

# **The Strategic Impact of Nanotechnology on the Future of Business and Economics**

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The rapid evolution of advanced technology has constantly served up innovation after innovation in super-compressed time frames--from the mapping of the Human Genome and cloning to supercomputers and the Internet. Information technology is now responsible for as much as one third of the US Gross National Product. This is an astounding metric validating we are entering an era driven by accelerated technology developments that have increasingly a significant economic value. We are in the midst of a large-system paradigm shift driven by accelerated exponential growth of new technology. Nanotechnology is a continuation of the next chapter in the acceleration of advanced technology and perhaps, more importantly, it may indicate the transformation of the future global economy.

Nanotechnology may become a essential large-systems strategic competency that will shape the sustainability and wealth of nations, organizations and entire industries in the future--only if we plan today to meet the readiness challenges ahead.

## **Nanotechnology May Drive Prosperity and Global Competitiveness**

Recent developments in emerging technology and its impact on business and economics would indicate that forecasts are less than accurate in predicting the future. Few would have accurately forecasted innovations such as of the Internet, wireless communications or the mapping of the Human Genome. Also, there have been numerous wild forecasts that have historically seemed more like science fiction than fact. Predictions about nanotechnology have fueled the imagination. Much of this is still imagination but the future looks promising. Nevertheless, new innovations in technology are reshaping the global economy at a dizzying speed. It would be prudent to consider the possible economic outcomes given the accelerated emergence of advanced technology. It is with this in mind that we turn to nanotechnology. Why is the potential economic impact of nanotechnology so important to consider? Nanotechnology is a fundamental design science that may well provide us with the tools to engineer inorganic and organic matter at the atomic level. Nanotechnology, if even partially realized, over the next few decades has the potential to realign society, business and economics at the structural

level.. Nanotechnology will touch all aspects of economics: wages, employment, purchasing; pricing, capital, exchange rates, currencies, markets, supply and demand. Nanotechnology may well drive economic prosperity or at the least be an enabling factor in shaping productivity and global competitiveness.

If developments in nanotechnology reach a critical mass in supplying radically innovative breakthroughs in automated self-assembly, as one example, most vertical industries will be influenced. Most industrial and post-industrial supply chains will be touched. Most value chains, supportive linkages, alliances and channels of distribution will be altered. Institutions of learning, financial services and certainly manufacturing will be reshaped. The issues that remain are to consider in what timeline what actions might be taken. How might we prepare as a society for these changes? Will there be radical dislocations or a smooth coordinated adaptation? We must plan for multiple scenarios. Radical nanotechnology innovations potentially unleashed on immature markets, fragile economies and a business community ill prepared for rapid post-industrial transformation would be problematic.

Imagine the emergence of a nanochip that tomorrow would deliver over 50 gigahertz of speed with the processing power of ten supercomputers for the price of a quartz watch and smaller than a key chain. What might the economic impact on the computer industry be overnight?

Imagine a super-strong and inexpensive material to be used for construction and manufacturing that would eliminate the market for steel and plastics. How might that influence the economy?

In a world being reshaped daily by innovations, the absurd today is reality tomorrow. But with the intimate inter-linkage of markets, industries and economies radical breakthrough technologies will have a widespread and far reaching impact--positive and negative. It is entirely possible, that just as computers and the Internet have become vital linchpins woven into the fundamental economic landscape of today's strong economy, that nanotechnology will emerge as the technology that shapes the future economy. Many of the necessary factors are in place to drive this scenario: widespread potential cross-industry applications; fast track R&D; government investment. The risks in not preparing for and examining the economic and business impact are too large to consider. Nations today, ill prepared to capitalize on the Internet, the transformation of supply chains or the mobile commerce sparked by advanced telecommunications are playing catch up and it has hampered their productivity, GDP and competitiveness.

## **The Nanotechnology in Business Study**

In 1999 the Institute for Global Futures deployed a privately funded study to assess the general awareness and readiness of the business community regarding the economic and business impact of nanotechnology. A series of interviews with a broad range of business

executives in health care, manufacturing, medicine, real estate, information technology, consumer goods, entertainment and financial services was conducted, and is still being conducted at this time.

The Institute for Global Futures, a ten year old San Francisco organization advises the Fortune 1000 and government on the impact of leading-edge technology on markets, society, customers and the economy. The Institute covers telecommunications, robotics, computers, life sciences, the Internet, software, artificial intelligence and a host of other technologies and forecasts trends and conducts strategic planning impacting on over thirty vertical industries worldwide.

## **Preliminary Findings**

Overall, the level of awareness and readiness is low, based on the survey results. Less than 2% indicated that they thought they knew what nanotechnology was. An additional 2% had heard of nanotechnology but could not explain what it meant. 80% of those surveyed agreed when nanotechnology was explained in basic terminology that this was an important technology that had the potential to affect them and their business. 45% of those surveyed expressed an interest in learning more about nanotechnology.

## **Nanotechnology Economic Scenarios: How Nations Prepare**

In addition to this survey of business executives another activity has been undertaken as an integral part of this study. Given the relative and varying levels of social adaptation, we examined what might the potential scenarios be given the contrasting readiness factors of a society. The following scenarios are briefly described as a way to generate further exploration and discussion. The value of these scenarios may be viewed as a catalyst for mapping future impact on an economy and society.

An attempt was made here to incorporate the key drivers that would shape the scenarios explored. Readiness is viewed as a precursor to these scenarios. The relative nature of socio-economic readiness, awareness and preparation will pre-determine these scenarios, and others yet to be envisioned here. This is a work in progress and will be updated as new information becomes available. Societal readiness was defined as the awareness and ability to take action, it is viewed, as a mission-essential driver of economic and industrial adaptation. As Nanotechnology may translate into the sustainability of nations, organizations and entire industries--readiness, the preparation and planning process becomes vitally important.

Scenario One: Brave New World

Timeline: 2010-2050

Economic Environment: Nanotechnology comprehensively integrated into the economy due to high readiness, effective strategic planning and widespread investments by business, education, labor and government. Accelerated national policy and investments producing economic agility and rapid widespread large system change management. An understanding of the strategic economic value on the nation and the role on global leadership. Numerous benefits from nanotechnology applications. Comprehensive social and industry-wide adoption has led to a positive impact on national productivity and an enhanced quality of life.

Key Characteristics: Robust gross national product; high productivity; global trade leadership; sustainable economic growth; global patent leadership; superior industrial competitiveness; integrated education and training resources; strong investment climate; plentiful capital liquidity; high investment on R&D; low unemployment; high government and industry collaboration.

Future Outlook: Very positive. An ever escalating predominance in key markets and industries leading to increased investments and innovations. An accelerated progressive and confident growth prognosis for the economy, and an enhanced quality of life for the nation. Global leadership and empowerment of third world and developing nations increasing. Accelerated investment in R&D and continued coordination with all sectors of society.

#### Scenario Two: Playing Catch-up

Timeline: 2010-2050

Economic Environment: Nanotechnology partially integrated into the economy due to low readiness and inadequate strategic planning. Economy playing catch-up. Slow social and industry-wide nanotechnology adoption. Reactive cultural reaction to investment and organizational and industry leadership for accelerated national change management. Not a full commitment and investment in national nanotechnology policy.

Key Characteristics: Partial loss of leadership in key markets and industries; Lack of skilled talent; poor education and training; growing but still low investment in R&D; fragmented industry support; poor investment climate; liquidity insufficient; fragmented government and industry collaboration.

Outlook: Optimistic if rapid and strategic widespread large-systems change is undertaken in a concerted effort by business and government partnership. Difficult to regain ground in certain markets, but partial leadership in key markets is a success to be built on for the future.

#### Scenario Three: The Bumpy Road

Timeline: 2010-2050

Economic Environment: Absence of comprehensive nanotechnology integration, adoption and readiness leading to a drastic reduction in post- industrial growth, poor performance in global competitiveness with a negative growth impact on the overall

economy. Denial of the strategic value and importance. Inability to invest in the actions required to manage comprehensive large-system socio-economic change.

Key Characteristics: Loss of key markets and industries; rising unemployment; chaos in selected sectors; brain drain going offshore; lack of investment liquidity; low investment in R&D; fragmented business and government collaboration; flight capital moving offshore; educational support low.

Outlook: Moving forward into the future, it will be difficult to seize and attain market and industry leadership without a significant investment in R&D, education, training and private/government collaboration. A commanding market share in key industries and global leadership will have been sacrificed. Regaining this ground, certainly global leadership, will be a massive undertaking certain to strain capital and human resources. An acceptance of a less involved global leadership role will be the probable outcome.

## **Towards the Evolution of a Nanoeconomy and the Future Wealth of Nations**

As the global economy continues to be transformed by new technology, there will become a keen competition for talent, intellectual property, capital and technical expertise. We see many of these factors responsible for shaping how nations today compete, interact and trade. Technical innovations will increasingly shape economies and market robustness. Technology will continue to drive global and domestic GDP. Competition will be fueled increasingly by fast breaking innovations in technology. Today this is obvious as rapid technological changes in telecommunications, life sciences, and the Internet demonstrates the emergence of entirely new economic and business realities. If the proliferation of today's technologies to form new business models is any indication of the speed and power of change in the economy, future nanotechnologies will make for an even more dramatic paradigm shift.

The evolution of a nano-economy as contrasted by a petro-economy of today is an intriguing idea. How might an economy not dependent on oil realign itself? More study will be needed to understand and map these scenarios. Fundamental nanotechnology innovations, yet to come will set the timeline for this economic transformation. Or, nanotechnology may just become integrated into industries such as health care, manufacturing and energy much like artificial intelligence became an embedded component of new products.

In conclusion, the readiness of a nation to prepare for large-scale economic change is a challenging task. Nevertheless, the future wealth of nations, certainly the economic sustainability of nations will be shaped by the preparations we make today. The coordinated large-systems strategic planning efforts that may well shape our ability to adapt. Strategically important decisions will need to be made. Huge cultural issues related to managing large-scale change will need to be better understood and plans formulated.

Nanotechnology provides a stimulating and somewhat awesome challenge to meet. If we had the knowledge in the 1960's and 1970's to prepare for the impact of computers or telecom in the 1990's how might we have prepared the nation? Today we have real-time examples and a history of rapid accelerated economic change due to new technology to learn from, in preparing for the future. The business community needs to be enabled and invited into the strategic planning process to support what will either be a Brave New World or a Bumpy Road.