Chapter 7: Technology to the Rescue?[1] [DRAFT]

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To the difficult problems raised in previous chapters, technology may be the solution. Businesses as the guardians and commercializers of technology play a key role in getting new know-how and ideas to the market. How can the processes of foresight be better used for the purpose of technology commercialization? Two roles that may be played are in identifying promising opportunities and in testing business strategies.

. The generic types of scenarios introduced in this book (see Chapter 2); are romances (positive), tragedies (negative), and in-between states (comedies), but the number and types of possible scenarios are not confined to these possibilities. Hypothetically, one can imagine many different circumstances prevailing in the future (for example, see Appendix B). The future, after all, is not predictable; this has been a prime argument in this book. The purpose of creating scenarios is not to forecast what is to come but to imagine what *might* happen. It is not to accommodate necessity and submit to fate, but to influence the course of events, to take action to bring about positive results and prevent negative ones.

With this conception in mind, one can consider many possibilities of what the future can bring, a whole spectrum of shades of color – not just white, black, and gray, but reds, blues, greens, yellows, purples, magentas, oranges, fuchsias, mauves, and browns (See Figures 7.1 and 7.2). One can then use these possibilities to identify technological opportunities and to test business strategies. In the instance of the opportunities, one can establish a scoring system based on technological needs. Start with what customers want

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[a] This chapter is based on parts of Prof. Amin's course "Pivotal and Emerging Technologies," at the Univ. of Minnesota, and his presentations during 2006-2008 in the U.S., China, Egypt India and Italy.

and rate technological options given different conditions that can exist in the future – the various colors listed horizontally. Establish a scoring system. The highest needs of customers may be assigned ten; the medium needs six, and the low ones two. The results of the analysis will depend on the scoring system used. This analysis cannot be carried out by top management alone. Top management may not be fully knowledgeable of customer needs. The analysis must involve many people in the organization. Moreover, the analysis cannot be a static one. It must be regularly updated. Both of these points have been made repeatedly in this book.

Figure 7.1: Option Identification

Scenarios to Identify Technological Opportunities

TECHNOLOGIES

SCENARIOS	1	2	3	4	5	6	**Totals**
RED	2	0	0	0	0	0	2
BLUE	0	0	0	**10**	0	0	10
GREEN	0	2	0	0	0	0	2
YELLOW	0	2	0	0	0	0	2
PURPLE	0	0	0	0	2	0	2
MAGENTA	0	0	0	0	0	0	8
ORANGE	0	0	0	0	0	2	2
FUCHSIA	0	0	**10**	0	6	0	**16**
MAUVE	0	0	**10**	0	0	0	10
WHITE	0	**10**	0	2	0	2	**14**
BLACK	0	0	0	0	0	0	0
GRAY	0	0	0	0	0	0	0
BROWN	2	0	0	0	0	0	2
Totals	4	**14**	**20**	**12**	8	4	

High needs = 10
Medium needs = 6
Low needs = 2
No-needs = 0

Figure 7.2: Option Feasibility

Scenarios to Test Business Strategies

STRATEGIES

SCENARIOS	1	2	3	4	5	6	**Totals**
RED	6	6	0	0	0	0	12
BLUE	0	**10**	0	0	0	2	12
GREEN	0	2	0	2	0	6	10
YELLOW	0	0	0	0	**10**	0	10
PURPLE	2	0	2	6	0	0	10
MAGENTA	6	0	2	0	0	2	10
ORANGE	0	2	2	6	2	0	12
FUCHSIA	0	**10**	2	0	2	2	**16**
MAUVE	0	0	2	0	6	2	10
WHITE	0	0	2	2	0	**10**	**14**
BLACK	6	2	2	2	0	0	12
GRAY	2	0	0	2	0	6	4
BROWN	2	2	6	2	0	0	12
Totals	24	**34**	20	22	20	**30**	

High feasibility = 10
Medium feasibility = 6
Low feasibility = 2
Non-feasible = 0

In Figure 7.1, the highest scoring technological option is number three (20 points). The best scenario for the company is fuchsia. So the technology of choice would be number three and the company would want to influence the world in a fuchsia direction. A risk adverse organization, however, also would want to have backups. It cannot assume that the world will move in a fuchsia direction. The best backups would be technology number two (14 points) and technology number four (12 points). These backups cover scenarios blue and white that are not well covered by technology number three. If the world evolves in these directions, the company will have the resilience to switch gears and recover. It has these alternatives in place just in case. Of course, the choices the company makes require much discussion. A quantitative scoring system of this nature necessitates qualitative as well as quantitative analysis. Nothing is automatic. Laying out the options in this way is the start of serious debate. It should not be the end of it.

The second role that scenarios can play is in testing strategies which can be used to pursue the technological opportunities (see Figure 7.2). The strategies should consist of some combination of moves the company can make. These moves might involve a combination of (i) product and/or service repositioning, (ii) mergers, acquisitions, divestitures, and alliances, (iii) globalization, and (iv) innovation (see Chapter 3). The combination of moves can be carried out in different sequences. The question that a company will have is how likely are these strategies to succeed under the different scenarios that might prevail in the future (see Chapter 5) – red, blue, and so on? How feasible are the different strategies given different states in the future? A scoring system again might be put into place with the high feasibility combination of strategies, those that are most likely to succeed, assigned a score of ten; a medium feasibility combination of strategies assigned a score of six, and a low feasible combination given a score of two. Again, any firm that engages in this exercise should involve many people in the scoring. The knowledge to carry out this exercise does not belong exclusively to those in top management positions. Here as well the scoring should not be static. As new information becomes available people in the organization should be ready to make changes. They should be willing to revise what they think will work and will not work.

In the example given (see Figure 7.2), the dominant strategy is the second one (34 points), but it does not have a large lead over the sixth strategy (30 points). Strategy two makes the most sense if the future is likely to be blue or fuchsia. Under these conditions it is the most likely to succeed. Strategy six makes the most sense if the future is white. Strategy five makes the most sense if the future is yellow.

When there is a fuchsia future, the need is highest for technology three and strategic option most likely to succeed is two. The company overall does best in a fuchsia world where it pursues this technology using these moves. Obviously, this suggests that pursuing this technological opportunity and this strategy should be united with actions to make the world more of fuchsia one. The company should not sit passively and expect the world to move in this direction. It should try to create the conditions that will bring a fuchsia world into being. It should try to shape the future to the extent it is able.

Technology two and strategy six work best in a white world. A white scenario therefore is a good backup for this company. A backup is needed because the company cannot guarantee that no matter what it it does it will obtain the world it seeks. The company must have an option it can turn to just in case. The company must be prepared should events not evolve as it hopes. Thus, it also should work for the white world. . It needs to put some effort into bringing about the white world as well as the fuchsia one. The best case for this company is fuchsia. The second best case is white. Other possibilities should be opposed. The gray world scores particularly low on both technological opportunities (0 points) and strategic options (4 points). It should be particularly resisted. The company not only should try to create a world to its liking but it should attempt to prevent a world that it does not want to happen from occurring.

Relying on scenarios for these purposes does not assure the company's success. It just improves the chances. People in the company must be engaged in these types of analysis on a regular basis either formally or informally in larger groups or by themselves. They must remain skeptical of any results they obtain. These results must be seen as provisional. In accord with new evidence, people in the company must be ready to revise and change their analyses. They must be ready to rethink and redo them. These techniques are highly useful in organizing one's thought and systematizing them, but they are no substitute for critical thinking. People in the company should be ready to question all assumptions. Scenarios play not one but three critical roles – to help the company succeed, to help it avoid failure, and to help it discover what lies around the corner (see Table 7.1).

Table 7.1: Three Roles for Scenarios

Romance: **Farsighted**	**Tragedy:** **Blind Sighted**	**Comedy/Farce:** **External Sensing**
To Succeed	To Avoid failure	To Discover What Lies Around the Corner
• Foreshadowing weak signals • Discovering new customers, technologies, channels • Staying ahead of curve • Seeing opportunity early	• Developing early warning systems • Being prepared • Avoiding being blind sided • Preventing error • Showing vigilance against threats	• Being sensitive to the multiplicity of possible outcomes • Showing curiosity about what exists on the periphery and the edges • Dealing with the uncertainty of unstructured problems where the odds are not known • Mapping out the uncertainty • Testing strategies with flexible options • Monitoring and exploring, rather than *solving* well defined problems with established analytical tools and good data • Dealing with open systems, chaos, and complexity, rather than closed systems that are well-worked out • Removing regret

Key Differentiators

For any company wishing to succeed, the technologies it chooses to pursue can be key the differentiators between success and failure. Technological change is like a "series of explosions" with innovations concentrating in specific sectors, so-called leading-edge industries that provide the momentum for growth.[2] Without these leading sectors to propel the economy forward, economic growth would not be possible. People in companies, seeing the opportunities for profit, vigorously exploit the possibilities inherent in leading-edge sectors. These pioneers typically are followed by a swarm of imitators. The combined activity of the pioneers and their followers generates boom conditions. Soon, however, there are so many imitators that prices for the new products and services that have been introduced fall and bust follows. Lagging sectors fall behind, their time passes, and they wither and die or are kept afloat by government subsidy and bailout. To spur a revival, new the commercialization of new technologies is needed. This process is one that the Austrian economist Schumpeter calls "creative destruction."[3]

According to the Russian economist Kondratiev, economic progress takes place in waves, each of which lasts about half a century.[4] Each wave has periods of prosperity, recession, depression, and recovery. Since the industrial revolution, these waves have been connected to specific technological innovations.[5] The first wave (1782-1845) saw major innovations in steam power and textiles; the second (1845-1892), in railroads, iron, coal, and construction; and the third (1892-1948), in electrical power, automobiles, chemicals, and steel. The prosperity of the post-World War II period has been built on innovations in semiconductors, consumer electronics, aerospace, pharmaceuticals, petrochemicals, and synthetic and composite materials.[6] A dynamic growth phase existed from 1945 to 1973, but from 1973 to the present, the growth rates in advanced industrial nations has slowed. From where will the next wave of technological innovation come? What are the technologies from which people in companies can pick to increase the chances that their firms will succeed?

Today, particularly promising technological developments are occurring in such fields as genetic engineering advanced computing, telecommunications, biomedical engineering, the material sciences, and energy. These revolutions in technology offer many opportunities for better managing resources and improving the quality of life, but which companies will best be able to seize upon them for commercial gain has not yet been determined. .

The New Genetics. Biology (genomics/molecular biology/designer life forms) including the Human Genome Project has provided the foundation for medical advances and for agricultural biotechnology that offers the potential for feeding the world's population using less land. The genetic code of living organisms has been mapped in preparation for the ongoing restructuring and remodeling of genes to enhance or eliminate various traits in humans and other life forms. This map may provide scientists with the ability to predict and correct genetic diseases. It may allow them to create drugs to better fight diseases such as cancer. It should give them the ability to create crops that are pest-resistant and drought-proof and have other useful properties (See the Boxed Insert in Chapter 5 titled Monsanto's Quest). It has been estimated by some indeed that in 2010, the cost of synthesizing bacteria genome-sized DNA sequence will be equivalent to the price of a car. The potential of the new genetics is indeed staggering.

Information Technology. The impact of the ongoing information revolution (communications/computing/sensors/electronics/machine intelligence) already has been great. It has included:

- Telecommuting ("tele-everything")
- Shopping at home, web-based, robotic delivery
- Entertainment/leisure (at home, immersive 3-D, interactive/multisensory via VR/holography)
- Travel (3-D/interactive/multisensory tele-travel)
- Education (at home, low-cost, web-based on-demand asynchronous, immersive/virtual presence, life-long distance learning)
- Health (at home interactive tele-medicine)
- Politics (increased real-time virtual involvement of the body politic)
- Commerce (tele-commerce, already ubiquitous)
- Tele-socialization
- Tele-manufacturing

An ability to disseminate knowledge instantaneously around the globe has given rise to virtual communities and an expanding international economy. It has resulted in fiber optics, which carry many signals at once (such as, television, telephone, radio, and computer), that have greatly improved and expanded communications. Micro waves send wireless digital information to satellite dishes. Advanced satellites can be used for pinpoint surveillance and mapping. Advanced computing will unlock up additional new vistas. Evolving chip technologies are opening up the promise of even faster and more powerful computers. Information from audio, video, and film is being digitized so that it can be retrieved more quickly and used more effectively. The use of memory systems such as optical disks, film, and bar-code readers has been expanded. Parallel processing permits the use of many computers simultaneously. It greatly enhances computer power and performance and thereby increases the complexity of the scientific and technical tasks that can be handled. Computer use is continuing to expand to areas where human intelligence has been applied. Computers are increasing their ability to carry out such activities as learning, adapting, recognizing, and self-correction. Related developments are likely to take place in quantum technologies such as crypto computing, sensors, optics, electronics, and in societal systems such as motivational asynchronous "distance learning," immersive/virtual presence, "tele-everything," "robotic everything," and digital earth/digital airspace. The impact of the ongoing information technology revolution on society has been immense and its full promise is only starting to be tapped.

Materials Advances. Designer alloys, ceramics, polymers, nanotechnology, and biomimetics are offering new capabilities in areas such as computer memory and speed, sensors, superconductivity, and super strength. Many new materials are already more widely available. Lighter, stronger, more resistant to heat, and able to conduct electricity, new polymers can be used in many products from garbage bags to tanks, ball bearings, batteries, and running shoes. New materials can be constructed molecule-by-molecule and atom-by-atom using supercomputers in their design. Tailor-made enzymes for industrial use are being developed. High-tech ceramics resistant to corrosion, wear, and high temperatures are being used in autos and elsewhere to create cleaner-running and more efficient engines. Lightweight and noncorrosive fiber-reinforced composites that are stronger than steel are being used in buildings, bridges, and aircraft.

Energetics. Many new energy technologies (solar/biomass/storage) exist or are coming into existence such as fuel cells, which use hydrogen as opposed to fossil fuels like oil (see Boxed Insert in Chapter 6: Hope or Hype at General Motors). Solar energy cells already are being used in pocket calculators and remote power applications. Superconductors carry electricity with less loss of energy. They make possible cheaper and more advanced magnetic imaging machines for hospitals. They can also be used in TV antennas. Later in this chapter there will be additional discussion of the potential developments in this area.

Biomedical Engineering. Microwave scalpels equipped with lasers (light amplified by the stimulated emission of radiation) are replacing metal scalpels used in surgery. Through bioelectricity, damaged or malfunctioning nerves, muscles, and glands can be stimulated to promote their repair and restore their healthy functioning. This technique can be used in humans with severed bones or defective hearts or lungs. It speeds the healing rates of wounds.

Nanotechnology. Nanotechnology holds out huge promise for the advances it can bring about in many related areas such as coatings, barriers, computers, sensors, materials, and assemblers. There are a number of ways in which technologies can play role including: applications for a special use, like microwave water heating; applications to multiple uses; combinations that enable a single use; and. combinations that enable multiple uses. Nanotechnologies allow for multiple uses whether singly or on combination with other technologies. The opportunities spread very broadly into many other technological fields, such as:[7]

Aerospace and Defense

- Structural Materials, Coatings, Fuel, Electro-mechanical Systems, Weapons, Surveillance, Smart Uniforms, and Life Support

Automotive and Transportation

- Structural Materials and Coatings, Sensors, Displays, Catalytic Converters and Filters, and Power

Information Technology and Telecommunication

- Photolithography, Electronics and Opto-Electronics, Quantum Computing, and Telecommunications

Energy Production and Distribution

- Fuel Cells, Solar Power, Rechargeable Batteries, Power Transmission, Lighting, Energy Savings (plastic batteries may be possible with up to eight times their nominal capacity charged in less than a minute)

Medical and Pharmaceutical

- Detection, Analysis, and Discovery; Drug Delivery; Prosthetics; Antimicrobial, Antiviral, and Antifungal Agents

Chemicals and Advanced Materials

- Catalysts, Membranes and Filtration, Coatings and Paints, Abrasives, and Lubricants, Composites and Structural

Is the bio-nano world the next important stage in the development of technology? Is it the next mega-trend that will transform nearly everything?

Empowered by People

The Nobel Prize winning economist Robert Solow claims that technology typically drives 60 percent of the growth in the GDP in an economy. Technology, however, must be powered by people. It requires human skills, discipline and creativity to make it work. It relies on people to bring about the prosperity that the planet needs. Again and again this book has emphasized the importance of people.

Though projections are from certain (see chapter 5), expectations are that by the year 2050 the distribution of people in the world will be quite different than it is today (see Figure 7.3). The most significance differences are Europe where the population is expected to decline by about 9 percent and Africa where the population is expected to grow by 120 percent. This will make Africa outside of Asia the second most inhabited continent in the world. Of course, many assumptions go into these projections and therefore they may not be realized. Overall trends obscure more than they reveal, for within regions there are likely to be areas of great heterogeneity (see Figure 7.4). Results will not be uniform. Pockets within each region will be growing and declining. Within region change is likely to be as large as between regions, but throughout the world, the movement from countryside to city is likely to continue. By 2020, there are expected to be more than 30 mega-cities, many of the new ones being in developing countries. By 2050, there are expected to be nearly 60 such cities (see Figure 7.5).

Figure 7.3: Expected Distribution of the World’s Population in 2050

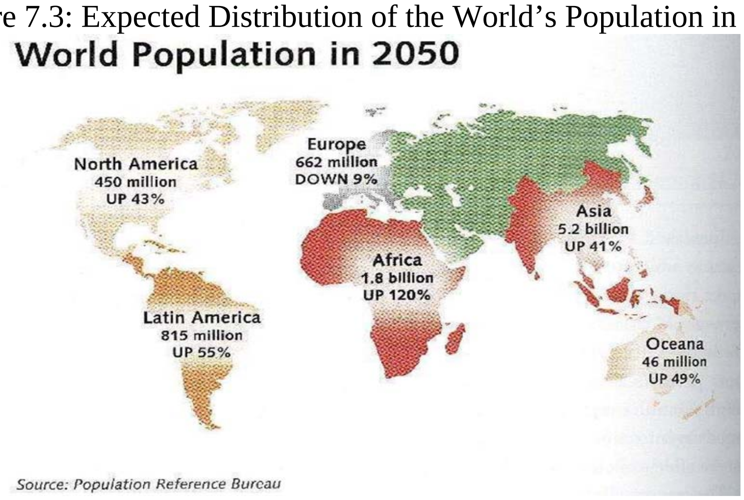


Figure 7.4: Pockets of Exponential Population Expansion

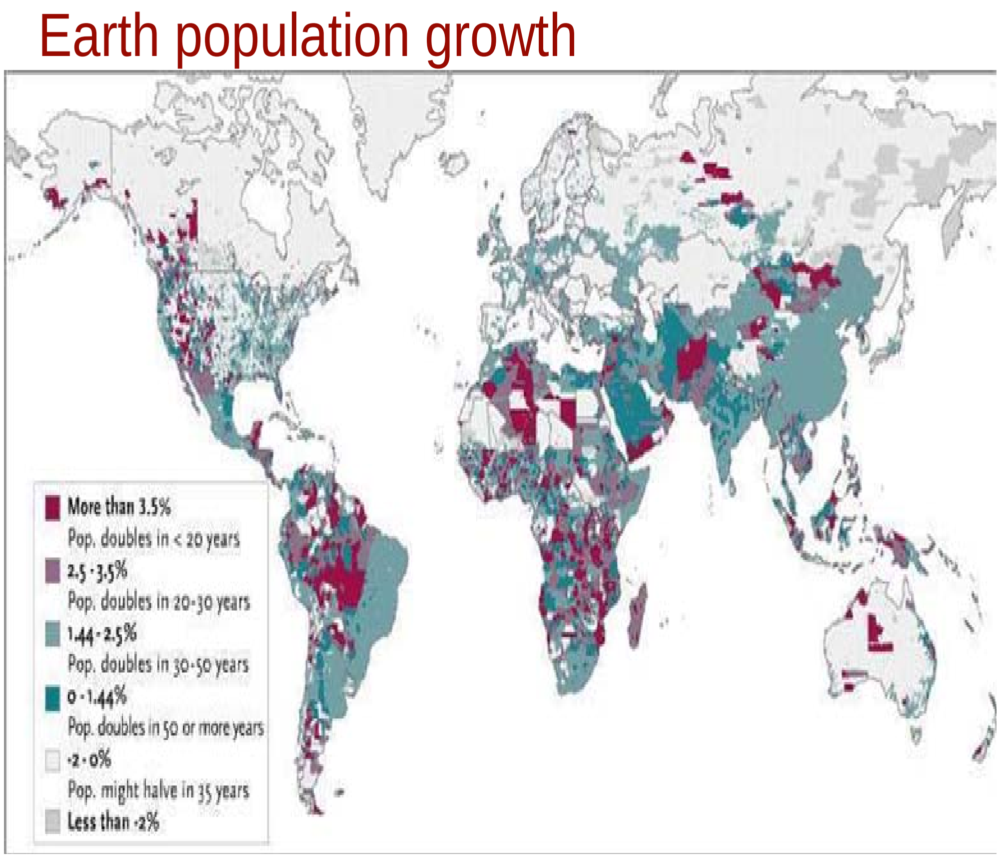
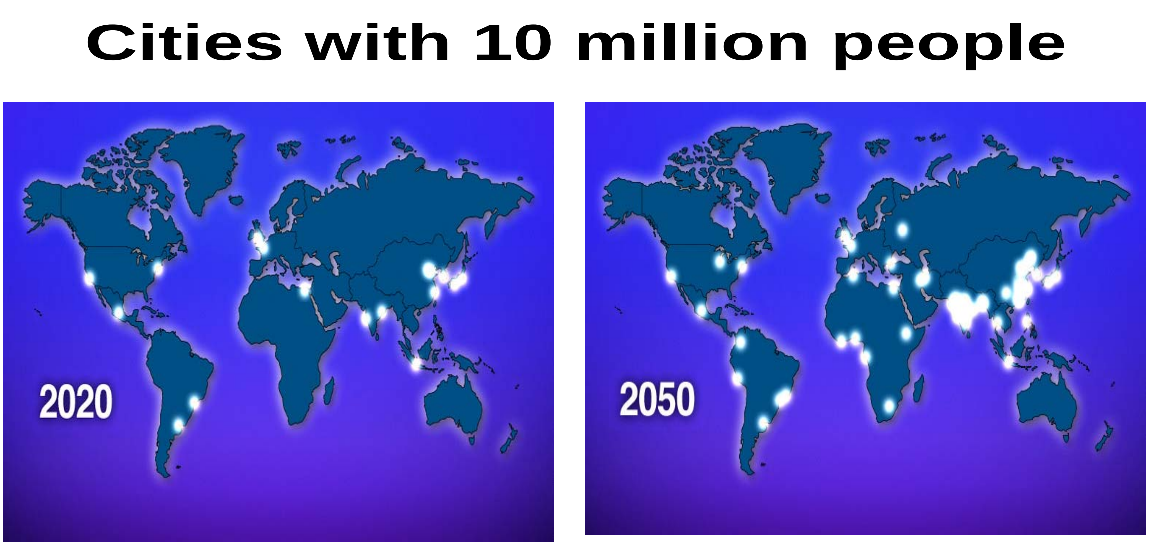


Figure 7.5: Continued Growth of Mega-Metropolises



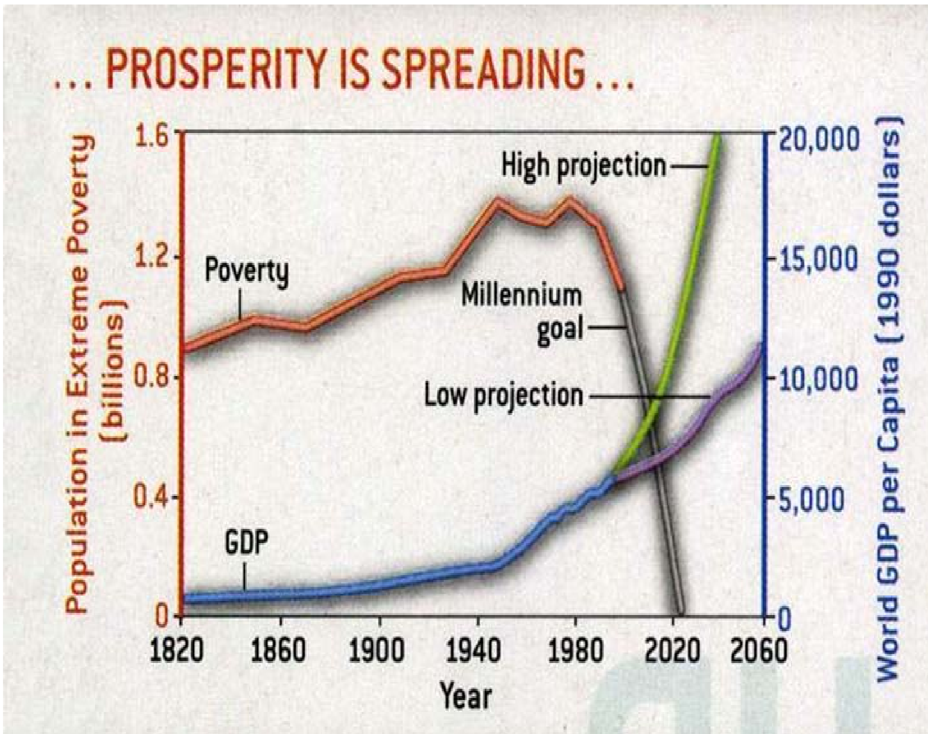
If the past provides a guide to the future, the pace of change in the future will continue to be very rapid. For example:

- Internet use grew 183 percent from 2000. There were1 billion users in 2007. By 2011, there are likely to be two billion users.
- Two billion cell phones were in circulation in 2006. By 2009, there are likely to be three billion in circulation.
- Wireless "hotspots" were taking off. In 2008, there were100,000 of them. By 2010, there were expected to be 200,000.
- The Internet carried 647 petabytes (billion million bytes) of data each day in 2007. By comparison, the Library of Congress holdings represented only 0.02 petabytes. This number was only likely to increase.

These changes, however, will not always be smooth. There will be glitches; and there will be anxiety associated with the changes as some groups will be advantaged and others will be disadvantaged.

Prosperity has been spreading fast but perhaps not fast enough (see Figure 7.7). The results of the uneven distribution of technology's benefits in developing nations are obvious. They include such social and economic ills as vast population dislocations, social upheavals, and extreme poverty and debt. In developed nations, the results have not always been that good either. They have included such issues as crumbling infrastructures, environmental pollution, and unhealthy lifestyles, often leading to obesity and heart disease. With about a quarter of the world's population living in abject poverty, and as many as 800,000 people malnourished, feeding the additional people on the planet will continue to be an immense challenge and the only way out of this dilemma will be to rely increasingly on technology.

Figure 7.6: The Incomplete Advance of Prosperity

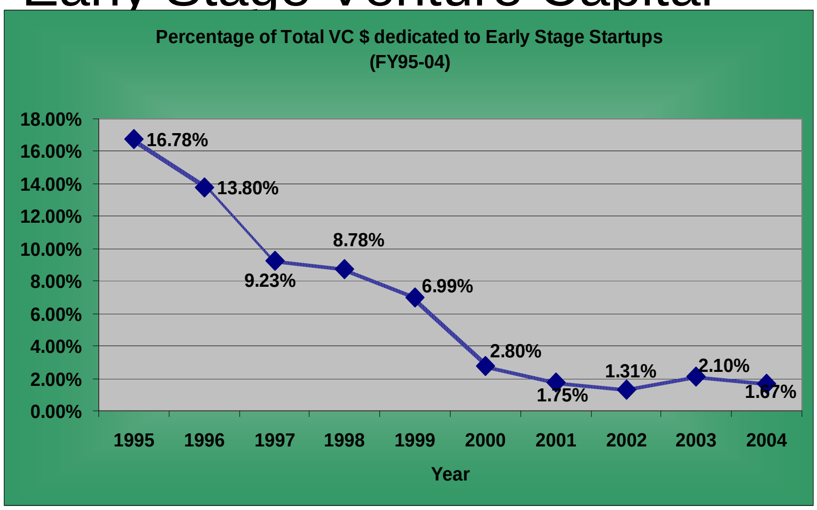


In the future, would the most profitable companies continue to be headquartered in the United States? Very likely fewer of them would be U.S. companies. In 2004, for instance, eight of the world most profitable companies (ExxonMobil, Citigroup, General Electric, Bank of America, Freddie Mac, Altria, Wal*Mart, and Microsoft) were headquartered in the U.S. The only non-U.S. firms to break into the list were BP (English) and Total-France (French). However, by 2008, only four of the world's most profitable companies were headquartered in the U.S. (ExxonMobil, General Electric, Chevron, and Microsoft). The other companies on this list represented a broad diversity of countries including Shell (Dutch/English), Gazprom (Russian), BP (English), Total (French), HSBC (English), and PetroChina (Chinese)

Would the U.S. continue to be a center of entrepreneurial dynamism and vigor? There were signs of U.S. decline in this domain (Figure 7.7). U.S. venture capital was becoming less patient. Early stage venture capital was drying up. Estimated investments by angel funders also were going down. Fewer seemed to be willing to take the risks needed to develop radically different technologies. Their taste for daring appeared to be contracting.

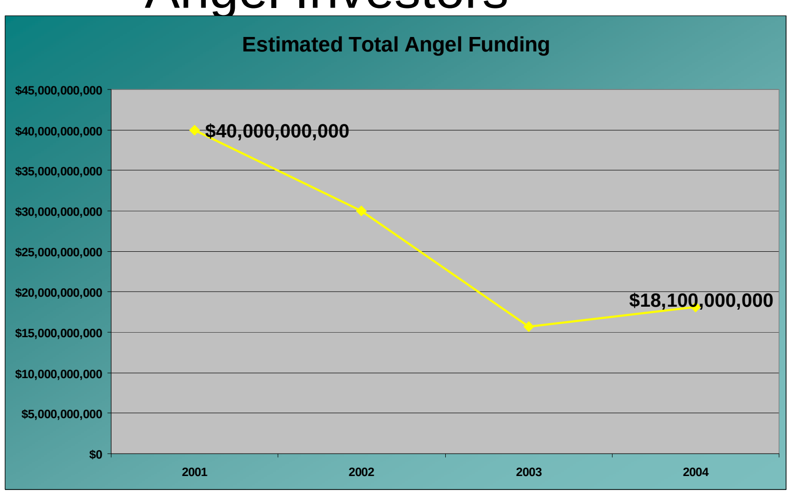
Figure 7.7: Waning U.S. Venture Capital

Early Stage Venture Capital



Source: Price Waterhouse Money Tree Survey FY04

Angel Investors



Source: University of New Hampshire, Center for Ventu

Meanwhile more R&D was moving outside the U.S. There were many indicators of the global diffusion in technology. China and India accounted for 31 percent of global R&D employees by end of 2007, up from 19 percent in 2004. Seventy seven percent of new R&D sites planned by 2010 would be built in China or India.

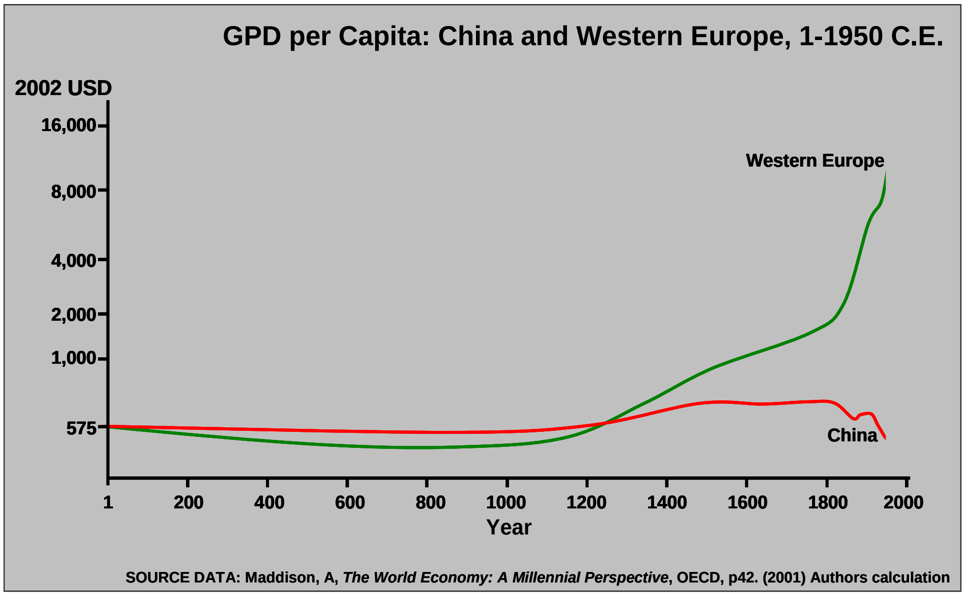
Prosperity has been closely linked to the amount of money nations have spent on R&D. The leaders in R&D spending per unit of GDP have been such nations as Sweden, Finland, Israel, Japan, the U.S., and Singapore, but would these countries remain the leaders? How long would it take countries like Brazil, Russian, China, and India to catch up (See Figure 7.8)?

Figure 7.8: National Spending on R&D

In Europe, technologies like printing, gunpowder & compass and the industrial revolution created dramatic changes in the European economy. Similarly, technologies including atomic science, semiconductors, computer technology, lasers and automation have helped to create a turnaround in the Chinese economy This turnaround began after the West's opening to China and Premier Deng Xiaoping established new direction for his nation based on modernization and other improvements in agriculture, industry, the military, and science and technology (see Figure 7.9). A key to the Chinese turnaround has been a 20 percent cumulative average growth in R&D Expenditures from 991–2002. Total Chinese R&D expenditure has become the largest globally, just behind the U.S. and Japan. The Chinese economy has been on a very well-planned move from raw materials and agricultural to industrial, information, and knowledge products and services (see Figure 7.10).

Figure 7.9: The Resurgence of Chinese Economic Strength

Chinese Economic Development Lags



Chinese Economic Development Surges

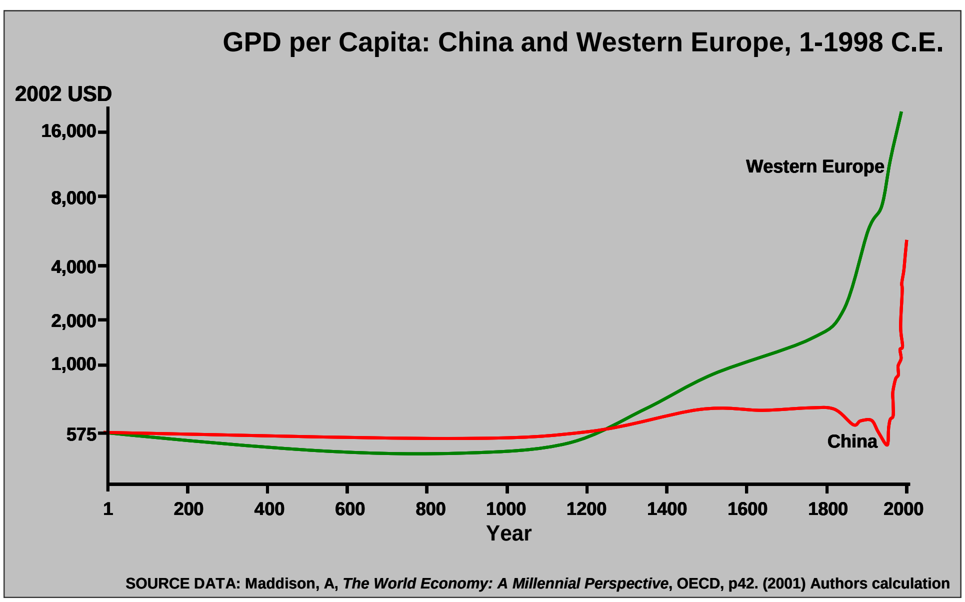
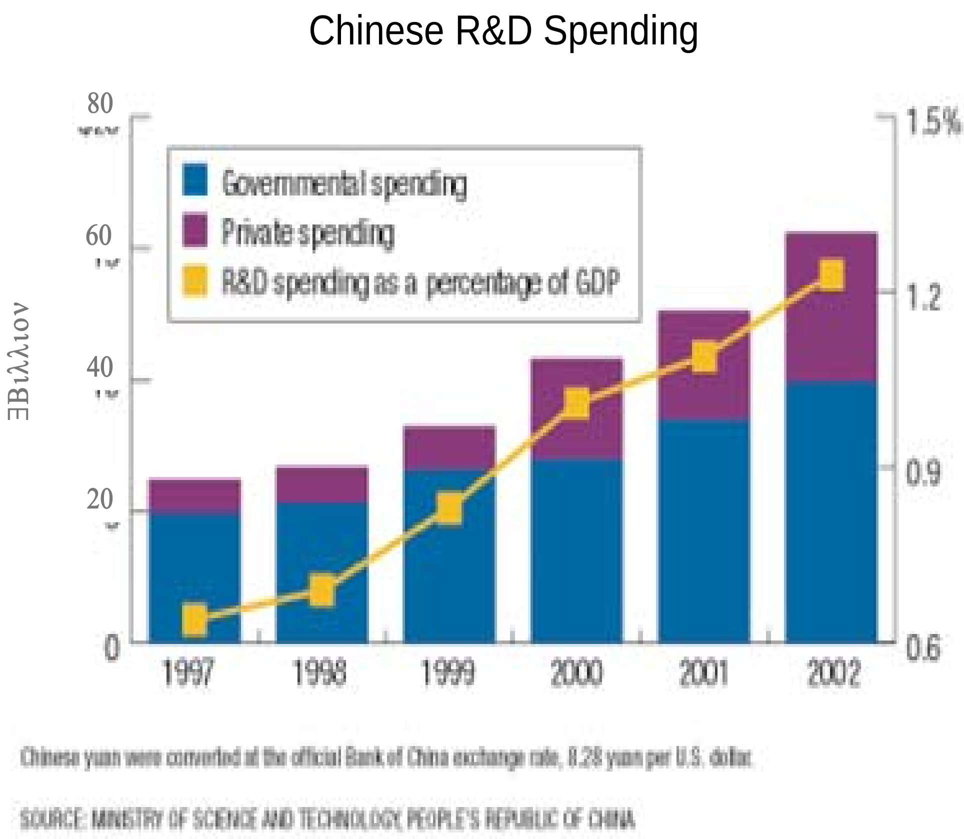


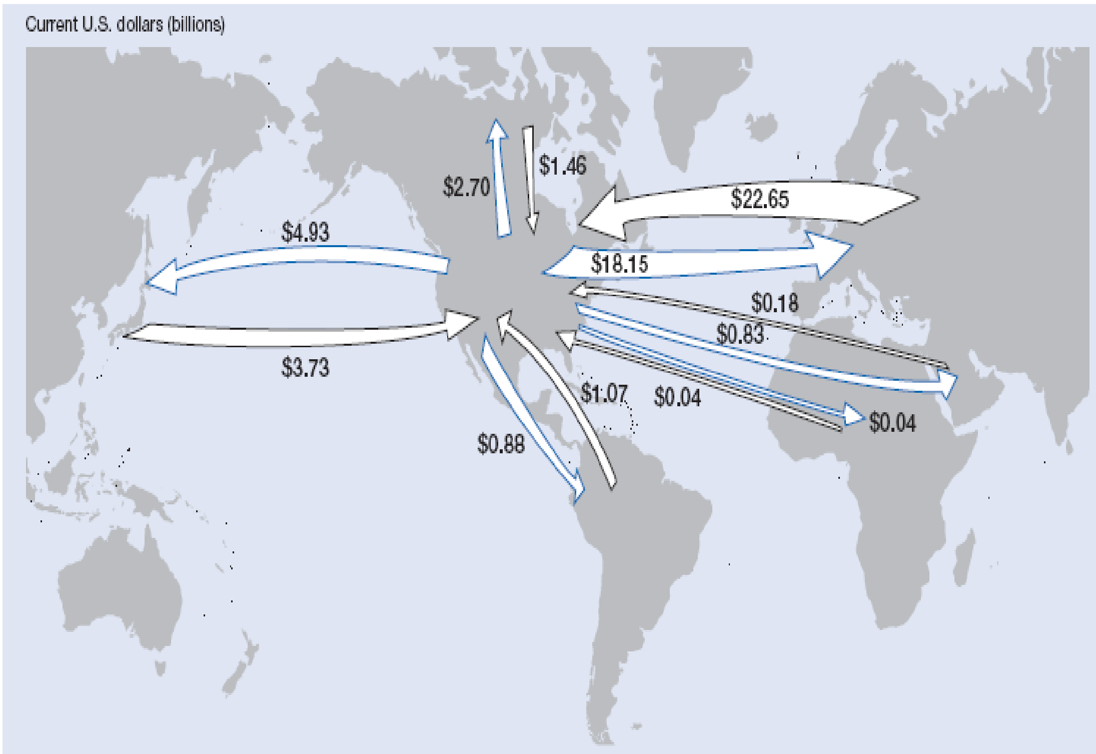
Figure 7.10: Increase in Chinese R&D Spending



Worldwide there has been a mushrooming of industrial technology alliances between foreign owned firms and U.S.-owned companies. Most of these alliances have involved companies from the United States, Europe, and Japan, and have focused on biotechnology and information technology products, services, or techniques. Other technology areas have included advanced materials, aerospace and defense, automotive, and (non-biotechnology) chemicals. Increasingly, these alliances are bringing in China and other nations in the developing world. They are becoming part of the same alliance structure that has fueled the growth of U.S. European, and Japan based firms. Foreign-owned R&D in the U.S. and U.S. owned R&D in foreign nations has been on the rise (See Figure 7.11)

Figure 7.11: Worldwide Movement in Foreign-Owned R&D

Foreign-owned R&D in United States and U.S.-owned R&D overseas, by investing/host region: Post-2004



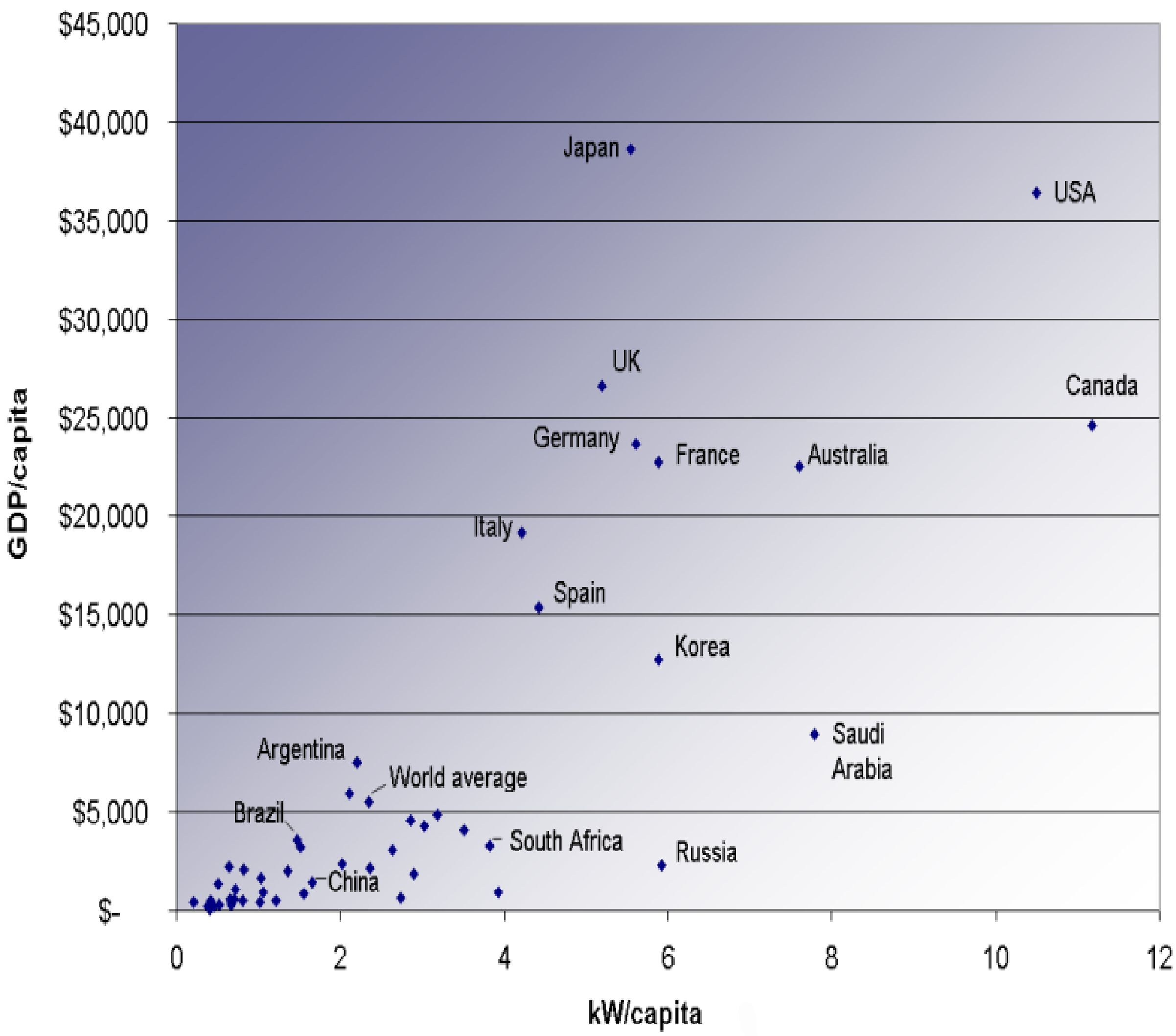
SOURCE: National Science Board, *Science and Engineering Indicators-**2008***

<u>The Energy Gap</u>

The developing world still suffers from a huge energy gap (see Chapter 6). Half the world's population subsists on agrarian or lower levels or energy access and their population density exceeds the carrying capacity of the environment. Energy is critical for the basic food, water, shelter, and minimal health services needed for the survival of people. It is needed to increase quality of life through higher levels of literacy, life expectancy, improved sanitation, physical security, and social security, and lower levels of infant mortality. Amenities such as recreation only become more widespread when there is sufficient energy.

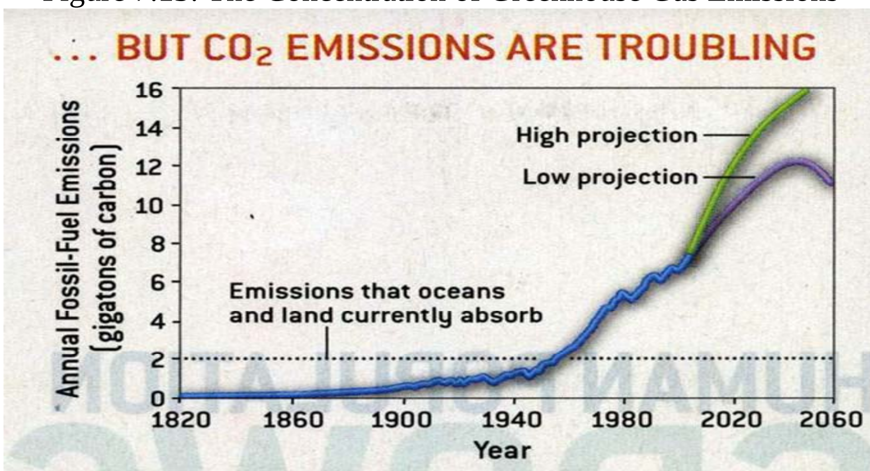
If energy were to become more amply available, there would be more international cooperation, greater R&D, investment, and technological diffusion. GDP and the quality of life are highly tied to electrical consumption (See Figure 7.12). The vast network of electrification that currently exists in the world was one of the twentieth century's greatest achievements.

Figure 7.12: Electrification and Economic Growth

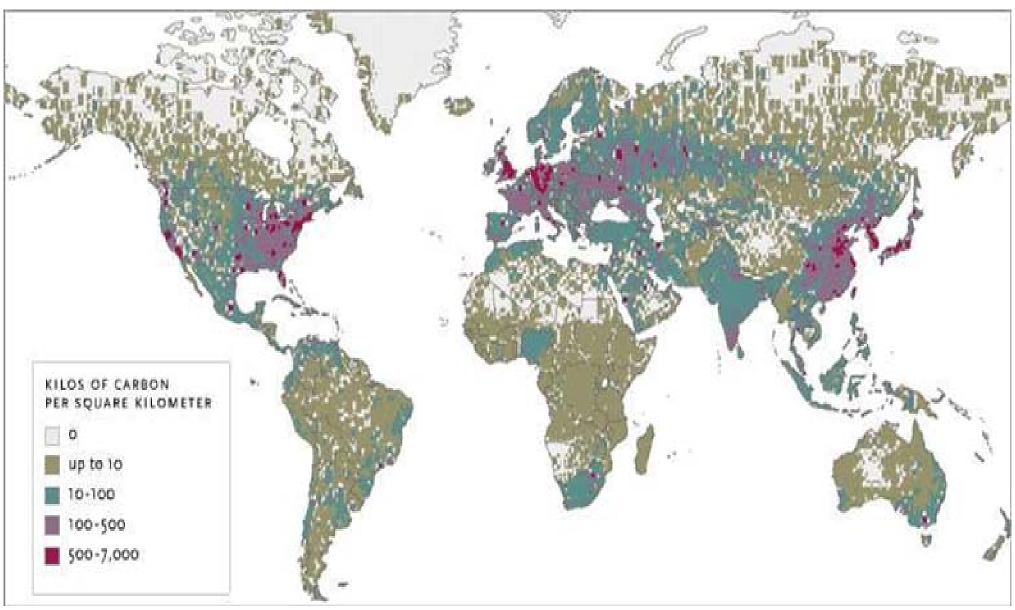


However, the increase in greenhouse gas emissions is very worrying. Greenhouse gases are concentrated in some of the world’s most important manufacturing areas (See Figure 7.13).

Figure 7.13: The Concentration of Greenhouse Gas Emissions

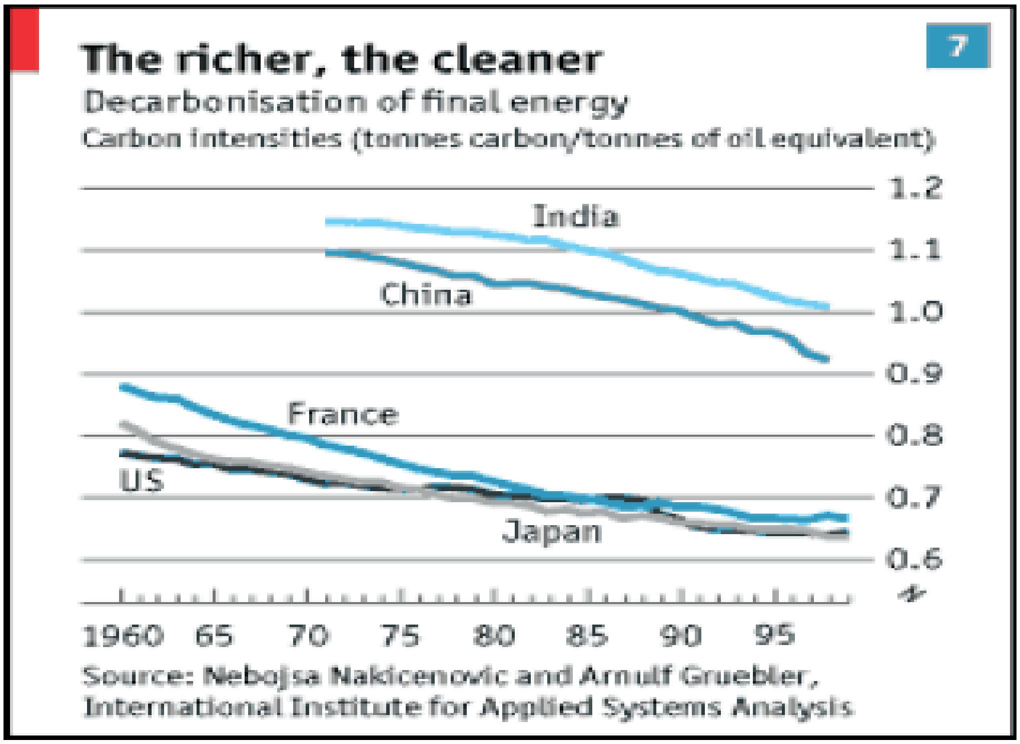


Global Emissions



As countries get richer their greenhouse gas emissions tend to go down. The U.S., France, and Japan are about at half the carbon intensities levels of China and India. That means per unit of GDP they create far less greenhouse gas emissions (see Figure 7.14).

Figure 7.14: Carbon Intensities of Major Countries



Source: RFF, 2002

Nevertheless in developed countries huge advances still are possible in increasing energy efficiency and lowering energy demand. The U.S. electrical system, for instance, loses 55.9 quads of energy for every 35.0 useful quads of energy it creates. For a carbon constrained world, the following technologies will play a larger role: end-use efficiency, nuclear, renewables, biomass, and plug-in hybrids. Gasoline engines are considered to be 13 to 18 percent efficient, while hybrid vehicle efficiency is considered to be in the 62 to 77 percent range. While a plug in hybrid can travel from 1631 to 2185 miles per barrel of oil consumed, a conventional vehicle only can travel 1231 miles per barrel. .

Many technologies must be tried. There have fundamental breakthroughs that today cannot be really imagined (see Chapter 6). In a smart grid utilities will create a network of technologies and services that will not just provide illumination. Every node in the will be awake, responsive, adaptive, price-smart, eco-sensitive, real-time, flexible, humming, and interconnected.[8] The power delivery system of the future will have these characteristics. It will be:

- Intelligent: autonomous digital system identifies surges, outages
- Predictive rather than reactive, to prevent emergencies
- Resilient: “self-healing” and adaptive - instantaneous damage control
- Reliable: dynamic load balancing
- Flexible: accommodates new off-grid alternative energy sources
- Interactive with consumers and markets
- Optimized to make best use of resources and equipment
- Integrated, merging monitoring, control, protection, maintenance, EMS, DMS, marketing, and IT
- Secure: less vulnerable to attacks

The Problem for Companies

The problem for companies is that while there is a technological shakeout, there will be few outright winners and many undecided contests. There are many theories about how companies can win competitive battles from Andy Grove who argues that companies should anticipate what is to come next and concentrate their energy to Michael Porter who maintains that they should dominate the five industry forces and be unique to C.K.

Prahalad who holds that they should develop hard to imitate competencies to Michael Eisner whose theory was to create many distribution channels for the creative content of his firm, to Gary Hamel who preaches that firms should make a “revolution.”[9]

Companies have many moves that are to them (see Chapter 3). After examining the external environment and investigating their internal capabilities and competencies, they can reposition products and services by lowering prices and thereby undercut competitors and gain market share or they can increase by means of Advertising, promotion, sales, distribution to differentiate their products and thereby enhance customer loyalty and achieve higher margins. They can redefine the businesses in which they compete through mergers, acquisitions, divestitures, and alliances. They can compete not in the realm of products and services but in the realm of strategic business models creating industries in the process that do not currently exit. These moves that they make are not one time thrusts forward but they must be made continually.

Often times, bigness is a liability and large firms have trouble competing against smaller and more nimble ones. The small firms engage in a type of judo-strategy in which they use movement to avoid direct confrontation with the large concerns, they bend, but do not break when they are subject to retaliation from the larger firms and they rely on leverage, using the weight and strength of their large opponents against them.

Winning is rare but being a diminutive moving target often allows small firms to beat large one. In a study of 1000 companies from 1992-2002 only 32 firms were able to sustain competitive advantage for the entire period based on their stock performance, 64 did the exact opposite and in 37 of 78 industries the companies were fighting to a draw.[10] There were no clear winners. In this sample of companies, it was general the case smaller companies beat larger ones. The 32 winners averaged $3.5 billion in revenues and 14,500 employees, while the 64 losers averaged $10.7 billion in revenues 48,000 employees.

Winners in general were less well known than the losers. They included such companies as Alliant Tech, Amphenol, Ball, Brown & Brown, Forest Labs, SPX, Cabot, Donaldson as well as Southwest Airlines, Johnson Controls, Harley Davidson, and Best Buy. In contrast the losers included such well known companies as Goodrich, Delta Airlines, Disney, Conagra, ADM, Merck, Readers Digest, Kodak, McDonalds, Nordstrom, Halliburton, Kmart, Mattell, Honeywell, Pharmacia, and Saks as well as Snap On, Parametric, and LSI Logic.

To be a winner a company had to have these attributes

1. They had to be in a sweet spot or a relatively uncontested market niche.
2. They had to have the agility to get into this niche.
3. They had to have the discipline to protect.
4. And they had to have the focus to fully exploit it.

Losers had the opposite characteristics. They were in sour spots, they were rigid, they were inept, and they were diffuse and unable to fully exploit the market niches they occupied. The implications are that it is hard to manage the tensions between growth and profits, reinvention and operational excellence, exploration and exploitation, and so on (see Figure 7.15)

Figure 7.15 Managing the Tensions

Implications:
Manage the Tension

A Sweet Spot	Agility (move)	Discipline (protect)	Focus (extend)
Goal	Achieve growth	Enhance profits	Profits and growth
	Innovation	Efficiency	reform and refinement
	Reinvention	Operational excellence	fine-tuning
Actions	**Explore**	**Exploit**	**Explore and exploit**
	Prospect	**Defend**	**Analyze**
Strategies	Vision	Mission	Mission-vision
Conditions	*Disequilibrium*	*Equilibrium*	*Equilibrium- disequilibrium*
Technologies	Disruptive	Sustaining	sustaining-disruptive
Industries	Dynamic	Static	dynamic-static
Image of the Future	**Unpredictable**	**like today**	**gradually evolving**
People	**Revolutionaries** *Break rules*	**Controllers** *Enforce rules*	**Improvers** *Fix rules*

Innovation Versus Management

The paradox of innovation in a corporate environment is that innovation means risk, while good management is meant to minimize risk. Can accounting and financial tools fully capture the value of innovation? Most people in business have powerful reasons for keeping risk to a minimum. In deliberating about whether to undertake a particular project, they have to consider both technical and commercial feasibility. They have to estimate:[11]

- The probable development, production, and marketing costs
- The approximate timing of these costs

- The probable future income streams
- the time at which the income streams are likely to develop

All of these calculations are fraught with uncertainty. The only way to reduce uncertainty is to undertake safe projects. Thus, people in business tend to concentrate on innovations where success is easy. The bias is toward simple, well-tread areas, since fundamental research and invention involve greater uncertainties.

Managers typically establish new generations of existing products, introduce new models, and differentiate a product further rather than creating different products and new product lines. They reduce uncertainty by licensing others' inventions, imitating others' product introductions, modifying existing processes, and making minor technical improvements. An automobile with a new type of body and engine, for instance, is less likely to be introduced than an auto with simple modifications of existing bodies and engines.

For a new product to be launched, people in business must have an optimistic bias. Engineers, for instance, are known to make optimistic estimates of development costs even when they have strong incentives to be more objective in their appraisals. Without optimistic estimates, they would not be given the right to carry out the projects.

As hard as it is to estimate technical success, it is just as difficult to predict market success. Market launch and growth in sales are more distant in time, and conditions in the future vary. The reactions of competitors to the threat of new products are unknown. Achieving an advance understanding of the costs, given changing circumstances in the future, is difficult. How long a product will be on the market and how dominant it will be given the threat of technical obsolescence is hard to know in advance.

Even after prototype testing, pilot plant work, trial production, and test marketing, technical uncertainty is likely to exist in the early stages of innovation and entrepreneurship. The question typically is not whether a product will or will not work; rather, the issues at this stage are what standards of performance the product will achieve under different operating conditions and what the costs will be of improving performance under these conditions. Unexpected problems can arise before a product reaches the market, in the early stages of a promising commercial launch, and after product introduction. It is not only technical uncertainty that affects the introduction of new products. General business uncertainty also is a factor, and new products also can be hurt by inconsistent government support

For technological innovation to take place, the great English economist Keynes believed that "animal spirits" were necessary. He proclaimed that innovation of this nature, where the full consequence of what is to take place can be known only very much in advance, requires a spontaneous urge to action rather than too much rational calculation. If an individual was to do a quantitative analysis of the benefits multiplied by a quantitative analysis of the risks he or she might conclude that it would be better to go back to sleep. If animal spirits are reduced and spontaneous optimism falls, innovation surely would not be as common.... Keynes therefore argued for the supplementing such reasonable calculation with animal spirits

Systems Theory

Keynes did not argue for the elimination of reasonable calculation, just its supplementation. This book has been based on the argument that reasonable calculation can assist people in organizations when they take risks like of introducing new technologies. Underlying its understanding of future conditions is a system theorist's view of the world.[12] Foresight requires that individuals think in system's terms. They must take into account the big picture, the entire realm of factors that may affect the success of their endeavors. be long term winners, companies increasingly will have to rely on system's theory to understand the external environment. Understanding the full impacts of decision pathways requires an integrated understanding of the many dimensions of in the firm's external environment and its foundations as well as the role of science and technology in this broader picture.

It is worth concluding with some examples. Changes in one factor (energy prices, terror, etc.) induce changes in another which in turn bring about changes in a third, and so on (see Table 7.2). These changes link together in chains of cause and effect. Identifying the discrete contribution of each factor to the end result is difficult because the factors themselves are not coherent entities; each consists of conflicting tendencies. With an aggregation so broadly conceived as the global economy there are countless driving forces. Testing system propositions against actors' motivations and interactions (see Chapter 2) therefore is useful in understanding the logic by which systems can cohere and/or disintegrate.

Table 7.2: System-Level Propositions

High Energy Prices	The Global Economy
• Population pressure increases energy prices. • A robust economy increases energy prices. • High energy prices negatively affect the global economy. • High energy prices can stimulate new technologies. • Technology can raise (or lower) energy prices	• A robust economy can strengthen government. • A robust economy can strengthen technology. • A robust economy can increase population pressure. • A robust economy can accelerate climate change. • Population pressure increases climate change.

• Government can raise (or lower) energy prices • High energy prices can inhibit climate change. • Technology can accelerate (or reduce) climate change. • Governments can accelerate or reduce climate change. <u>Terror</u> • Strong governments can prevent terror. • High energy prices can increase terror. • Youth bulges can bring about terror. • A robust economy can mitigate terror. • Terror raises energy prices. • Terror negatively affects the global economy. • Terror weakens government. • Terror retards the diffusion of most technologies. • Terror inhibits the free flow of people.	• Population pressure can have a negative effect on the global economy. • Climate change can have a negative effect on the global economy. • Government can affect population pressure. • Technology can have a positive impact on the global economy. • Government can affect technological development • Government can have a positive impact on the global economy. • The interaction of government and technology can moderate the effects of terror, energy prices, population, and climate change on the global economy.

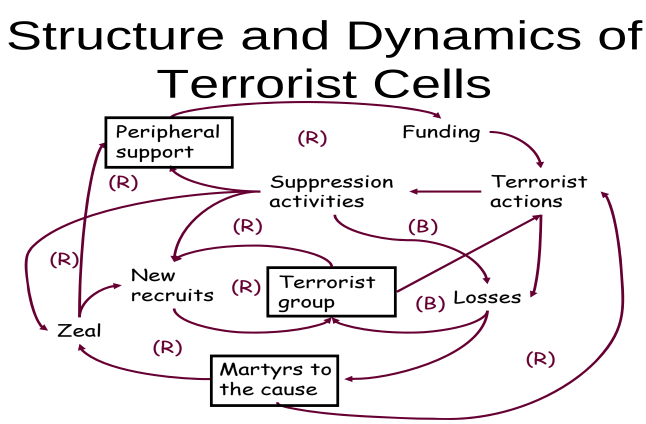
Systems may display great resiliency. They can be in equilibrium for long periods of time, but countervailing forces also exist that migrate quickly in surprising directions and throw systems off-course. Systems then plunge rapidly from high degrees of organization and stability to low degrees of both. What provides for ongoing system coherence and prevents rapid disintegration? Is it the linkages among elements and feedback loops that freeze elements into fixed cycles? Or does the opposite take place -- some elements in the systems experience strains, fall apart, and cause collapse? When does linear change terminate and non-linear transitions take over, and at what speed does this process happen?

A comprehensive checklist of propositions sensitizes people engaged in the scenario exercise to the array of possibilities. Global insecurity, for instance, affects population movement and composition. It can inhibit global commerce by slowing down the smooth and regular flow of technologies, goods, services, and money. Terror raises energy prices. However, these impacts may be moderated to some degree by the extent to which national and international governance systems remain free, open, and strong in the face of these threats. Oil prices can skyrocket because of global prosperity and rising demand. They can increase because of global climate change. Scarcity may induce governments to raise energy taxes or take other steps to get people to conserve. The higher energy prices can limit economic growth unless there are technological breakthroughs in energy saving devices and fuels. These breakthroughs can be speeded up or retarded by the policies of governments and the kinds of investments they make or fail to make in research and development. All of these factors affect the degree to which economic conditions are stable in the short, medium, and long term. The more stable and predictable that economic conditions are, the better the climate will be for investment. A better climate for investment creates a positive feedback loop which induces more investment and better economic results. The key is to understand these connections and be mindful of how system-level propositions affect and are affected by actors' motivations and behavior (see Chapter 2).

Technology is a key hinge forcing functions, critical junctures, and pinch points. The goal is to target constrained development resources to maximize benefit and minimize unintended consequences. In a systems model there are blockers, accelerators, feedback loops, and outputs. The tools for systems thinking are to focus on modeling dynamics trends over time, to use causal-loop diagrams, and to stand back far enough to get a systems view or a view that deliberately blurs discrete events into patterns and structure of behavior. Problems should be defined in terms of trends over time, the important variables, historical data, and possible and preferred dynamics. These then should be used to focus systems thinking and modeling

Delays, pressures, irrationalities, and intentional policies meant to govern decisions can be tracked. Causal mapping is a powerful tool for representing structure. An increase in factor A makes factor B *higher* than it would have been without the change. An increase in factor C makes factor D *lower* than it would have been without the change, ceteris paribus that is, all other conditions held constant. A feedback loop exists when something changes the state of the system. Reinforcing loops (represented by R in Figure 7.16) are growth producing, accelerating, and destabilizing, while balancing loops (represented by B in Figure 7.16) are counteracting, goal seeking, and stabilizing. Figure 7.16 may be usefully compared to the theory for understanding youth violence that was developed in Chapter 4. Systems theory can be productively applied to the foresight problems in this book.

Figure 7.16: A System's Diagram



[1] The material in this afterword originally was presented in somewhat different form by Massoud Amin at the Nile University Strategic Management Breakfast Seminar in the Cairo, Marriott Hotel Zamalek, Aida Ballroom, July 13, 2008.

[2] J. Schumpeter, Business Cycles (New York: McGraw-Hill, 1939).

[3] Ibid.

4.N. Kondratiev, "The Major Economic Cycles," Voprosy Konjunktury, 1, 1925, pp. 28-

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[7] Polla Other Construction, Textiles, Agriculture, Environmental Areas identified from The Nanotechnology Opportunity Report, CMP/Cientifica, Vol. 1, March 2002.

[8] -- The Energy Web**,** Wired Magazine, July 2001

http://www.wired.com/wired/archive/9.07/juice.html

[9] Strategy gurus

[10] Big winners

11.C. Freeman.

[12] Richardson