5: Real GDP per capita growth	NZ Indic
Interest	B. Implicit GDP Price Indices	MSTI OECD	GDP	Real Gross Private Domestic Investment	CEA
			Interest	FIGURE 68: Real interest rates	NZ Indic
	Policy	**109**		**Policy**	**4**
TaxPol	2.2.08 Corporate tax rate on profit	IMD			
Regul	Number of procedures required to start a business	GCI Indx			
Regul	Time required to start a business (hard data)	GCI Indx			
TradePol	Prevalence of trade barriers	GCI Indx			
TradePol	Foreign ownership restrictions	GCI Indx			
IntelProp	Intellectual property protection	GCI Indx			
OthPolicy	Rule of Law, 2005 (Governance Indicators, World Bank) Several indicators whicl	WB Kam			
	Infrastructure	**146**		**Infrastructure**	**55**
Freedom	A. Judicial independence: the judiciary is independent and not subject to interfe	Econ Freedo	OthInfra	FIGURE 76: Overall infrastructure quality	NZ Indic
LegalSys	4.3.19 Intellectual property rights (and Economic Freedom Index)	IMD	Environ	Quality of environmental governance	CanPerf
			OthInfra	Openness to competition index	CanPerf
			OthInfra	Innovation Composite Rank	CanPerf
	Mindset	**17**		**Mindset**	**48**
PubUnder	4.3.14 Youth interest in science	IMD	InfoSour	Leading source of information about science and technology, by respondent ch	NSF S&T
Entrepr	(1) Business' assessment of whether buyers are knowledge-able and demandin	InnovPolFora	PubUnder	Level of public interest in science and technology issues: Most recent year	NSF S&T
			PubUnder	Feeling informed about selected policy issues: Selected years, 1979–2004	NSF S&T
			PubUnder	Correct answers to specific science literacy questions, by country/region: Most	NSF S&T
	Total Global Indicators	**1372**		Total National Indicators	**1230**

Appendix F - Regional and Enterprise Indicators – Page 1

	Innovation Vital Signs Project			Innovation Vital Signs Project	
	Consolidated Project Team Scores			Consolidated Project Team Scores	
Sub-Category Type	**REGIONAL Indicator Family**	Source of Indicators	Sub-Category Type	**ENTERPRISE Indicator Family**	Source of Indicators
	Regional Indicators - highest ranked within those examined			**Enterprise Indicators - highest ranked within those examined**	
	R&D	79		**R&D**	2
IntProp	Patents per Capita	SilcVal Indx	RDExp	Indicator VII.1: Total R&D expenditure and business expenditure on R&D as %	EU Benmk E
RDExp	18 R&D per capita 2002	ASTRA			
RDExp	6 Total Federal expenditures, 2002 (millions of dollars)	ASTRA			
RDExp	18 Industry R&D, 2002 (millions of dollars)	ASTRA			
RDExp	AcademicR&D per capita	ASTRA			
RDExp	Public R&D expenditure (% of GDP)	Lazio Reg			
RDExp	Business expenditure on R&D (% of GDP)	Lazio Reg			
	Talent	151		**Talent**	6
EdExp	State Appropriations for Higher Education per capita	StateMilk	LabFor	Indicator VI.1: Tertiary graduates per 1000 population, aged 20 to 29, (2001-200	EU Benmk E
HighEd	Bachelor's Degree or Greater	StateMilk	SciEng	Indicator VI.2: Graduates in science and technology per 1000 population, aged	EU Benmk E
HighEd	Advanced Degree or Greater	StateMilk	LabFor	Indicator VI.3: Active population participation in lifelong learning (2002 - 2003)...	EU Benmk E
HighEd	PhD Degrees	StateMilk			
HighEd	Number of Students in Science & Engineering	StateMilk			
K-12	Average Verbal SAT Scores	StateMilk			
K-12	Average Math SAT Scores	StateMilk			
	Capital	58		**Capital**	36
Equity	Initial Public Offerings	Wash Indx	VenCap	Indicator I.4: Number of business angel networks (1999-mid 2004) . 21	EU Benmk E
VenCap	3 Number of SBIR awards, 1999-2002 (and Wash Index)	ASTRA			
VenCap	Venture Investment by Region	Wash Indx			
VenCap	Venture Capital	SilcVal Indx			
VenCap	SBIR Awards (Wash Index)	StateMilk			
	Networks	43		**Networks**	5
Collab	6 Businesses Created from University R&D (# of spin-outs per $1 billion spent) :	ASTRA			
Collab	Number of Business Incubators	StateMilk			
Computer	Households With Computers	StateMilk			
Internet	The number of commercial Internet domain names (".com") per firm	StNewEc			
Internet	Percentage of households with internet connection (and ArkKnow)	HKCreativy			

Appendix F - Regional and Enterprise Indicators – Page 2

	Innovation Vital Signs Project			**Innovation Vital Signs Project**	
	Consolidated Project Team Scores			Consolidated Project Team Scores	
Sub-Category Type	**REGIONAL Indicator Family**	Source of Indicators	Sub-Category Type	**ENTERPRISE Indicator Family**	Source of Indicators
	Regional Indicators - highest ranked within those examined			**Enterprise Indicators - highest ranked within those examined**	
	Management	0		**Management**	20
			Manage	New ideas threaten existing product lines Lack of rewards for creative behaviour	FujitIndx
	Product Development	0		**Product Development**	37
			ProdDev	Number of approved patents over the last year	EC Intang
			ProdDev	Number of patents and patent citations (and EC intangibles)	KapNorTang
			ProdDev	Time and money to develop processes	EC Intang
	Efficiency	0		**Efficiency**	3
			Production	Reduce Costs	FujitIndx
	Process	11		**Process**	206
Organiz	Enterprises innovating in-house, 1998-2000 (% of total)	Lazio Reg	OthrProc	Speed in the launching of the new product	NZ Innov
CustRel	Percentage of business receipts from selling goods, services or information thro	Creativityy	OthrProc		
	Output	27		**Output**	82
NewEnt	New Company Creation	Wash Indx	MarShar	Develop new regional/ global markets	FujitIndx
OthrOutpt	Value added of SMEs as percentage of GDP	HKCreativy	MarShar	Define new market segments	FujitIndx
			NewProd	Table 2 Number of Innovations Introduced Number of launched products •Num	NZ Innov
			Rev	Proportion of Total Sales from Innovations Introduced	NZ Innov
			Rev	Table 24 Proportion of Total Sales from Exports and Table 23 Proportion of Exp	NZ Innov
	Impact	146		**Impact**	4
ClustDev	Technology-intensive employment as a percentage of total employment	S. Innov Indx	ClustDev	Indicator V.1.a: Gross-birth rates of enterprises (2000-2001)... 48	EU Benmk E
Employ	1 High Tech Jobs Gained/Lost in State 1998-2003	ASTRA	ClustDev	Indicator V.1.b: Net-change of enterprise population* (birth rate minus death rat	EU Benmk E
Income	8 Personal income per capita, 2004 (dollars) and Real Per Capita Income (S. V	ASTRA	StockVal		EU Benmk E

Appendix F - Regional and Enterprise Indicators – Page 3

Innovation Vital Signs Project Consolidated Project Team Scores			Innovation Vital Signs Project Consolidated Project Team Scores	
REGIONAL Indicator Family	Source of Indicators	Sub-Category Type	ENTERPRISE Indicator Family	Source of Indicators
Regional Indicators - highest ranked within those examined			Enterprise Indicators - highest ranked within those examined	
Macroeconomy	0		**Macroeconomy**	2
		Inflat	Indicator IV.3: Comparative price levels (1996-2002)........ 42	EU Benmk Er
Policy	2		**Policy**	1
Tax Burden	Wash Indx	TaxPol	Number of new laws on taxes, excises, and duties	DE IntCap
Infrastructure	61		**Infrastructure**	4
Enumerated data about HK's protection of intellectual property rights	HKCreativiy	LegalSys	Legal Rights Index	EU Benmk Er
Number of new buildings designed	HKCreativiy			
Home A f f o rd a b i l i t y and Housing Affordablity (Wash Index)	SilcVal Indx			
	Wash Indx			
Mindset	40		**Mindset**	5
Value placed on creative activity	HKCreativity	Entrepr	"The Wish to Own One's Own Business"	DKFora
Value placed on school-aged children's creative activity	HKCreativiy			
Total Regional Indicators	613		Total Enterprise Indicators	413

Appendix F - Private Sector Indicators – Page 1

Sub-Category Type	Innovation Vital Signs Project Consolidated Project Team Scores PRIVATE SECTOR Indicator Family	Source of Indicators	
	Private Sector Indicators - highest ranked within those examined		
	R&D	*	
R&D - IntPro	Licensing Survey	AUTM - Association of University Technology Managers	
	Talent	*	
LabFor	Statistics at a Glance	AIP - American Institute for Physics	
LabFor	Growing The Nation's Biotech Sector: State Bioscience Initiatives 2006	BIO - Biotechnology Industry Organization	
SciEng	Engineering College Profiles and Statistics - Engineering and Engineering Tech	ASEE - American Society for Engineering Education	
SciEng	CRA Taulbee Survey	CRA - Computing Research Association	
	Capital	*	
FDI, BusInv	Hardware Technology Spending Survey: North America And Europe, Software T	Forrester Research	
FinAsset	Commercial Real Estate in a Flat World: The Implications of Economic Globaliz	NAIOP - National Association of Industrial and Office Properties	
Multiple	Thomson features solutions in the form of information on the following industries	Thomson Financial	
VenCap	Venture Capital Yearbook - Industry statistics for the past twenty years, includi	NVCA National Venture Capital Association	
VenCap	VentureSource	Venture One	
	Networks	*	
Commun	Publishes The Source: Newspapers by the Numbers	NAA - Newspaper Association of America	

Appendix F - Private Sector Indicators – Page 2

Sub-Category Type	Innovation Vital Signs Project Consolidated Project Team Scores PRIVATE SECTOR Indicator Family	Source of Indicators
	Private Sector Indicators - highest ranked within those examined	
	Management	*
Manage	Experience Exchange Report - annual	BOMA - Building Owners and Managers Association
	Product Development	*
	Efficiency	*
	Process	*
Multiple	Dataquest	Gartner Group
Organiz	Series of ongoing client sponsored Benchmarking projects	RBA - Retail Benchmarking Association
Skills	State of IT Services Business	CompTIA - Computing Technology Industry Association
Supply	Point-of-sale (POS) and consumer panel market research	NPD
Supply	Cross-Industry Comparison of Standard Benchmarks	CAPS: Center for Strategic Supply Research
	Output	*
MarShar	Key Performance Indicators, Metrics and Benchmarks are available for a variety	Aberdeen Group
Multiple	TIA's 2007 Telecommunications Market Review and Forecast	TIA - Telecommunications Industry Association
Multiple	Chemical Economics Handbook; Business of Chemistry: Situation and Outlook	ACC - American Chemistry Council
NewProd	Plastics Machinery and Equipment Statistics Annual and Quarterly Reports	SPI - Society for the Plastics Industry
NewProdInt	World Semiconductor Trade Statistics (WSTS) - Semiconductor Industry Capa	SIA - Semiconductor Industry Association
Other	Optoelectronics Industry Market Data and Forecast Report	OIDA - OptoElectronics Industry Development Association
Other	Quarterly Robotics Industry Statistics	RIA - Robotics Industry Assocaition
	Impact	*
ClustDev	Wind Power Weekly, Global Wind Energy Market Report	AWEA - American Wind Energy Association
OthImp	Technology Review Highlights & SUPERMARKET Facts - Industry Overview	FMI - Food Marketing Institute
nter		

Appendix F - Private Sector Indicators – Page 3

	Innovation Vital Signs Project		
	Consolidated Project Team Scores		
Sub-Category Type	**PRIVATE SECTOR Indicator Family**	**Source of Indicators**	
	Private Sector Indicators - highest ranked within those examined		
	Macroeconomy	*	
nter			
	Policy	*	
	Infrastructure	*	
Health	Researches and publishes on Workforce Issues, Educational Programs, and m	ADA - American Dental Association	
Health	Trendwatch Chartbook	AHA - American Hospital Association	
Physical	Publish Industry Statistics - investment, subscribers, broadband deployment	NCTA - National Cable & Telecommunications Association	
	Mindset	*	
OthrMindset	Consumer Confidence, Help-Wanted Advertising, Help-Wanted Online, U.S. Lea	The Conference Board	
	* 96 indicators were cataloged for this phase of the project.		
	There are hundreds potentially available from myriad other sources that were not reviewed.		
	Total Private Sector Indicators	**96**	

Appendix G – Agenda for Innovation Vital Signs Workshop

Innovation Vital Signs Workshop

Washington, DC

April 26-27, 2007

In support of the Secretary of Commerce's Measuring Innovation in the 21st Century Economy Advisory Committee, this workshop is being held to explore innovation data currently collected and to identify possible data gaps.

Participants will be asked to consider:

1) what data is currently collected that could be used to improve our understanding of the innovative process? and
2) what are the economy-wide and sector-specific indicators that could be used to quantify innovation and/or its impacts?

The findings of the workshop will be consolidated and submitted to the Advisory Committee through the process outlined in the Federal Register Notice Request for Comments dated March 31, 2007.

Orientation Session

Carroll Square, 975 F Street, NW
Thursday, April 26, 2007

4:30 p.m. **Welcome & Introductions**

Moderator Egils Milbergs will welcome participants and introduce the purpose of the *Innovation Vital Signs Workshop* ("IVSW"). Participants will introduce themselves and share their interest in participating in the Workshop

5:15 **Objectives of the Workshop - a "Walk Through" of IVSW**

Overview of the agenda and expected outcomes of the IVSW in support of the goals of the Department of Commerce's Advisory Committee on Measuring Innovation

5:30 **Walk Through of the Workshop Process – The Innovation Cafe**

The workshop materials and group interaction process will be reviewed.

6:00 – 7:00 **Reception & Optional Dinner**

A reception and optional dinner will follow this orientation session

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Agenda for Innovation Vital Signs Workshop

Friday April 27, 2007

7:30 a.m. **Registration**

8:00 a.m. **Continental Breakfast**

8:30 a.m. **Opening Plenary Session**

Speaker: **The Hon. Robert Cresanti, Undersecretary for Technology Policy,**
U.S. Department of Commerce

8:45 a.m. **Panel Discussion: Explore Currently Collected Innovation Data, Including Economy-Wide and Sector-Specific Indicators, How to Include the Perspective of Small Companies and Entrepreneurs**

Panel Participants:

Michael Tavilla – John Adams Innovation Institute, Massachusetts Technology Collaborative
John Jankowski – National Science Foundation
Daryl Hatano – Semiconductor Industry Association

9:30 a.m. **'Exploring Current Innovation Data' Breakout Groups**

Topic: existing innovation indicators and are they up to the task of measuring innovation, either directly, indirectly, or through derivative measures that capture trends or changes in state? Discussion questions will be distributed to the individual groups. Groups will consist of teams of 4-6 with moderators and recorders identified for each discussion group.

10:00 a.m. **Harvest Answers from Each Group**

Record the Harvest from Panel I Breakout Groups

10:30 a.m. **Break**

10:45 a.m. **Panel II: What's Missing? Closing the Gaps and Identifying the 'Known Unknowns' about Innovation Indicators**

Panel Participants:

Kenan Jarboe – The Athena Alliance
Dr. Elias Carayannis – George Washington University
Dr. Robert Atkinson – The Information Technology and Innovation Foundation

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11:15 a.m. **'What's Missing' Breakout Groups**:

Topic: what types of information or indicators are needed for evaluating and quantifying innovation beyond those measures that are in common usage. Discussion questions will be distributed to the individual groups. Participants will be rotated to alternate tables for this exercise.

11:45 a.m. **Harvest Answers from Breakout Session**

Luncheon

The luncheon will be used as an opportunity to engage participants in an open discussion about innovation and its measurement within their organization, their industry, or their broader community of interest.

1:30 p.m. **Panel III: Speaker - Patricia Buckley, Executive Director, Department of Commerce's Advisory Committee on Measuring Innovation in the 21st Century Economy**

Opportunities and Challenges in Measuring Innovation – the need for innovation in measuring and reporting innovation.

2:00 **'Opportunities and Challenges" Breakout Group:**

Topic: given that understanding innovation is critical to our understanding of our transition to an information economy, what are suggested approaches to: understanding various types of innovation, identifying performers of innovative activities, aggregating official statistics with private data, improving the timeliness of data collection and reporting

Participants will be rotated to tables other than those they participated in during sessions 1 and 2 for this exercise.

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2:30 **Harvest Answers from Group Breakout**

3:00 **Afternoon Break**

3:15 **Closing Plenary Session**

General session with all participants involved will explore key points raised, and conclusions reached, during the day's discussions. The plenary will also consider and discuss ways to provide useful input to the Secretary of Commerce's Advisory Committee.

3:45 **Adjournment – and Informal Reception at Carroll Square**

For those who would like to join us, there will be a room available for continued discussion and interactions among participants and presenters.

WORKSHOP SPONSORS

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Candidate Innovation Vital Signs – by Framework Category

Definitions and Indicator Descriptions and Interpretations

Input Factors
1 – Research and Development
2 – Talent
3 – Capital
4 – Networks
Process Factors
5 – Management
6 – Product Development
7 – Efficiency
8 – Process Factors
Outcome Factors
9 – Output
10 – Impact
Context Factors
11 – Macroeconomic
12 – Policy
13 – Infrastructure
14 – Mindset

Appendix H is a summary overview of the candidate innovation vital signs that were identified during the course of this project. These vital signs are summarized and discussed in detail on the following pages. This has been done to provide added perspective on the nature of the information that is collected for these indicators, as well as offering an in-depth perspective on the uses of these indicators might be put to.

There is also discussion and analysis provided on potential derivative measures that might be developed from the basic vital signs that are presented.

The analysis and descriptions provided also list references and sources for the various data items presented for discussion and analysis. This is provided to summarize some of the key current issues in compiling data sources such as these. It also contains discussion of the latest efforts to improve and/or refine these measures, and as such, providing a summary of the state of the art for each of the indicators, and indicator categories reviewed below.

	Innovation Indicator	Definition	Derivative Measures	Interpretation and References
1.0	**R&D Expenditures**	**R&D expenditures are** the most commonly use indicator of innovation capacity and competitive advantage. This consists of the total expenditure on R&D by nationally resident companies, research institutes, university and government laboratories, etc. It excludes R&D expenditures financed by domestic firms but performed abroad. Three types of R&D activities are typically covered: basic research, applied research and development leading to new products, processes and services.	The main aggregate used for international comparisons is gross domestic expenditure on R&D (GERD). Derivative indicators include: • R&D as percentage of GDP • R&D per capita • R&D by performing sector and source of funds • Basic Research expenditures by performing sector and source of funds • R&D financed overseas • R&D by government defense and civilian agencies • R&D by performer such as universities, government labs, private sector, etc • R&D by discipline • R&D expenditures by state or region • R&D by broad social objective, such as health, environment, security, high performance computing, biotechnology, nanotechnology, etc • R&D expenditures classified by high, medium and low tech manufacturing and service sectors	Trends in the R&D expenditures are a popular measure of competitiveness, innovation and potential for future economic growth. However, empirical studies are not clear on the nature, causality and related factors of this correlation. EU has adopted the Lisbon Strategy that calls for increasing R&D expenditure to 3 per cent of GDP by 2010, two thirds of which should come from the business enterprise sector. The BEA is experimenting with treating R&D as an investment, not as a current expense, with the effect of boosting GDP growth estimates. For international comparisons of R&D and other expenditure indicators countries are also presented in million current PPP dollars or million 2000 dollars—constant prices and PPP. The *Frascati Manual—The Measurement of Scientific and Technological Activities: Proposed Standard for Surveys of Research and Experimental Development*—is the international standard developed by OECD for collecting and using R&D statistics. ***Sources***: NSF, OECD, World Bank, and UNESCO are major sources for R&D expenditure data.

	Innovation Indicator	Definition	Derivative Measures	Interpretation and References
1.0	Patents	**Patent statistics** are used as an indicator of the inventiveness of countries, regions, and firms as well as proxies for knowledge diffusion and how internationalized innovative activities are. Among the available indicators of R&D output, patent indicators are probably the most frequently used. There is no standard method of presenting indicators from patents. Methodological choices include: 1) **patent applications;** 2) **patents granted;** 3) **triadic patent family;** and 4) **international applications** using the Patent Cooperation Treaty (PCT) procedure. **1) Priority date** is the initial date of filing a patent application **2) Application date** is the date on which the patent office receives the necessary documents and filing fee **3) Publication date** is the date on which the patent is published. **4) Grant date** is the date when the patent office issues a patent to the applicant	• USPTO patents per million population • Triadic patent families per million population • Patents allocated to the country of the inventor, using fractional counting in the case of multiple inventor countries. A **triadic patent family** relates to patents applied for at the EPO and the Japanese Patent Office (JPO) and patents granted by USPTO by priority date to form patent families.	In the US a patent is awarded to the first person to make an invention regardless of who first files an application for that invention **(first to invent)** while in most countries the patent is awarded to the first person to file an application on that invention regardless of who was the first to invent **(first to file).** The US can be expected to be more dominant than other countries in these statistics due to a home advantage effect. OECD suggests patent time series should be computed with respect to the priority date, which is the earliest and therefore closest to the invention date. On average it takes three years for a patent to be granted at the United States Patent and Trademark Office (USPTO) and five years at the European Patent Office (EPO). **Sources:** Thomson ISI, *SCI* and *SSCI,* http://www.isinet.com/products/citation/; ipIQ, Inc.; and National Science Foundation, Division of Science Resources Statistics, special tabulations. OECD,
1.0	Scientific publications	Scientific publications are widely utilized as performance indictors of national science and innovation systems.	• **number of papers—**number of papers published during time period • **total citations—**number of citations received in time period • **citation impact—**number of citations received per paper published	**Bibliometrics** refers to statistical analysis of scientific publications and their citations. The **NSF** through its series of biennial Science Indicators Reports, **Science and Engineering Indicators,** publishes information on **science and engineering (S&E) articles**. This data source is derived from the Science Indicators database prepared specifically for the NSF by CHI Research, Inc. The Institute for Scientific Information (ISI) also known as Thomson

	Innovation Indicator	Definition	Derivative Measures	Interpretation and References
			• **percent cited papers—**number of papers cited during period divided by the number of papers published during period • **impact relative to world—** citation impact for country divided by citation impact for the world • **percentage papers in world—** number of papers for country divided by the total number of papers for the world • **percent cited relative to world—**percentage of cited papers Indicators can be further analyzed by field.	ISA produces a major statistical database—*National Science Indicators database*—on scientific papers and citations that reflect research performance by over 170 countries and covers 6,400 of the world's leading journals of science and technology. It is made available online through the Web of Science database, a part of the Web of Knowledge collection of databases. ***Sources*:** NSF, OECD
2.0	**Expenditure on tertiary education**	Measure of direct public and private expenditure in tertiary education institutions including expenditure on R&D.	• Gross Higher Education Expenditures • Related measures are expenditure per student and as a percentage of GDP. Some indicator reports disaggregate by public and private expenditures. • State appropriations for Higher education	A widely used indictor of investment in human capital. **Sources:** *Education at a Glance: OECD Indicators* is released annually by the OECD and compares country performance with up-to-date array of education performance indicators.
2.0	**Tertiary Education in Science and Technology**	A measure of the stock of human resources in science and technology (HRST). An innovation economy requires an increasingly educated, skilled and adaptable workforce. Highly skilled S&T human resources are necessary to support technology intense innovation and diffusion. The indicator specifically, measures supply of new S&E (science and engineering) graduates in the fields of life sciences,	• Overall percentage of population with higher education • Total S&E Graduates • S&E Graduates per 1000 population • S&E students enrolled in college by sex, race, ethnicity, family income and institution type. • First time entry rates into tertiary education	More countries are systematically tracking scientific, technical and engineering personnel deemed necessary for innovation and longer term economic growth. International comparisons of educational levels should be interpreted cautiously because of large differences in educational systems, access, and the level of attainment that is required to receive a tertiary degree. Indicator may cover everything from graduates of one-year diploma programs to PhDs. Graduates of one-year programs are of value to incremental innovation in manufacturing and in the service sector. Current US policy concern over

	Innovation Indicator	Definition	Derivative Measures	Interpretation and References
		physical sciences mathematics and statistics, computing engineering and engineering trades manufacturing and processing and architecture and building,.	• Full-time S&E graduate students by field, citizenship • S&E degrees award by degree level (associate, bachelor, masters, doctoral) and type • S&T graduates employed by characteristics, wage, type of institution	trends in foreign enrollment in tertiary education and intentions to stay in US or return to country of origin. International migration is important channel through which companies can access skills and talent, especially in knowledge-based sectors. The OECD developed "Canberra Manual" provides definitions of S&T human resources in terms of qualification (levels and fields of study) and occupation. HRST is defined as persons who have completed education at the third level in an S&T field of study or employed in an S&T occupation where the above qualifications are normally required. **Sources:** This indicator area is tracked by most global innovation and competitiveness reports. NSF maintains an extensive time series database and special tabulations on these indicators. NSF, World Bank, UNESCO

2.0	R&D personnel	**R&D personnel indicators** includes all persons employed directly on R&D, as well as those providing direct services such as R&D managers, administrators, and clerical staff. Overhead staff whose work indirectly supports R&D is excluded	• Total R&D personnel
			• R&D personnel per 1000 employees
			• R&D personnel by occupation, covering researchers, technicians and other supporting staff.
			• R&D personnel by the performing sector, including:
			  • Business
			  • Government
			  • Higher education
			  • Non-profit
				The unit for R&D personnel can be either full-time equivalent or head count. Both the national total of R&D personnel and the R&D personnel in each institutional sector can be broken down by type of activity, location (state or territory), socio-economic objective, and field of study.
				Source: NSF S&E Indicators has extensive database drawing on WebCASPAR and National Center for Education Statistics. OECD – Education at a Glance.

	Innovation Indicator	Definition	Derivative Measures	Interpretation and References
2.0	**Verbal and Math Proficiency**	Science and math proficiency is considered a core measure of the quality of K-12 education and an indicator of the competencies of the future workforce	Average math scores of students in 4.8.12 grade Average verbal scores of students in 4.8, 12 grades. Student characteristics of the above, by country, by school attribute.	The program for international student assessment (PISA) administered to 15 year olds in participating countries, measures math literacy, scientific literacy, problem solving and reading literacy. It is not a conventional school test. Rather than examining how well students have learned the school curriculum, it looks at how well prepared they are for life beyond school... The World Economic Forum Competitiveness report tracks quality of science and math education based on 1-7 scale with a sample countries responding to survey of whether math and science education lag far behind most countries or are among the best in the world. Extensive compilations of data in NSF S&E indictors. National Center for Education Statistics, National Assessment of Educational Progress (US Dept of Education), OECD education database, PISA international database
2.0	**Population completing secondary education.**	The indicator measures the qualification level of the population in terms of formal educational degrees. Provides a measure for the "supply" of human capital of that age group and for the output of education systems in terms of graduates.	The reference population is all age classes between 20 and 24 years inclusive	The level of education attainment is positively linked to entry into the labor market, income levels of individuals and access to higher education. They also have a markedly higher employment rate than persons with at most lower secondary education. However the quantity of graduates may have little to do with the quality and relevant skills of graduates. **Sources:** National Center for Education Statistics, OECD, NSF
2.0	**Participation in life-long learning**	This is an indicator of number of persons involved in life-long learning and the investment being made in continuing education and on-going competencies. Productivity, service quality and the rate of innovation are all improved by training. Continuous learning by workers enhances a firm's to cope with fast paced technological change and intense global competition. Activities that qualify as life learning include courses of relevance to the employment and general interest	Participation in life-long learning per 100 population aged 25-64)	An innovation economy is characterized frequently as a knowledge economy is in which individuals are continually learning new ideas and skills and participating in life-long learning activities. The ability to learn creates a more flexible and adaptable workforce and faster adjustments to economic and technological disruption. . It includes initial education, further education, continuing or further training, and training within a company, apprenticeship, on-the-job training, seminars, distance learning, and evening classes.

	Innovation Indicator	Definition	Derivative Measures	Interpretation and References
		courses, such as in languages or arts		
3.0	**Gross Capital Formation**	A measure of the new investment by enterprises in the domestic economy in fixed assets of the economy plus net changes in the level of inventories. Normally these assets are tangible assets, but in some cases they are intangible such as intellectual property (e.g. software). The main asset types are plant & machinery, equipment, vehicles, land-improvements and buildings.	• Gross Capital Formation • Gross Capital Formation % GDP • Capital Formation by type of asset, business sector	Investment in fixed assets is an important indicator of future economic growth, although not all types of investment contribute to future growth in the same way. Also, it is difficult to internationally compare capital goods purchased because characteristics of a capital good even with the same international brand and serial or model may actually differ from country to country because of variations in local conditions, climates, regulations or producer pricing and strategy. The characteristics of physical structures are also quite complex, variable and many times unique among countries. **Sources:** Detailed standard definitions of GFCF are provided by the United Nations System of National Accounts (UNSNA) and the IMF Balance of Payments system. The definitions used by the US Bureau for Economic Analysis for the National Income & Product Accounts (NIPA's) are very similar.
3.0	**(ICT) Investment in Equipment and Software**	**Information and communication technologies (ICT) Investment** indicators typically cover acquisition of equipment and computer software that is used in production for more than one year. ICT has three components: information technology equipment (computers and related hardware), communications equipment and software. Software includes acquisition of pre-packaged software, customized software and software developed in house.	• Total ICT Investment • ICT expenditures (% of GDP) • ICT per capita, employee, business sector	ICT has been the most dynamic component of overall investment activity and is considered by economists as a key driver of national economic growth and productivity. One disadvantage of this indicator is that it is ultimately obtained from private sources, with a lack of good information on the reliability of the data. Another disadvantage is that part of the expenditures is for final consumption and may have few productivity or innovation benefits. The system of national accounts can vary considerably by countries, especially in regard to the measurement of software investment, methods of depreciation, the breakdown by institutional sector and the length of time series. Expenditure on software has only

	Innovation Indicator	Definition	Derivative Measures	Interpretation and References
				recently been treated as investment in the national accounts, and methodologies vary greatly across countries.
3.0	**Angel Investment**	Measures activity of **angel investors who are** affluent individual that provide seed capital for business start-up. Angels typically invest their own funds, unlike venture capital funds that professionally manage pooled money.	• # of deals • $ invested in deals • Average size of deals • # of angel networks • Can be disaggregated by region, type of business, technology area.	Angel capital fills the gap in start-up financing between the "three F's" (friends, family, and fools) of seed capital and venture capital. Most traditional venture capital funds do not consider investments under US$1–2 million. Thus, angel investment is a common second round of financing for high-growth start-ups, and accounts in total for almost as much money invested annually as all venture capital funds combined. **Sources:** Angel Capital Association (US/CA). European Business Angel Network, UNH Center for Venture Research http://en.wikipedia.org/wiki/Angel_investor - note-0
3.0	**Venture capital**	Investment measure of specialized firms acting as intermediaries between primary sources of finance (such as pension funds, wealthy individuals or banks) and firms Management buyouts, management buy ins, and venture purchase of shares is excluded.	• Early-stage venture capital % of GDP • Venture Capital (% of GDP) • Venture capital by state or region • Cross border inflows and outflows by country of management and country of destination. • Venture capital by stage of financing: • **seed capital** is provided to research, assess and develop an initial concept • **start-up financing** is	Data on venture capital are collected by national or regional venture capital associations from their members. Statistics only capture formal venture capital (provided by specialized intermediaries). As business angels are excluded, international comparisons may be affected since in the United States business angels have tended to invest much more in new firms than venture capital funds. Not all funds managed by a venture capital firm operating in a given country are from investors in that country. **Sources:** National Venture Capital Association

	Innovation Indicator	Definition	Derivative Measures	Interpretation and References
			provided for product development and initial marketing. • **expansion financing** is provided for the growth and expansion of a company that is breaking even or profitable.	
3.0	**SBIR Funding**	Expenditure activity of the Federal government Small Business Innovation Research (SBIR) Program aimed at increasing the role of small firms (>500 employees) in federally supported R&D. Federal agencies set-aside a fixed percentage of R&D budgets for this purpose.	• Total SBIR Expenditures • # of SBIR awards • SBIR expenditures by Phase 1, 2 and 3. • SBIR expenditure as % of venture capital • SBIR expenditures by region • SBIR by technical field	Much of the growth in the U.S. economy has been in technology-based industries whose origins can be traced to government-funded research and support. SBIR program can help drive commercialization of research and technical ideas. Companies can apply for a Phase I SBIR grants to assess scientific and technical merit or projects and feasibility of an idea. Phase II grants develop the idea further. In Phase III, the innovation must be brought to market with private sector investment
3.0	**Initial Public Offering (IPO)**	An IPO (initial public offering) is a first and one-time only sale of publicly tradable stock shares in a company that has previously been owned privately.	• # of IPO's • $ value of IPO's • IPO's by company, country, region, business sector, technology, offering price	IPO's are often smaller, younger companies seeking capital to expand their business. NASDAQ is a popular market for raising capital through IPO's. The IPO of a company serves as a significant liquidity opportunity for early investors, including founders and the Venture Capital investors. The IPO procedure is specified by the U.S. Securities and Exchange Commission (SEC). The SEC maintains a publicly available, searchable database on IPO and other corporate information that is required to be filed with the SEC. The database is called EDGAR (for: Electronic Data Gathering, Analysis, and Retrieval). **Sources**: Thomson Financial, Ernst and Young Global IPO Report
3.0	**Stock Market Value**	Valuation of enterprises reflected by stock price based on the outlook for earnings and market value of assets. Can also be measured in terms of price/earnings (P/E) ratios.	• Aggregate value of corporate equities • % change in valuation • Value and rate of change by sector, business, country, region, R&D intensity and other innovation variables.	There is growing body of literature on how financial markets value innovation and knowledge assets of publicly traded firms. The conclusion is that the market value of corporations is strongly related to its knowledge assets, and intangible assets such as intellectual property, branding, relationships are important indicators driving equity value beyond what is formally on income and balance sheets and usual

	Innovation Indicator	Definition	Derivative Measures	Interpretation and References
				R&D measures. The movements of the prices in a market or sector can be captured in price indices of which there are many. The most regularly quoted are the US Dow Jones Industrial Average, S&P 500 and Wilshire 5000, the British FTSE 100, the French CAC 40, the German DAX, the Japanese Nikkei 225 and the Hong Kong Hang Seng Index. Other indexes with regional or sector interest include the Russell Global 1000 and Biotech Index. Such indices are calculated on the basis of total market capitalization weighted to reflect contribution of the stock to the index.
3.0	**R&D Tax Incentives**	In the US this would refer to the R&D tax credit and other forms including write-off of current R&D and other allowances.	• Value of R&D subsidy	This indicator represents policy used by governments of many countries as an indirect way of encouraging business R&D expenditure, in contrast to direct financial support for business R&D. OECD has developed and used a 'B index methodology' to measure and benchmark the net tax treatment of R&D in OECD countries. **Sources:** Data on R&D tax incentives are found in OECD publications such as the: • *Science, Technology and Industry Scoreboard* • *Science, Technology and Industry Outlook*.
4.0	**Computers and Broadband Deployment**	Measures of business and home access to computers, internet and high-speed broadband networks. Broadband corresponds to fast Internet, and includes several technologies (DSL, Cable, wireless, dedicated lines, optical fiber, etc)	• # of broadband connected businesses and homes • Broadband penetration rate (number of broadband lines per 100 population) • # of computers per capital • Internet use by business • Internet costs • Broadband costs • # of internet domain names	The US, Europe and developing nations give high priority to expanding access to high speed internet connections as critical to deployment of advanced internet applications, digital services, networking and collaborative innovation. It is a key measure of innovation capacity of the economy and is a driver of productivity. However, broadband definitions vary widely. "Broadband" is commonly understood as high speed, always-on communication links that can move large files much more quickly than a regular phone line. Broadband Internet access is available over a variety of platforms including, cable modems, digital subscriber lines (DSL), wireless, satellite, power line (BPL), fiber optics to the home (FTTH), or Long Reach Ethernet (LRE). Because telecommunications is one of the most intensely regulated industries and regulatory policy significantly affects the pace and nature of broadband

	Innovation Indicator	Definition	Derivative Measures	Interpretation and References
				infrastructure investment. **Sources:** NSF, OECD, World Bank
4.0	**Technology Alliances**	Measures of the number of R&D technology alliances being formed to develop and subsequently commercialize new technologies.	• # of technology alliances registered with Dept of Justice • # of alliances worldwide by country • Share of industrial alliances by field of technology	**Sources:** NSF funds two databases on technology alliances: the Cooperative Research (CORE) database and the Cooperative Agreements and Technology Indicators database, Maastricht Economic Research Institute on Innovation and Technology (CATI-MERIT). CORE records U.S. alliances registered at the U.S. Department of Justice pursuant to the National Cooperative Research and Production Act (NCRPA). CATI-MERIT covers domestic and international technology agreements and is based on public announcements, tabulated according to the country of ownership of the parent companies involved
4.0	**Federal CRADA's and Technology Transfer**	Cooperative Research and Development Agreements (CRADA's) are measures of federal laboratory-industry collaboration, technology transfer and partnerships.	• # CRADAs • # CRADAs by agency, laboratory, technology field • Other related indicators include: • Invention disclosures, patents and invention licenses.	CRADAs are one of several technology-based industry government collaboration tools available. Federal laboratories entering into CRADAs with industrial firms and other organizations may share personnel, services, or facilities (but not funds) as part of a joint R&D project with the potential to promote industrial innovation consistent with the agency's mission. Simple CRADA counts offer a limited but illustrative window for viewing overall trends and federal agency participants. Related metrics of invention disclosures, patents, and invention licenses. Differences R&D funding structures and character of work across agencies may influence the distribution and comparability of these indicators. CRADA and other technology transfer activities are highly concentrated. DOD and DOE. ***Sources:*** Data on these and other federal technology transfer activities are available from NSF and the Department of Commerce, pursuant to federal

	Innovation Indicator	Definition	Derivative Measures	Interpretation and References
				technology transfer statutes.
4.0	**University Spin-Outs**		• # university patent disclosures • # university licensing deals, exclusive and non-exclusive • $ licensing revenues • # companies created • $ venture capital invested in spin-outs • Efficiency of above can be measured by output generated by R&D expenditure. Data can also be broken out by institution, state, region and field of technology	**The Bayh-Dole University and Small Business Patent Act (**1980) established a uniform government-wide policy and process for government grantees and contractors to retain title to inventions resulting from federally supported R&D and stimulated invention disclosure, tech transfer and patent licensing activities at universities who were prime recipients of federal R&D funds. Metrics used to measure this activity and outputs may not be appropriate indicators for effectiveness or quality. Counting the number of spin-outs created and license deals executed per unit of R&D expenditure overlooks the importance of quality. It has been argued that narrowly defined metrics encourage universities to focus on negotiating licensing deals with industry or entrepreneurs, and may artificially increased the number of spin-out ventures. Channeling resources into licensing revenue may result in promising technologies to be prematurely spun-out with little change of attracting venture funding and being sustainable, thus failing to make a significant economic contribution. ***Sources:*** U.S. PTO, *Technology Assessment and Forecast Report: U.S. Colleges and Universities, Utility Patent Grants,* and NSF special tabulations, Association of University Technology Managers, *AUTM Licensing Survey* ASTRA
4.0	**Innovative SMEs co-operating with others**	Measures cooperative arrangements of innovating SMEs. Firms with co-operation activities are those that had any co-operation agreements on innovation activities with other enterprises or institutions in the three	• Innovative SMEs cooperating with others (% of total number of SMEs)	This indicator measures the degree to which SMEs are involved in innovation co-operation. Complex innovations, in particular in ICT, often depend on the ability to draw on diverse sources of information and knowledge, or to collaborate on the development of an innovation. This indicator measures the flow of

	Innovation Indicator	Definition	Derivative Measures	Interpretation and References
		years of the survey period. (*Community Innovation Survey*)		knowledge between public research institutions and firms and between firms and other firms. The indicator is limited to SMEs because almost all large firms are involved in innovation co-operation. **Sources**: EU Community Innovation Survey.
6.0	**Enterprise innovation processes**	Measures on the characteristics of innovation activity at enterprise level based on the Community Innovation Survey (CIS).	CIS indicators cover: • Product, process, ongoing and abandoned innovation • Innovation activity and expenditure • Intramural research and experimental development (R&D) • Effects of innovation • Public funding of innovation • Innovation co-operation • Sources of information for innovation • Hampered innovation activity • Patents and other protection methods • Organizational and marketing Indicators can be disaggregated at the level of country, type of innovator, size-classes (employees), unit (percentage and absolute value), classification of economic activities (in accordance with NACE Rev. 1) and innovation indicators.	The *Community Innovation Survey* is the best available cross country data set carried out on a two yearly basis covering EU Member States, candidate countries, Iceland and Norway. The guidelines for developing enterprise level indicators have been codified by the OSLO Manual, most recently in its third edition 2006. The latest OSLO manual gives greater recognition to non-technological innovation such as organizational structures (business models), management practices and marketing innovation. The indicators that are comparable across the European Community are derived from European Community Innovation Survey. The US has no comparable innovation survey. The EC survey focuses on firm propensity to innovate and indicators related to sources of information, outcomes use of intellectual property and barriers to innovation. The most recently completed fourth survey (CIS-4) is a cross-sectional survey of all firms with over 10 employees in all 27 EU member states conducted in 2005 with over 60,000 respondents. The survey includes all manufacturing sectors and many service sectors. **Sources:** Data are available from the Eurostat New Cronos website

	Innovation Indicator	Definition	Derivative Measures	Interpretation and References
6.0	**Speed in Launching a New Product**	A measure of how quickly a new product or service is transformed from initial concept to market introduction.	• Time required for innovation stages of development • Cost reduction	For this measure to be credible it needs to be derived from a firm level performance system. Measures in this area are typically geared to production of tangible goods or services. The creation of economic value and wealth also lies in the creation, acquisition and exploitation of so-called intangibles. Competitive success requires a critical capacity to develop, manage, measure and control the flow of knowledge and intangibles. Our understanding of these processes is limited, and a major factor in this ignorance is the paucity of good data and disclosure guidelines on business intangibles.
8.0	**SMEs innovating in-house (% of SMEs)**	Sum of SMEs with in-house innovation activities. Innovative firms are defined as that that introduced new products or processes either 1) in-house or 2) in combination with other firms. This indicator does not include new products or processes developed by other firms.	• Total number of SMEs innovating in-house and as % of total SMEs. (Community Innovation Survey)	This indicator measures the degree to which SMEs that have introduced any new or significantly improved products or production processes. The indicator is limited to SMEs because almost all large firms innovate and because countries with an industrial structure weighted to larger firms would tend to do better. **Sources:** Community Innovation Survey
8.0	**Innovation expenditures by enterprises**	Measure of the total sum of total innovation expenditure for enterprises, in national currency and current prices. Innovation expenditures includes the full range of innovation activities: in-house R&D, extramural R&D, machinery and equipment linked to product and process innovation, spending to acquire patents and licenses, industrial design, training, and the marketing of innovations. (*Community Innovation Survey*)	• Aggregate innovation expenditure by business • Innovation expenditures (% of sales)	This indicator measures total innovation expenditure and as a percentage of total sales. Several of the components of innovation expenditure, such as investment in equipment and machinery and the acquisition of patents and licenses, measure the diffusion of new production technology and ideas. Overall, the indicator measures total expenditures on many activities of relevance to innovation. The indicator partly overlaps with the indicator on business R&D expenditures. **Sources:** Community Innovation Survey. No comparable US survey.
8.0	**SMEs who introduced an organizational innovation**	Measures small to medium sized enterprises who introduced an organizational innovation (% of SMEs)	Number or percent of SMEs who have either introduced: • "new or significantly improved knowledge management systems", • "a major change to the organization of work within their enterprise" or	The Community Innovation Survey mainly asks firms about their technical innovation, Many firms, in particular in the services sectors, innovate through other non-technical forms of innovation. Examples of these are organizational innovations. This indicator tries to capture the extent that SMEs innovate through non-technical innovation. **Sources:** Community Innovation Survey

	Innovation Indicator	Definition	Derivative Measures	Interpretation and References
			• "new or significant changes in their relations with other firms or public institutions". A 'Yes' response to at least one of these categories would identify a SME as having introduced an organizational innovation. (*Community Innovation Survey*)	
9.0	**New Products and Services Introduced**	Measures the introduction of products or services which are **new** to a business. Its characteristics or intended uses differ significantly from previously produced products or services. It does not include the selling of new products wholly produced and developed by other businesses.	• # of new products/services introduced • Type of innovating business by size and business sector • Source of innovation ideas by type of innovator • Type of innovative activity leading to new product or service • Ratio of R&D expenditures to total innovation expenditure for new product/service • Sources of innovation funding • Collaborative arrangements for development of new product/service • Export sales of new products and services • Intellectual Property receipts • Type and value of government funding support • Factors hampering innovative activity	Many of these indicators are adaptations of the EU Community Innovation Surveys such as Innovation in Zealand who conduct specialized country surveys. **Closely related indicators are:** **Significantly Improved Product/Service:** Is an existing product/service, whose performance has been significantly enhanced or upgraded. Purely aesthetic or minor modifications are not included. **New Production/ Manufacturing/ Delivery Process: i**ntroduction of new or significantly improved production technology or ways of delivering products. **Significantly Improved Production/Manufacturing/ Delivery Process:** significant changes to a business's existing processes which result in changes to the level of output, **New or Significantly Improved Service Process:** new or improved methods of supplying a service that improves the output, cost, quality or delivery of the service Numerous methodological issues are involved in attempting comparisons across national boundaries due to variances in data collection methods, sources, sample composition and definitions. Nevertheless, research in the area enterprise level innovative activity is expanding rapidly and becoming a rich source of metrics and analysis of innovation activity and outcomes. **Sources**: OECD, New Zealand Innovation, European Innovation Scorecard.

	Innovation Indicator	Definition	Derivative Measures	Interpretation and References
9.0	**Outcomes of Enterprise Innovation Activity**	Measures of the direct output and benefits gained by innovating enterprises	• Increased profitability • Increased product/service offering • Opened new or expanding market within country of operations • Opened new markets overseas • Replaced products being phased out • Improved efficiency • Reduced energy consumption • Reduced environmental impact • Met health, safety and other standards	These enterprise outcome indicators are an example of a country specific survey—Innovation New Zealand.
9.0	**Sales of new-to-market products**	Sum of total revenue of new or significantly improved products for all enterprises.	• Sales of new-to-market products • (% of revenue) Total revenues for all enterprises, in national currency and current prices.	This indicator measures the sales of new or significantly improved products, which are also new to the market, as a percentage of total sales. The product must be new to the firm, which in many cases will also include innovations that are world-firsts. The main disadvantage is that there is some ambiguity in what constitutes a 'new to market' innovation. Smaller firms or firms from less developed countries could be more likely to include innovations that have already been introduced onto the market elsewhere. **Source:** Community Innovation Survey
9.0	**Sales of new-to-firm products**	Sum of total revenue of new or significantly improved products to the firm but not to the market for all enterprises.)	• Sales of new-to-firm products (% of turnover) • Total revenue for all enterprises, in national currency and current prices. (Community Innovation Survey)	This indicator measures the revenue of new or significantly improved products to the firm as a percentage of total sales. These products are not new to the market. Sales of new to the firm but not new to the market products are a proxy of the use or implementation of elsewhere already introduced products (or technologies). This indicator is thus a proxy for the degree of diffusion of state-of-the-art technologies. **Source:** Community Innovation Survey

	Innovation Indicator	Definition	Derivative Measures	Interpretation and References
9.0	**New community trademarks**	A trademark is a distinctive sign, which identifies certain goods or services as those produced or provided by a specific person or enterprise. The Community trademark offers the advantage of uniform protection in all countries of the European Union on the strength of a single registration procedure with the Office for Harmonization.	• Number of new community trademarks per million population	The Community trademark gives its proprietor a uniform right applicable in all Member States of the European Union on the strength of a single procedure that simplifies trademark policies at European level. It fulfils the three essential functions of a trade mark at European level: it identifies the origin of goods and services, guarantees consistent quality through evidence of the company's commitment vis-à-vis the consumer, and is a form of communication, a basis for publicity and advertising.
9.0	**New community designs**	Number of new community designs. A registered Community design is an exclusive right for the outward appearance of a product or part of it.	• Number of new community designs per million population. • Outward appearance of a product or part of it resulting from the lines, contours, colors, shape, texture, materials and/or its ornamentation	A product can be any industrial or handicraft item including packaging, graphic symbols and typographic typefaces but excluding computer programs. It also includes products that are composed of multiple components, which may be disassembled and reassembled.
10.0	**Employment in high-tech manufacturing**	Number of employed persons in the medium high and high-tech manufacturing sectors. These include chemicals (NACE24), machinery (NACE29), office equipment (NACE30), electrical equipment (NACE31), telecommunications and related equipment (NACE32), precision instruments (NACE33), automobiles (NACE34) and aerospace and other transport (NACE35).	• Employment in medium-high and high-tech manufacturing (% of total workforce) • The total workforce includes all manufacturing and service sectors.	The share of employment in medium-high and high technology manufacturing sectors is an indicator of the manufacturing economy that is based on continual innovation through creative, inventive activity. The use of total employment gives a better indicator than using the share of manufacturing employment alone, since the latter will be affected by the hollowing out of manufacturing in some countries.
10.0	**Employment in high-tech services**	Measures employment in the high-tech services sectors including post and telecommunications (NACE64), information technology including software development (NACE72) and R&D services (NACE73).	• Employment in high-tech services (% of total workforce) • The total workforce includes all manufacturing and service sectors.	The high technology services go directly to consumers, such as telecommunications, and provide inputs to the innovative activities of other firms. The latter can increase productivity throughout the economy and support the diffusion of innovations, in particular those based on ICT.

	Innovation Indicator	Definition	Derivative Measures	Interpretation and References
10.0	**Trade in highly R&D-intensive industries and high technology industries**	**Highly R&D-intensive industries** are defined according to the *International Standard Industrial Classification* (ISIC) in and include: • aerospace industry • electronic industry • office machinery and computer industry • pharmaceutical industry • medical, precision and optical instruments, watches and clocks (instruments) industry	The OECD classification of manufacturing industries into **high technology**, **medium-high-technology**, **medium-low-technology and low-technology groups** can be used to generate indicators on industry employment or value added by technology intensity.	Data on **trade in highly R&D-intensive industries** are taken from the OECD *International Trade Statistics* database and have been converted from the Harmonized System (HS) and the Standard International Trade Classification. Data on **trade in high-technology industries** are taken from the OECD *International Trade Statistics* database. The conversion requires attributing each product to a specific industry. Because no detailed data are available for services at present, industry and product classification only concerns manufacturing industry. **Sources:** Data on technology trade are available from the OECD *Main Science and Technology Indicators Database,* an electronic data product of *Main Science and Technology Indicators*.
10.0	**High tech Exports**	Measures of high-tech exports, in national currency and current prices.	• Exports of high technology products as a share of total exports • Value of total exports, in national currency and current prices. High-tech exports include exports of the following products: aerospace; computers and office machinery; electronics; telecommunications; pharmaceuticals; scientific instruments; electrical machinery; chemistry; non-electrical machinery and armament	The indicator measures the technological competitiveness of a country and its ability to commercialize the results of research and development (R&D) and innovation in the international markets. It also reflects product specialization by country. High technology sectors are key drivers for economic growth, productivity and welfare, and are generally a source of high value added and well-paid employment. The Brussels European Council (2003) stressed the role of public-private partnerships in the research area as a key factor in developing new technologies and enabling the European high-tech industry to compete at the global level.
10.0	**Technology trade**	**Technology balance of payments** is a measure of commercial transactions related to exports and imports of technology consisting of money paid or received for the acquisition and use of patents, licenses, trademarks, designs, know-how and closely related technical services (including technical assistance) and for industrial R&D carried out abroad.	TBP payments as a percentage of gross domestic expenditure on R&D (GERD) gives an indication of the share of imported technology in domestic R&D efforts. TBP receipts relates to a country's exports of technology, which reflect its competitiveness in the international market for knowledge.	The technology performance of an economy is often measured by commercial transactions related to international technology transfers, and international trade and exports in the high-technology sector. Technology and international diffusion of technology are central to the changes running through the world economy. TBP records a country's exports and imports of technical knowledge and services. Although the TBP reflects a country's ability to sell its technology abroad and its use of foreign

	Innovation Indicator	Definition	Derivative Measures	Interpretation and References
				technologies, a deficit does not necessarily indicate low competitiveness. Most transactions also correspond to operations between parent companies and affiliates, which may create distortions in the valuation of the technology transfer. Thus, additional qualitative and quantitative information is needed to analyze correctly a country's deficit or surplus position. **Sources:** The **Technology Balance of Payments Manual (TBP Manual)**, released by the OECD in 1990, provides a definition of the types of transactions included in the TBP, and the characteristics of transactions and contracts.
10.0	Productivity	Productivity is a measure of how efficiently production inputs are used in an economy. P productivity is a major contributor to long-run economic growth and improved living standards. Productivity also provides a broad indication of the scope for non-inflationary increases in wages and salaries.Labor productivity is defined as GDP per hour worked. Multifactor or total factor productivity involves breaking down the growth of gross domestic product (GDP) into three components — the contribution of labor, the contribution of capital, and multi-factor productivity (MFP) which is calculated as a residual and characterized as a measure of innovation by prominent economists. Improving total factor productivity measures are a key priority in the US and Europe.	Productivity can be calculated at an aggregate national level as well as by business sector. **Labor productivity growth** can be calculated as the difference between the rate of growth of output or value added and the rate of growth of labor input. Value added is measured after deducting government real consumption of fixed capital (at constant prices) and real indirect taxes less subsidies. **Multifactor productivity** is the change in GDP that cannot be explained by changes in the quantities of capital and labor that are made available to generate GDP. MFP is sometimes described as 'disembodied technological progress'. It is the increase in GDP that is not 'embodied' in either labor or capital and comes from more efficient management of the processes of production—through better ways of using labor and capital, through better ways of	There are many different approaches to the measurement of productivity. Labor productivity measures are timelier and internationally comparable and suffer less from measurement errors than currently available multifactor productivity data. According to Dale Jorgenson existing official measures of Total Factor Productivity, generated by BLS, are not integrated with the national accounts. Also, the BLS industry-level measures of Total Factor Productivity are not consistent with the economy-wide measures; for example, industry-level measures of labor input are based on hours worked, while economy-wide measures reflect changes in the composition of hours worked by age, gender, and education that result in enhanced inputs of labor services. As a consequence, the industry-level measures fail to conform to the international standards established by the OECD *Productivity Manual*. Jorgenson and Steven Landefeld are working on a new underlying architecture of the U.S. System of National Accounts to facilitate development of improved and more granular measures of innovation and productivity by unifying the National Income and Product Accounts with productivity statistic. This would incorporate BEA's new system of official statistics on output, intermediate input, employment, investment, fixed assets, and imports and exports by industry, when it becomes available in 2008. The

	Innovation Indicator	Definition	Derivative Measures	Interpretation and References
			combining them, or through reducing the amount of intermediate goods and services needed to produce a given amount of output.	system of industry production accounts would use the North American Industry Classification System (NAICS) employed in BEA's official statistics. The accounts would include capital and labor inputs for each industry. Industry outputs, as well as intermediate, capital, and labor inputs would be presented in current and constant prices along with Total Factor Productivity. Another similar effort is the EU KLEMS multi-factor productivity (MFP) which is a productivity measure that relates gross output to primary (capital and labor) and intermediate inputs (energy, other intermediate goods, services). **Sources:** Bureau of Economic Analysis, BLS**.** OECD has developed a reference database on productivity, the so-called **Productivity database** which provides data on productivity and productivity growth in OECD member countries.
10.0	**Enterprise Birth and Death Rates**	Measures formation of new enterprises as well as net change after adjusting for enterprise death rate	• Gross birth rates of enterprises • Net change of enterprise population (birth rate minus death rate)	**Sources:** EU Regional Benchmarks
10.0	**High Tech Jobs Gained and Lost**	Measures employment in the high tech sector.	• High tech jobs gained • High tech jobs lost • Net change	**Sources:** ASTRA
11.0	**GDP per capita and Standard of living**	Gross domestic product (GDP) per capita is a frequently used as an indicator of national income.	• Real GDP per capita • GDP per capital by state and country • Growth rate of GDP per capita	It measures the gross value of all goods and services produced in a country and are generally accepted as an internationally comparable indicator of material living standards. **Sources:** BEA, UN, World Bank, OECD

	Innovation Indicator	Definition	Derivative Measures	Interpretation and References
11.0	Gross domestic product (GDP)	GDP in nominal and real terms is a broad measure of economic activity and considered the ultimate output of innovative activity and is a measure of overall economic performance. **Real Gross domestic product** can be defined in three different ways: as the sum of labor incomes, net profits and depreciation; as the difference between gross output and intermediate consumption; or as the sum of consumption expenditures, fixed capital formation, changes in inventories and net exports.	• GDP year to year growth • GDP per capita • GDP by state or region Real GDP growth rates are obtained by converting GDP to constant prices and calculating the change from year to year.	There are no standard rules for converting current price GDP to constant prices and there are some differences between countries in the ways that they convert government consumption and some types of capital equipment to constant prices. **Sources:** Data on GDP and growth of real GDP in OECD countries are available in a number of data sources and publications including: • IMF World Economic Outlook • OECD Economic Outlook • OECD in Figures • OECD Factbook 2005 • Science, Technology and Industry Scoreboard. • BEA
11.0	Inflation	Refers to a rise in the general price level, as measured against a standard level of purchasing power.	There are many varying measures. The most well known are the consumer price index (CPI) which measures the change in nominal consumer prices. The GDP deflator measures inflation in new products and services created and producer price indices (PPIs). Measure prices received by a producer	Inflation measures are often modified over time, either for the relative weight of goods in the basket, or in the way in which goods from the present are compared with goods from the past. This includes hedonic adjustments and "reweighing" as well as using chained measures of inflation. **Sources:** BLS
12.0	Public Policies	Measures that track a variety of public policies of significance to innovation activity and outcomes	• Corporate tax rate • Overall Tax Burden • # Of new laws on taxies excises and duties • # Procedures to start a business • Prevalence of trade barriers • Foreign Ownership Restrictions • Intellectual Property Protection • Rule of Law Governance Indicators	No comprehensive measure or database on policy indicators presently exists. Measures cited come from a variety of data sources. **Sources:** Global Competitiveness Index, World Bank, national (e.g. Denmark) and regional innovation reports (Washington State)

	Innovation Indicator	Definition	Derivative Measures	Interpretation and References
13.0	Infrastructure	Infrastructure measures of significance to innovation performance.	• Judicial Independence • Intellectual Property Rights • Infrastructure Quality • Environmental Governance • Openness to Competition Index • Innovation Composite Ranking • Legal Rights Index • # of New Buildings Designed • Home Affordability	Diverse indicator sources make up this measurement area. **Sources**: IMD, Economic Freedom Index, EU Benchmarking Enterprise, Hong Kong Creativity Index
14.0	Public Attitudes and Sources of S&T Information	Measures public attitudes to S&T issues and sources of S&T new s and information.	Attitudes to S&T by: • Level of interest • Youth interest in science • Science Related News Stories • Demographic characteristics • Visits to museums, zoos and libraries • How well informed about S&T Issues • S&T news source by: • Television • Internet • Newspapers • Magazines	The public gets news and information about S&T from a wide variety of sources. Traditionally the largest source is TV but internet is gaining as a medium, particularly for information about specific S&T subjects. Data in this area comes from a variety of organizations, each with a different purpose and context and therefore difficult to compare internationally. . **Sources:** NSF Surveys of Public Attitudes and S&E Indicators, Pew Research Center, News Interest Center, Survey of Consumer Attitudes, IMD, international surveys and special studies and tabulations.
14.0	Wish to Own One's Business	The indicator measures people's preferences to own their own business. .	• # of people interested in being employee, self employed or setting up a business • Reasons for wanting to be employed or self employed • % of entrepreneurs in relationship to total workforce • Fears, difficult Issues, risks and success factors in setting up a business	The development of entrepreneurship has gained top-level policy attention, particularly in Europe and emerging economies because of the important benefits, both economically and Socially. Entrepreneurship is a driving force for the creation of jobs, competitiveness and growth. It also contributes to personal fulfillment, creativity and the achievement of social objectives. Based on opinion survey that measures the degree to which national culture and norms support entrepreneurship and the starting up of new business. Numerous factors come into play in the decision to set up a company, for example, the

	Innovation Indicator	Definition	Derivative Measures	Interpretation and References
			• Demographic characteristics of entrepreneurs	existence of a business opportunity, administrative complexities, as well as financial obstacles or skills. The indicator is available for the 25 countries of the EU and for the USA, Norway, Iceland and Liechtenstein. **Sources**: The data is published by European Commission "Flash Euro Barometer" Another source of entrepreneurship indicators is the Global Entrepreneurship Monitor (GEM).
14.0	**Value Placed on Creativity**	This is a measure of cultural norms and attitudes towards creativity, value place on arts, art education and on the issue of intellectual rights protection	• Value placed on creative activity • Value place on school-aged children's creative activity	Richard Florida has articulated a framework for evaluating a creative economy in the book *The Rise of the Creative Class.* His key finding highlights the emerging pattern of geographic concentrations of the creative class in individual regions. According to his creative capital theory members of the creative class are more likely to be economic winners and succeed in generating high-end jobs and economic growth. Creative people prefer places that are diverse, tolerant and open to new ideas and the presence and concentration of creative capital in a region leads to higher rates of innovation. **Sources:** Creativeclass.com, Hong Kong Creativity Index

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