ปัจจัยที่มีอิทธิพลต่อทิศทางการวิจัยและพัฒนาในอนาคต

Influential Factors to R&D Directions

ทวีศักดิ์ กออนันตกูล

สำนักงานพัฒนาวิทยาศาสตร์และเทคโนโลยีแห่งชาติ

หัวข้อนำเสนอ

1. แนวโน้มสถานการณ์โลกที่มาแรง และโจทย์ที่ท้าทาย
2. การหลอมรวมของภูมิปัญญา เทคโนโลยี และสังคม -> ต่อจากการหลอมรวมกันของวิทยาการ Nano-Bio-Info-Cognitive sciences (NBIC)
3. ตัวอย่างการพัฒนาระบบสุขภาพของประชาชนด้วย ว และ ท ของสิงคโปร์

Government Office for Science

Global Trends and Challenges


Urbanization


Population


Food security

Poverty


Energy shortage


Climate Change


Water shortage


Terrorism


Weapon of Mass Destruction


New Diseases


Degradation of Biodiversity

Ref: Professor John Beddington 2009

Urbanization Stress

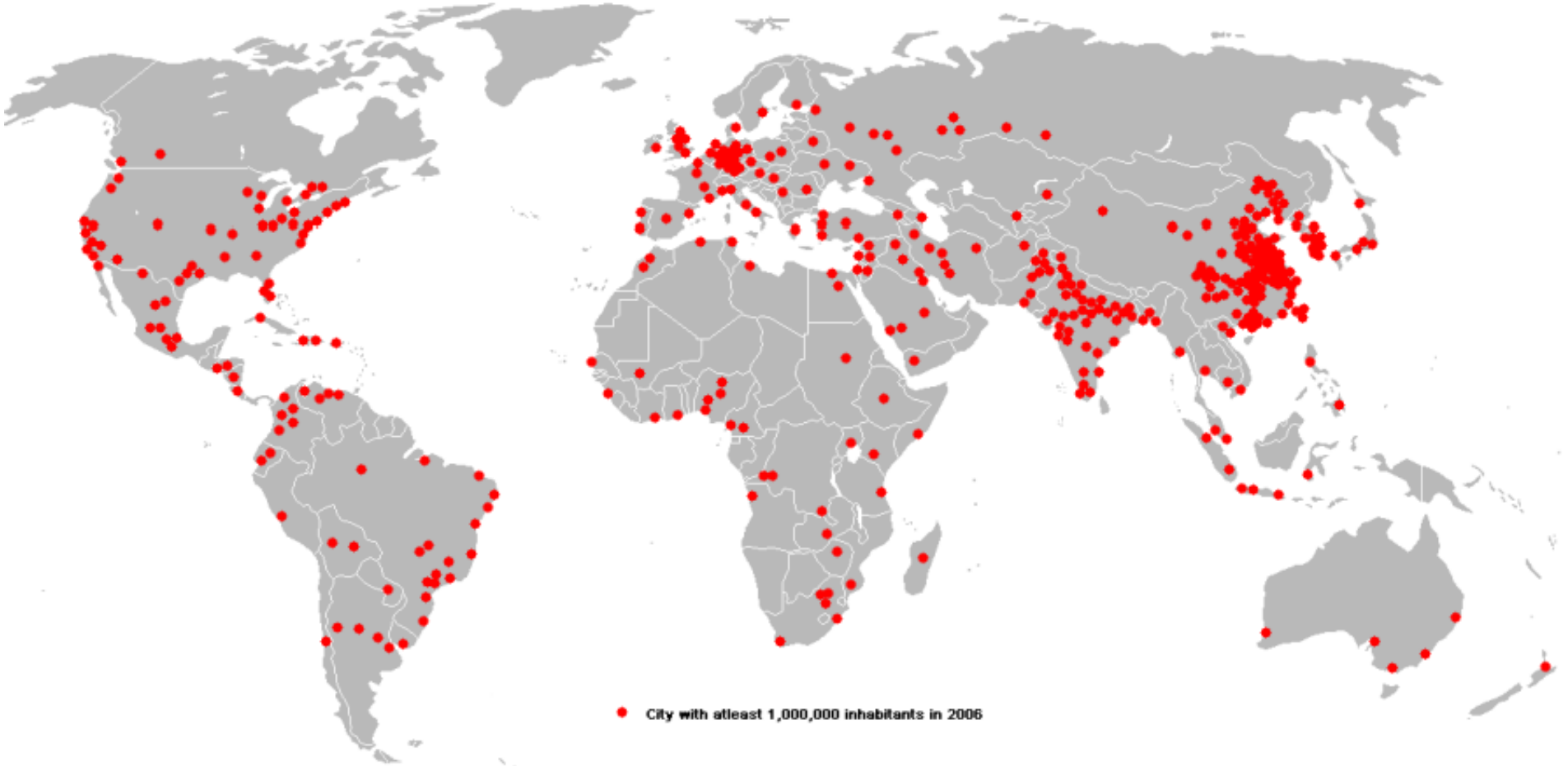
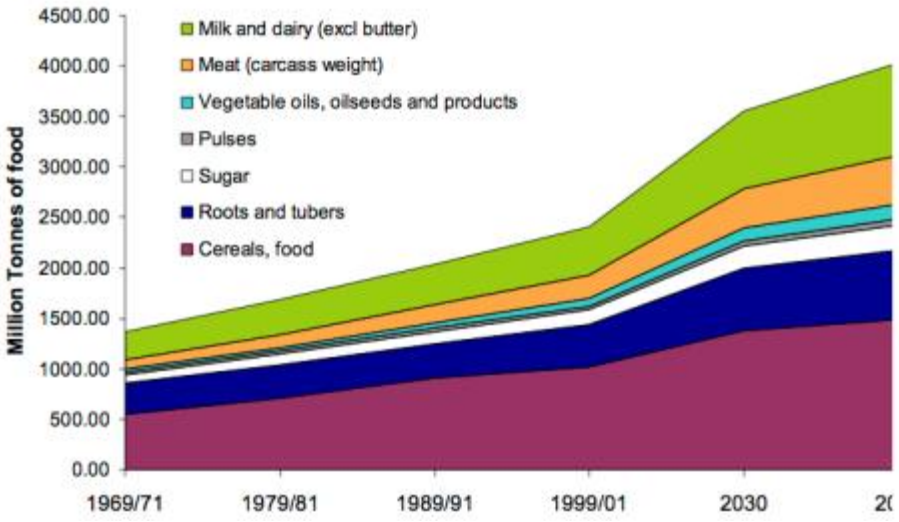
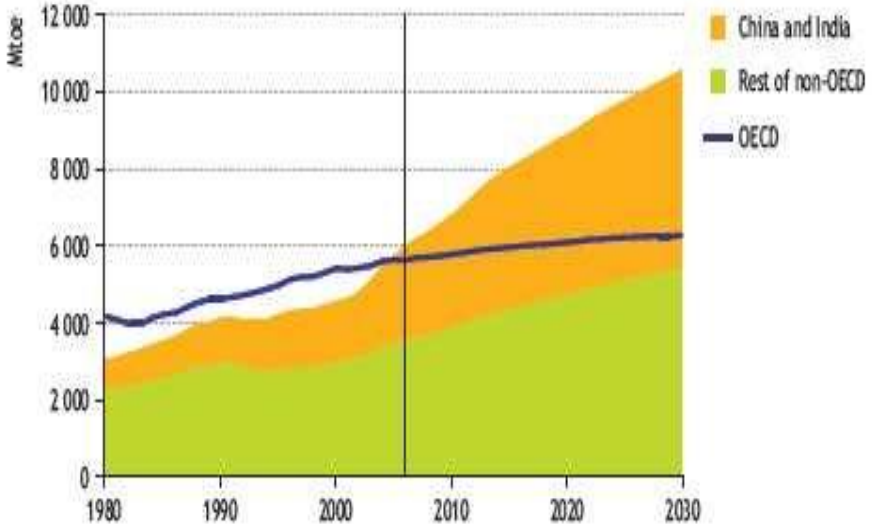


Figure 9.5 Map showing urban areas with at least one million inhabitants in 2006. Only 3% of the world's population lived in cities in 1800; this proportion had risen to 47% by 2000, and reached 50.5% by 2010. By 2050, the proportion may reach 70%. (Source: Wikimedia Commons, http://en.wikipedia.org/wiki/File:2006megacities.png.)

Government Office for Science

World Demands on Food and Energy





World food production

must rise by 50 % by 2030 to meet increasing demand.

(Source: UN 2008)

Total world energy demands

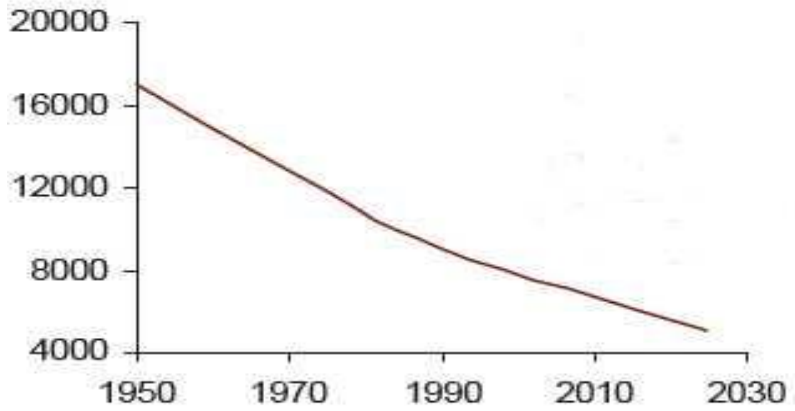
are predicted to increase by approx. **50% by 2030.**

(Source: IEA 2008: Reference Scenario)

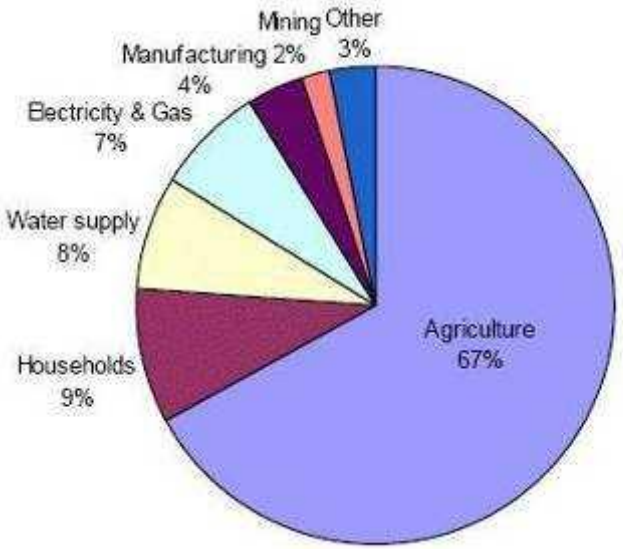
Ref: Professor John Beddington 2009

Government Office for Science

Available fresh water cu.m./people



Source: UNEP, 2002



Source: ABS 2005

"The challenge of securing safe and plentiful water for all is one of the most daunting challenges faced by the world."

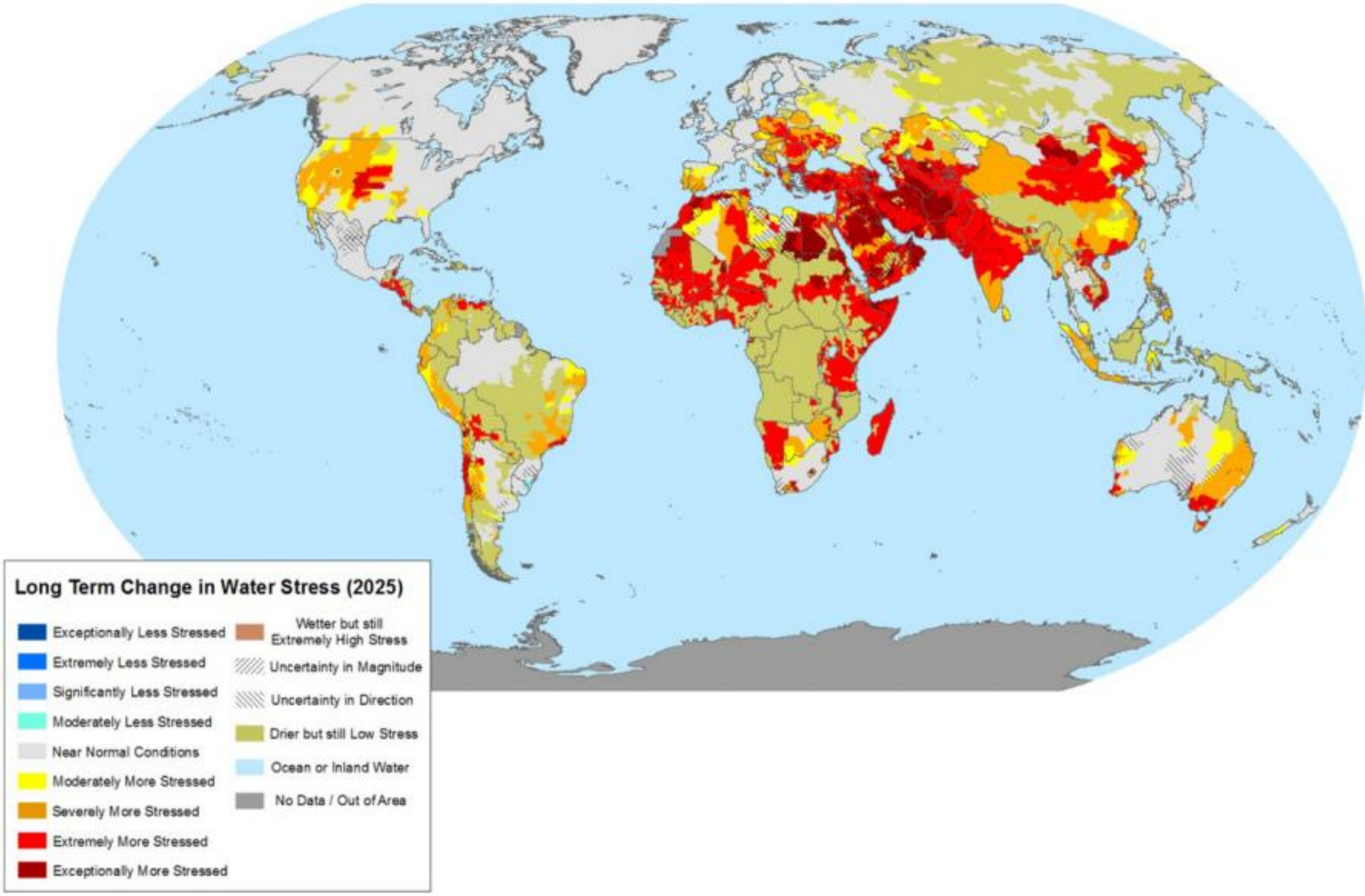
Source: Ban Ki-moon, 2008

Total world water demands

are predicted to increase by over 30% by 2030.

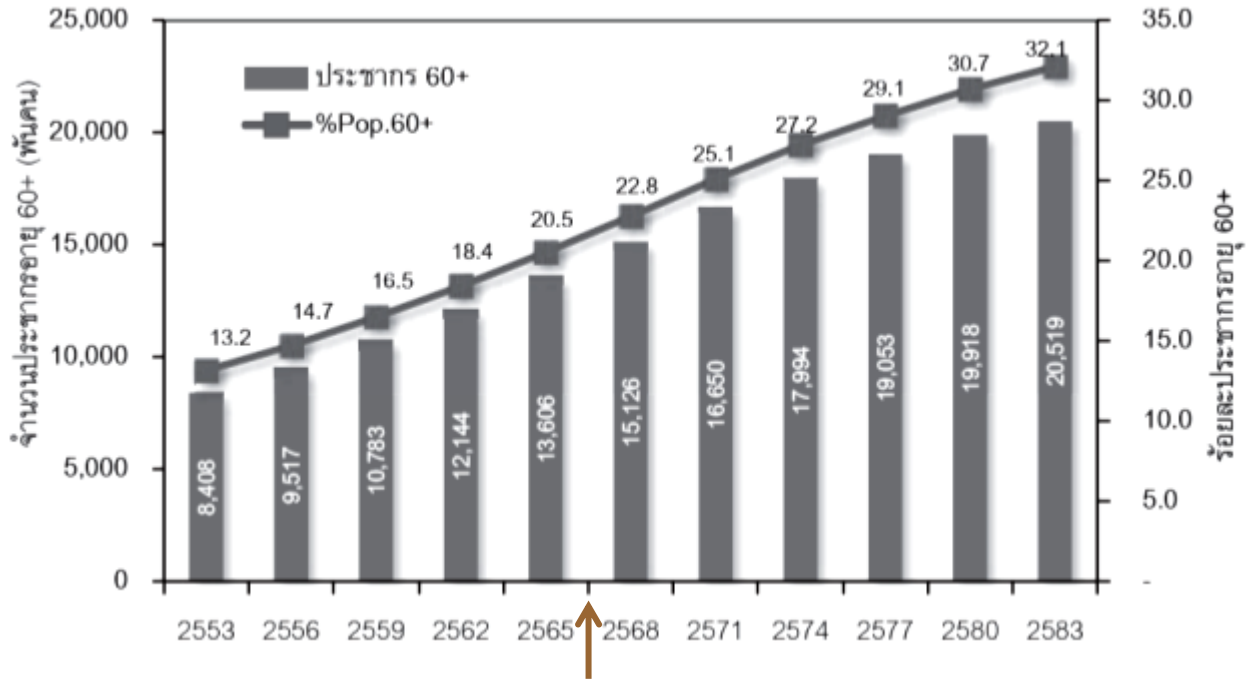
Source: IFRPI

Ref: Professor John Beddington 2009



http://www.wtec.org/NBIC2/

พ.ศ. 2547 ประชากรของประเทศไทย ก้าวเข้าสู่สังคมสูงอายุ (aging society)



พ.ศ. 2567 สังคมสูงอายุโดยสมบูรณ์ (aged society)

- ด้านแรงงาน
- ด้านการศึกษา
- ด้านสุขภาพ
- ด้านสิ่งแวดล้อม
- ด้านสวัสดิการ

สังคมผู้สูงอายุ

- นวัตกรรมบ้านผู้สูงอายุ (Smart Homes, Robots)
- งานวิจัยโรคผู้สูงอายุ

แหล่งข้อมูล: สำนักงานคณะกรรมการพัฒนาการเศรษฐกิจและสังคมแห่งชาติ.2556.

วิกฤตภาวะภาวะภูมิอากาศเปลี่ยนแปลง

ความมั่นคงด้านอาหาร | สุขภาพ

ความเสี่ยง

ระบบนิเวศ | สังคม

ลดการปล่อยก๊าซเรือนกระจก

สังคมคาร์บอนต่ำ (Low Carbon Society)

ความได้เปรียบในด้านสิ่งแวดล้อมที่ยั่งยืน GreenJob/Green Growth/Green Economy

ผลิตภัณฑ์ที่เป็นมิตรกับสิ่งแวดล้อม (Eco-product)

ฉลากคาร์บอนฟุตพรินต์ : น้ำ สิ่งแวดล้อมองค์กร (Green NSTDA)

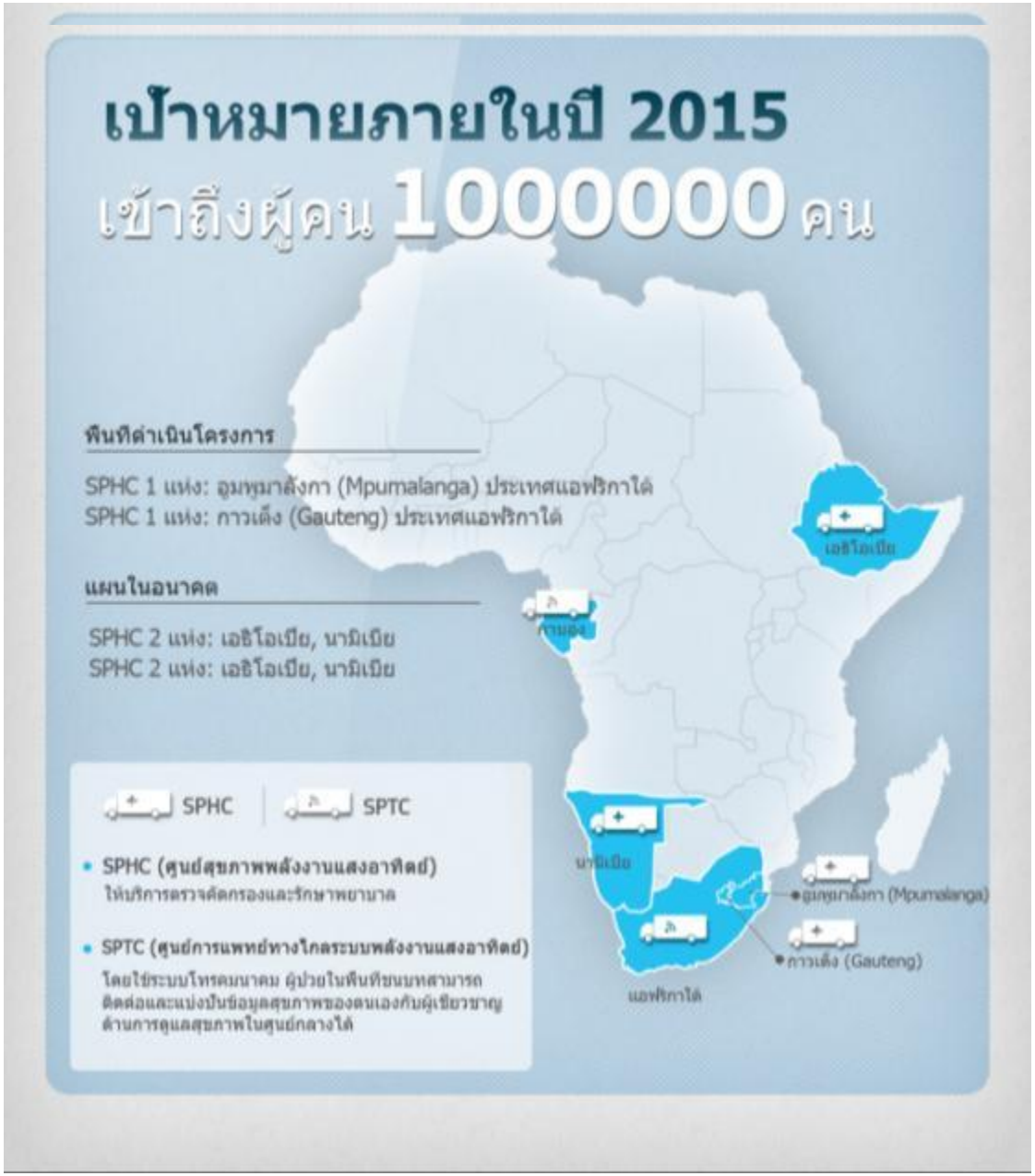
การพัฒนาและสร้างความสามารถในการแข่งขันของประเทศอย่างยั่งยืน

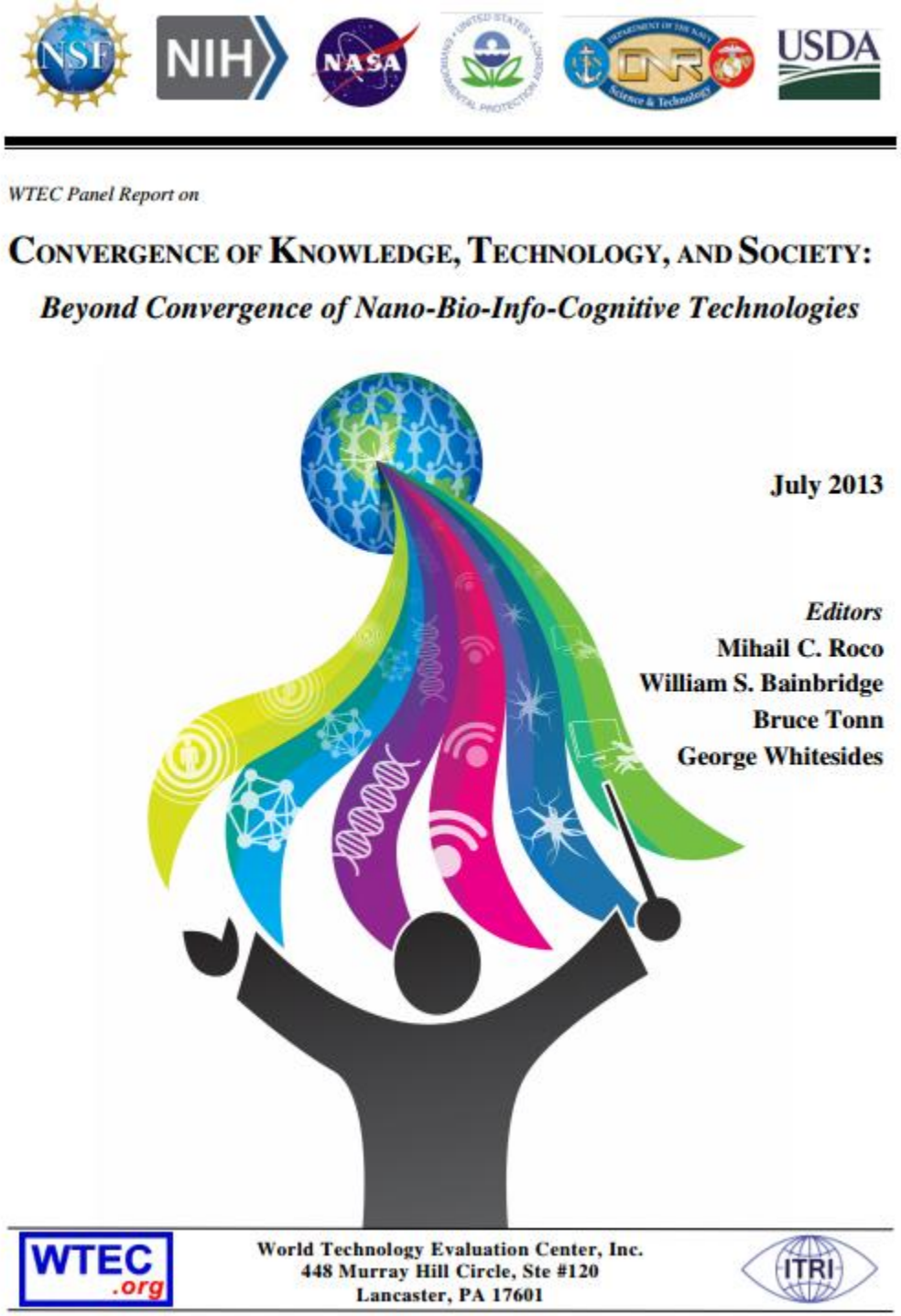
โรคอุบัติใหม่/อุบัติซ้ำ

แหล่งข้อมูล:ยุทธศาสตร์การวิจัยรายประเด็นด้านการเปลี่ยนแปลงสภาพภูมิอากาศ (พ.ศ. ๒๕๕๖–๒๕๕๙)

ตัวอย่าง


Samsung นำบริการด้านการแพทย์เคลื่อนที่ไปสู่พื้นที่ชนบทในแอฟริกา
ศูนย์สุขภาพพลังงานแสงอาทิตย์ (SPHC)
ป้องกันความเจ็บป่วยโดยการตรวจคัดกรองและการทดสอบแต่เนิ่นๆ
กว่า 60%
ของประชากรในแอฟริกาใต้ทะเลทรายซาฮารา
อาศัยอยู่ในพื้นที่ชนบท
ปัญหา
พวกเขามักจะ
ไม่มีเวลาและเงิน
ที่จะเดินทางเป็นระยะทางไกลๆ
เพื่อไปยัง
คลินิกและรับการรักษาพยาบาล
เชิงป้องกัน
วิธีแก้ปัญหา
นำความช่วยเหลือ
ไปสู่ผู้คน
SAMSUNG
คลินิกตา / คลินิกโรคเลือด
คลินิกทันตกรรม
คลินิกหู


เป้าหมายภายในปี 2015
เข้าถึงผู้คน 1000000 คน
พื้นที่ดำเนินโครงการ
SPHC 1 แห่ง: อุมพุมาลังกา (Mpumalanga) ประเทศแอฟริกาใต้
SPHC 1 แห่ง: กาวเต็ง (Gauteng) ประเทศแอฟริกาใต้
แผนในอนาคต
SPHC 2 แห่ง: เอธิโอเปีย, นามิเบีย
SPHC 2 แห่ง: เอธิโอเปีย, นามิเบีย
SPHC
SPTC
SPHC (ศูนย์สุขภาพพลังงานแสงอาทิตย์)
ให้บริการตรวจคัดกรองและรักษาพยาบาล
SPTC (ศูนย์การแพทย์ทางไกลระบบพลังงานแสงอาทิตย์)
โดยใช้ระบบโทรคมนาคม ผู้ป่วยในพื้นที่ชนบทสามารถ
ติดต่อและแบ่งปันข้อมูลสุขภาพของตนเองกับผู้เชี่ยวชาญ
ด้านการดูแลสุขภาพในศูนย์กลางได้
เอธิโอเปีย
นามิเบีย
อุมพุมาลังกา (Mpumalanga)
กาวเต็ง (Gauteng)
แอฟริกาใต้



การหลอมรวมของภูมิปัญญา เทคโนโลยี และสังคม -> มากยิ่งกว่าการหลอมรวมกันของวิทยาการ Nano-Bio-Info-Cognitive sciences (NBIC) ภาคสอง

http://www.wtec.org/NBIC2/Docs/FinalReport/Pdf-secured/01-NBIC2-FinalReport-WTECversion--web.pdf

NNI – NBIC – NBIC2

M.C. Roco, W.S. Bainbridge, B. Tonn, G. Whitesides

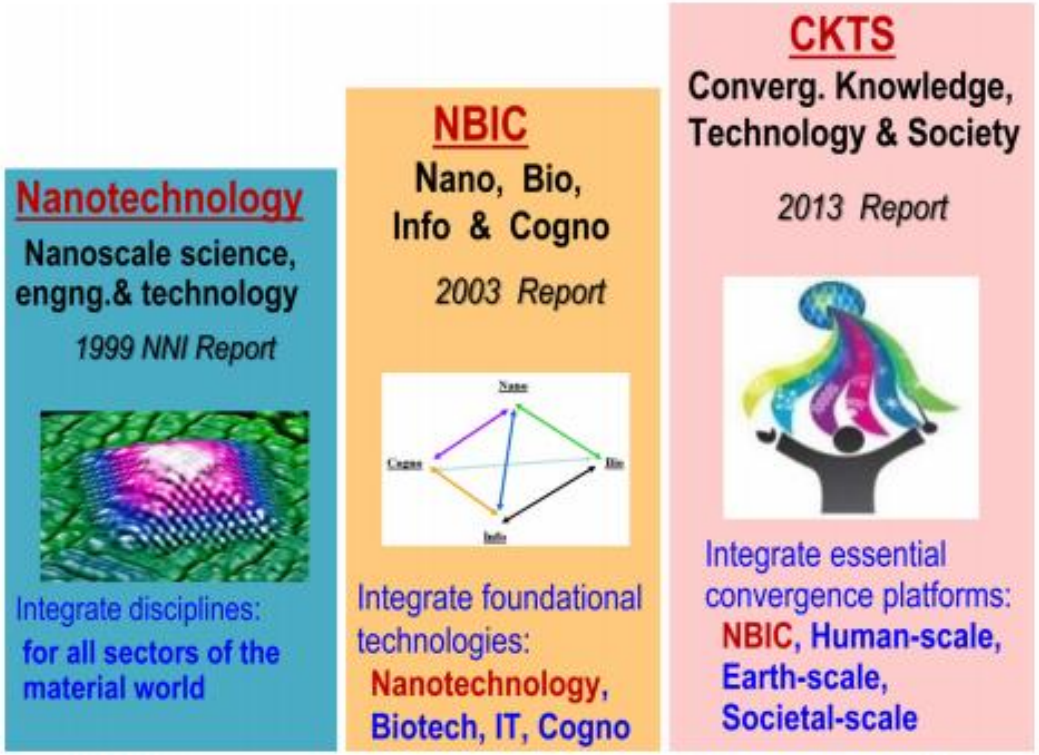


Figure 1 Successive levels of convergence for added value, as described in three reports: (from left to right) *nanotechnology* integrating disciplines for all sectors of the material world (Roco, Williams, and Alivisatos 1999); *NBIC* recognizing the novel synergies among different sciences and technologies (Roco and Bainbridge 2003); and *CKTS* looking holistically at the interconnections between science, technology, and society (this volume).

http://www.wtec.org/NBIC2/Docs/FinalReport/Pdf-secured/01-NBIC2-FinalReport-WTECversion--web.pdf

10.1.2 The Vision for the Next Decade

CKTS implications are expected to increase significantly in the next decade, with the following characteristics:

- Convergence will contribute to major changes in science, technology, and society, and will become a condition for national but also industrial and human competitiveness. The convergence approach will become increasingly proactive and systemic (decisions taken considering the system as a whole, as compared to a reactive approach based on interaction of system components). New socio-technical convergence platforms of various sizes will emerge. Systematic convergence in knowledge and technology promises to increase the rate of scientific breakthroughs, lead to the establishment of new S&T domains and support growing expectations for human progress, including improved productivity, education, and quality of life.
- A virtual spiral of creativity and innovation (see schematic in Figure 4.1 in Chapter 4) between and within CKTS platforms will be created, along with an increase in the speed of circulation (transfer) of ideas from one field to another. This will have a significant effect on innovation, productivity, and commercialization. It will be a condition of competitiveness for sectors or regions.

CKTS

>NBIC

OVERVIEW AND RECOMMENDATIONS

CONVERGENCE OF KNOWLEDGE, TECHNOLOGY, AND SOCIETY:
Beyond Convergence of Nano-Bio-Info-Cognitive Technologies

M. C. Roco, W. S. Bainbridge, B. Tonn, G. Whitesides

Science, engineering, and technology are recognized to permeate nearly every facet of modern life and to hold the key to solving many of humanity's most pressing current and future challenges (NRC 2012). In their recent book *That Used to Be Us*, Friedman and Mandelbaum (2011) identify one of the main challenges for the United States as bringing activities together driven by a higher national purpose—to "act collectively for the common good." Our report aims to address that challenge by identifying the basic mechanisms of human activity—including knowledge creation and technological innovation—and proposes an approach to better understand and use these mechanisms for a holistic purpose. The report advances convergence in science and technology to benefit society; evaluates methods to improve its transforming tools and governance; and identifies long-term trends in the application of converging technologies. The project has gathered information on interdisciplinary research, development, application projects, and trends from the Americas, the European Union, Asia, and Australia.

Some important themes pervade science, mathematics, and technology and appear over and over again, whether we look at an ancient civilization, the human body, or a comet. They are ideas that transcend disciplinary boundaries and prove fruitful in explanation, in theory, in observation, and in design (AAAS 1989). This report is centered on five such ideas focused on convergence of knowledge, technology, and society (CKTS): (1) *the principle of holistic system interdependence in nature, knowledge, and society with application to the economic, human-scale, Earth-scale, and societal-scale platforms*, (2) *the convergence–divergence (spin-off) evolutionary process in science and technology*, (3) *the cultivation of higher-level (multidomain) languages to support fruitful transfer and application of new knowledge*, (4) *the need for vision-inspired basic research and grand challenges to efficiently achieve desired outcomes*, and (5) *the merit of systematic channeling of public and private efforts to promote convergence activities*.

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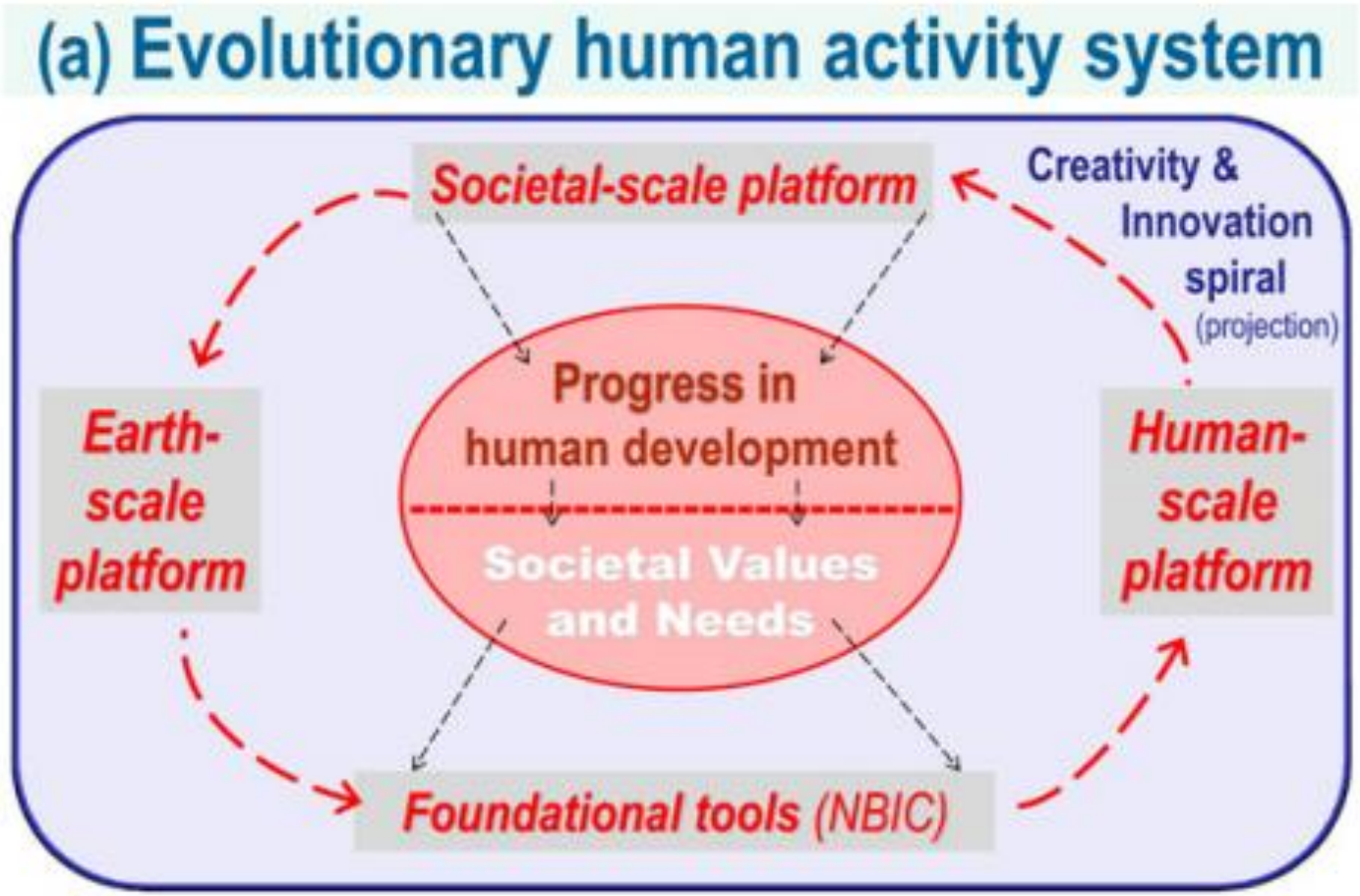
วงจรของกิจกรรมมนุษย์



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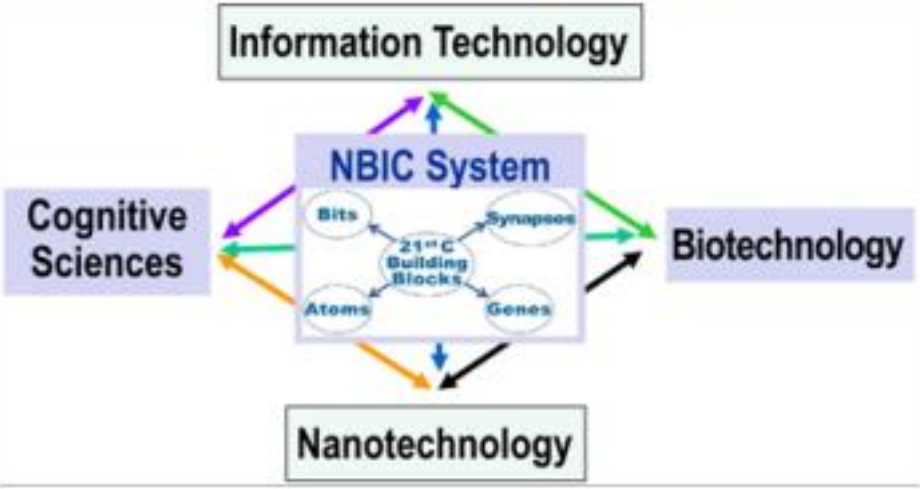
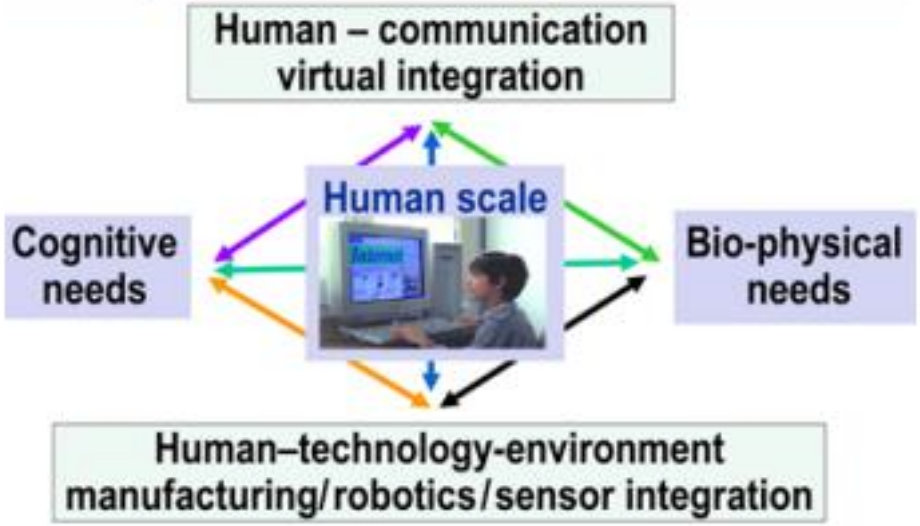
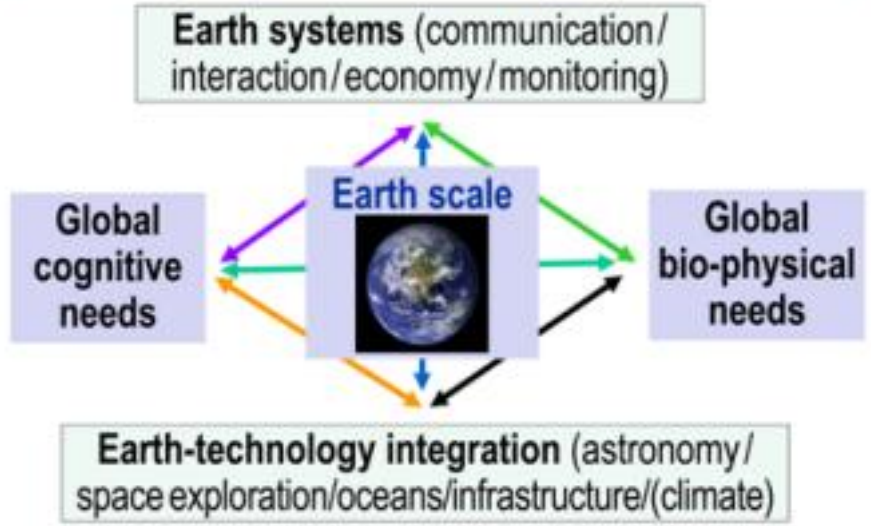
(b) Foundational tools (NBIC) platform



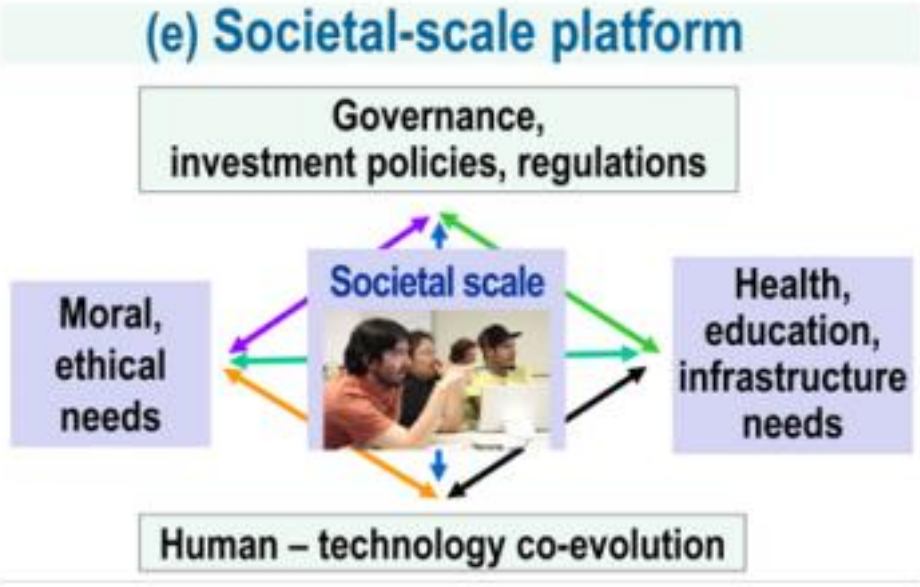
(c) Human-scale platform



(d) Earth-scale platform



(e) Societal-scale platform



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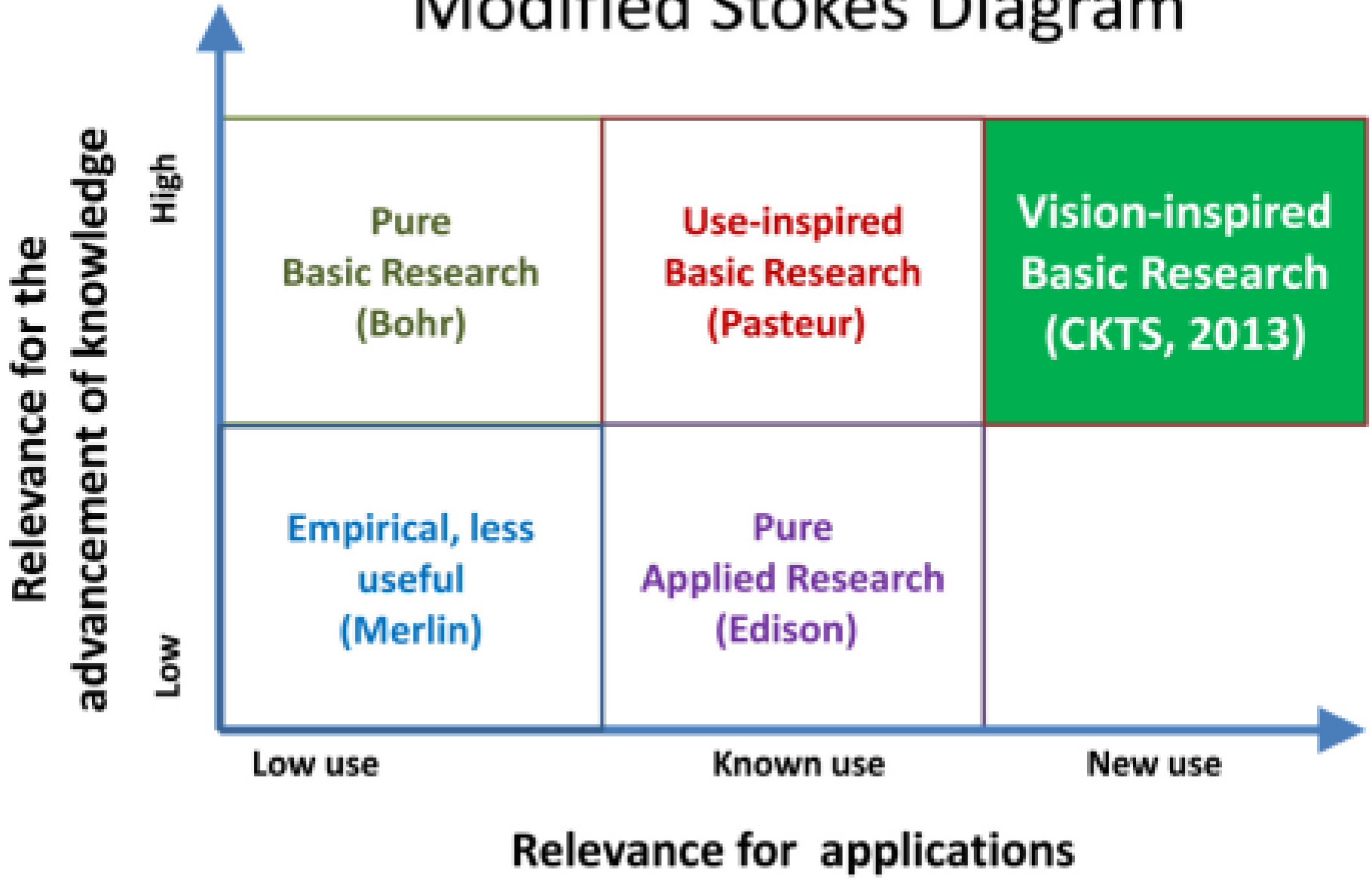
Modified Stokes Diagram



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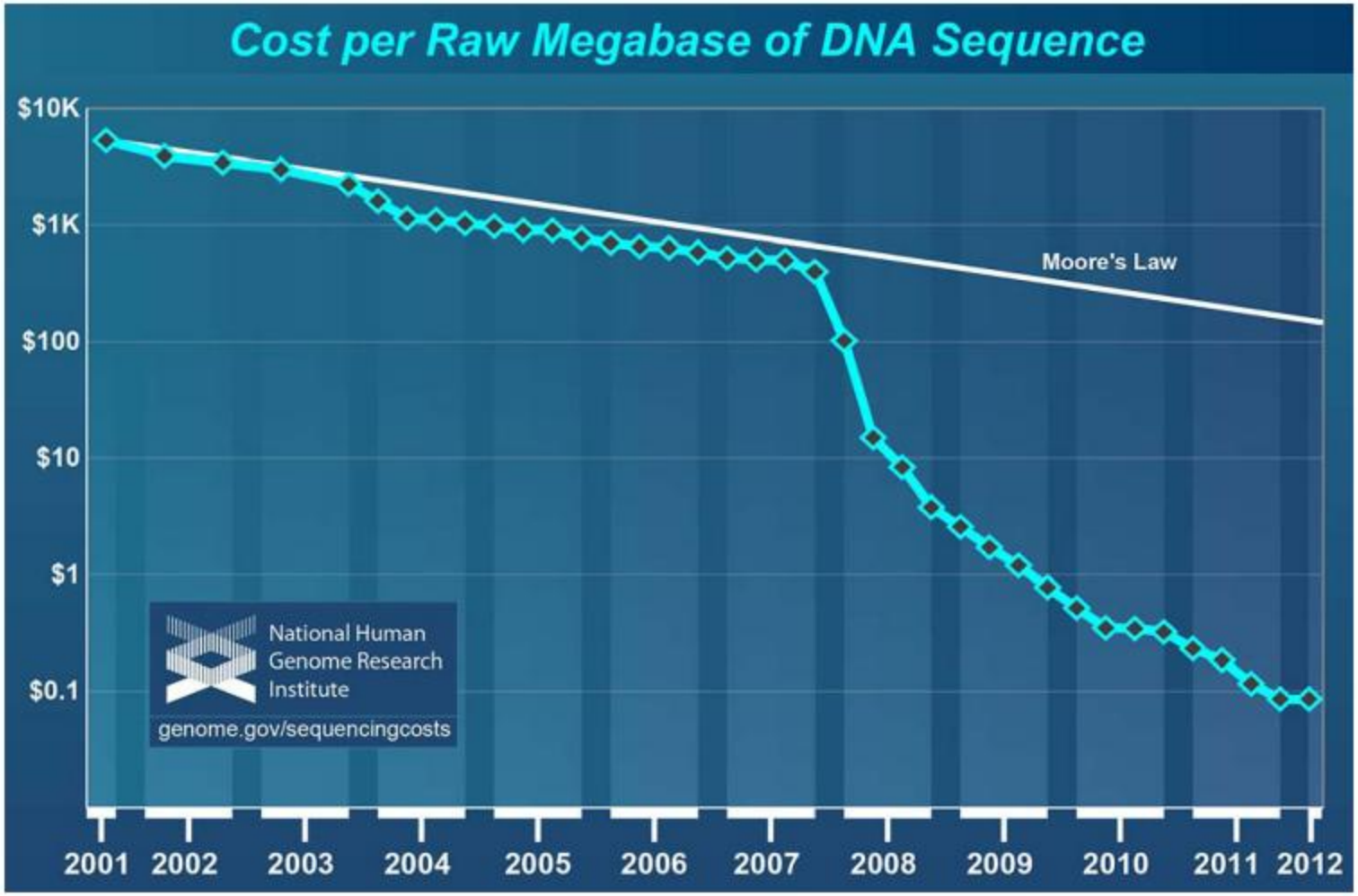


Cost of sequencing a megabase of DNA vs. time. (Source: NIH/NHGRI, K.A. Wetterstrand, http://www.genome.gov/sequencingcosts/, DNA sequencing costs: data from the NHGRI Genome Sequencing Program (GSP); accessed January 2013.)

http://www.wtec.org/NBIC2/

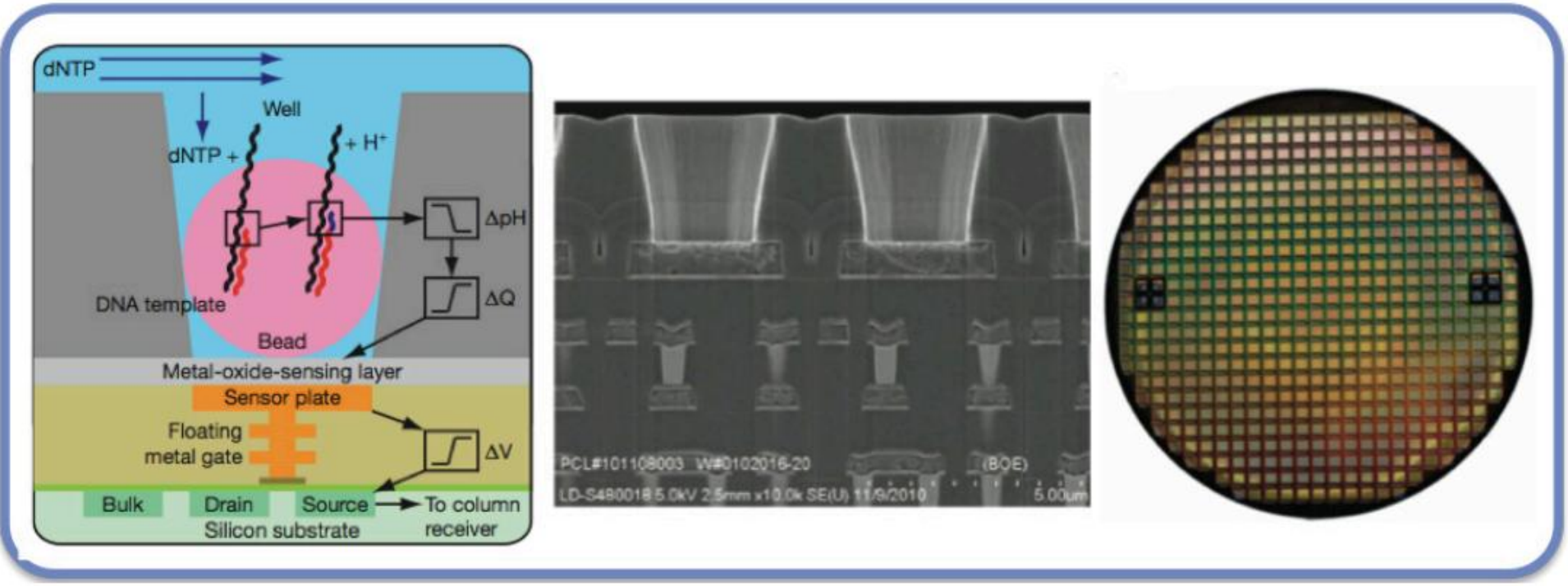


Figure 1.4 All-electronic gene sequencing (Ion Torrent). Illustration of 3D electronics: an emerging new era in integrated nanosystems built on a powerful CMOS technology platform. Ion-sensitive field-effect transistors (FETs) are integrated on silicon metal-oxide field-effect transistors (MOSFETs) (*left*). and integrated on CMOS chips to provide electronic readout and information processing (*middle*), resulting in a technology that can leverage high-volume, 200–300 mm silicon manufacturing technology (*right*) (adapted from Rotherberg et al. 2011, p. 349, Figure 1, ©*Nature;* reuse cleared through Rightslink).

http://www.wtec.org/NBIC2/

ตัวอย่างของ Earth-scale platform

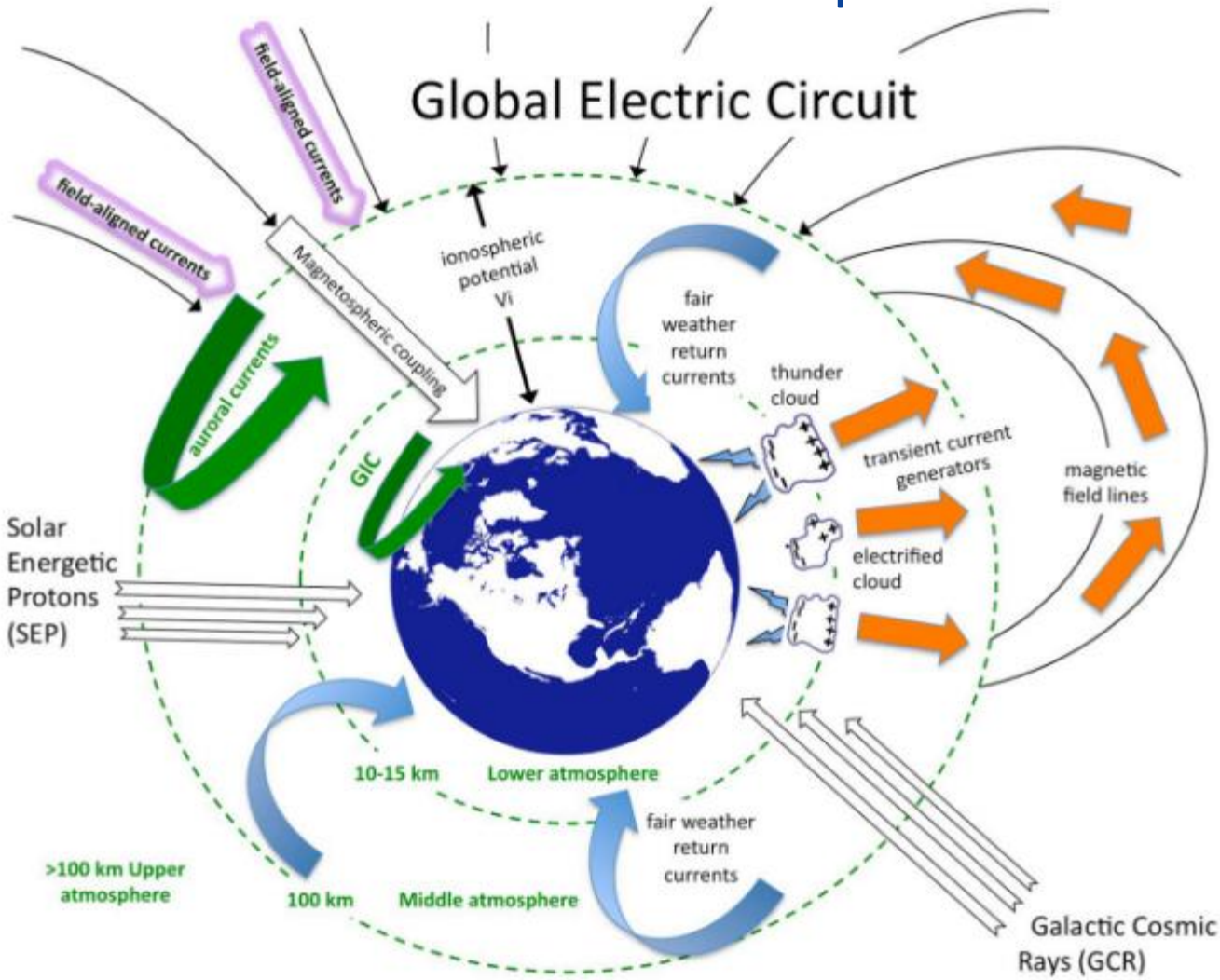


Figure 3.2 Global electric circuit and its effects on Earth (source: Jeffrey Forbes, University of Colorado Boulder, used by permission; available online: http://nsf.gov/news/news_images.jsp?cntn_id=121842&org=NSF).

Material Challenges

Will we have enough metals for the future?

Figure 9.6 Global estimates of end-of-life recycling rates for 60 metals and metalloids: 30 are <1%; 2 are 1-10%; 3 are 10-25%; 3 are 25-50%; only 18 are over 50% (Reck and Graedel 2012, adapted from a figure in Graedel et al. 2011; ©AAAS, reprinted with permission).

http://www.wtec.org/NBIC2/

Materials research needs

. Because our current consumption of critical metals is at an all-time high (Reck and Graedel 2012), there is an urgent need for novel strategies to decrease the utilization of critical materials in energy generation, conversion, and storage, and/or to replace them with earth-abundant elements. New technologies and strategies are also needed to augment the supply of critical materials through recycling and reuse. In the next 10–20 years, we expect that the convergence between nanotechnology, materials science, separations science, and engineering (e.g., chemical, mechanical, and systems engineering) will lead to the transformative advances required to ensure global materials sustainability including:

- Nanocrystalline-silicon thin films for high-efficiency photovoltaics cells
- Nanostructured materials based on earth-abundant elements (e.g., silicon nanowires) for high-capacity energy storage systems (e.g., batteries)
- More efficient magnets for electric vehicles and wind turbines using earth-abundant elements (e.g., iron, nickel, and manganese) as alternatives to rare-earth elements
- Nanostructured catalysts based on earth-abundant elements (e.g., iron, copper, nickel, and manganese) for fuel cells and solar fuel generation
- More efficient and cost-efficient separation materials (e.g., sorbents and membranes) and systems for extracting and recovering critical materials from nontraditional sources, including mine tailings, industrial wastewater, seawater, and brines

http://www.wtec.org/NBIC2/

Worldwide economic impact of treating diseases

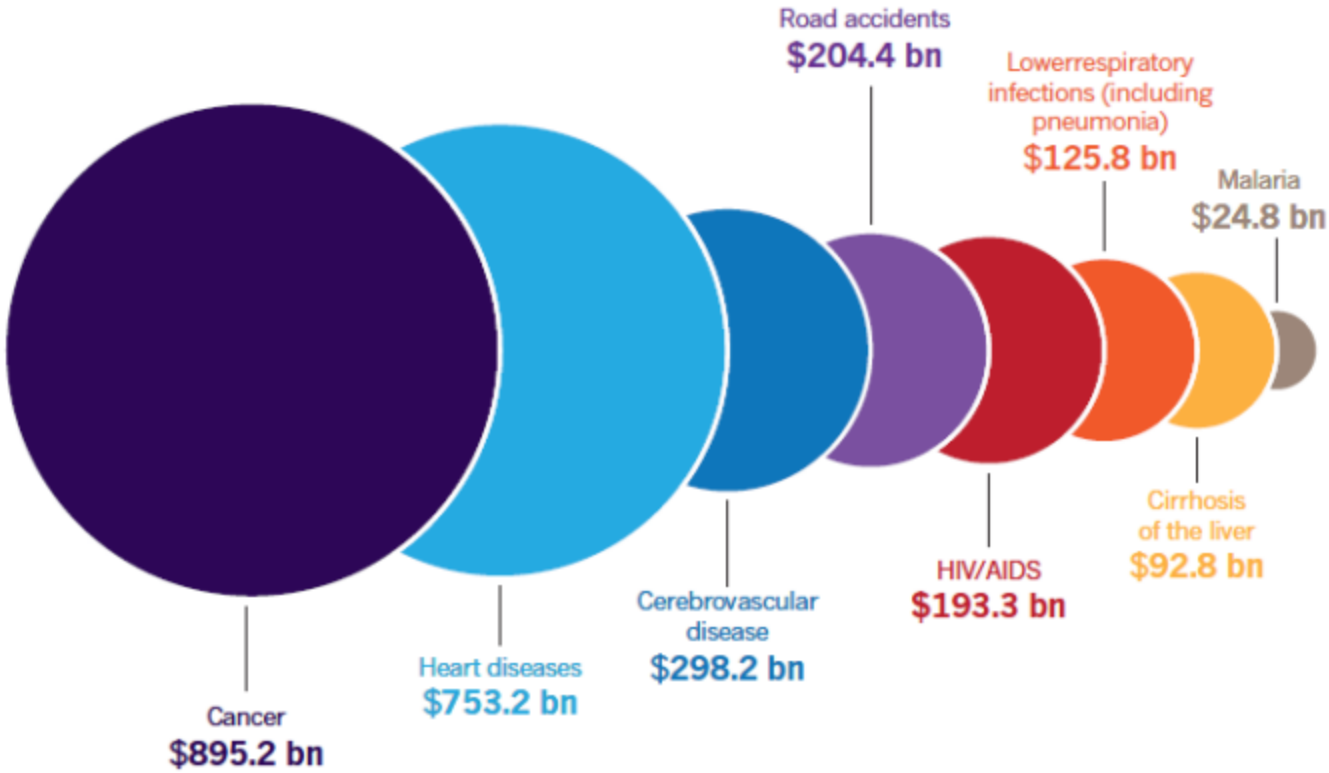


Figure 5.1 Worldwide economic impact of treating different diseases (O'Callaghan 2011; ©Nature Publishing Group 2011; permission to reuse through Rightslink).

http://www.wtec.org/NBIC2/

Evolution of death rates

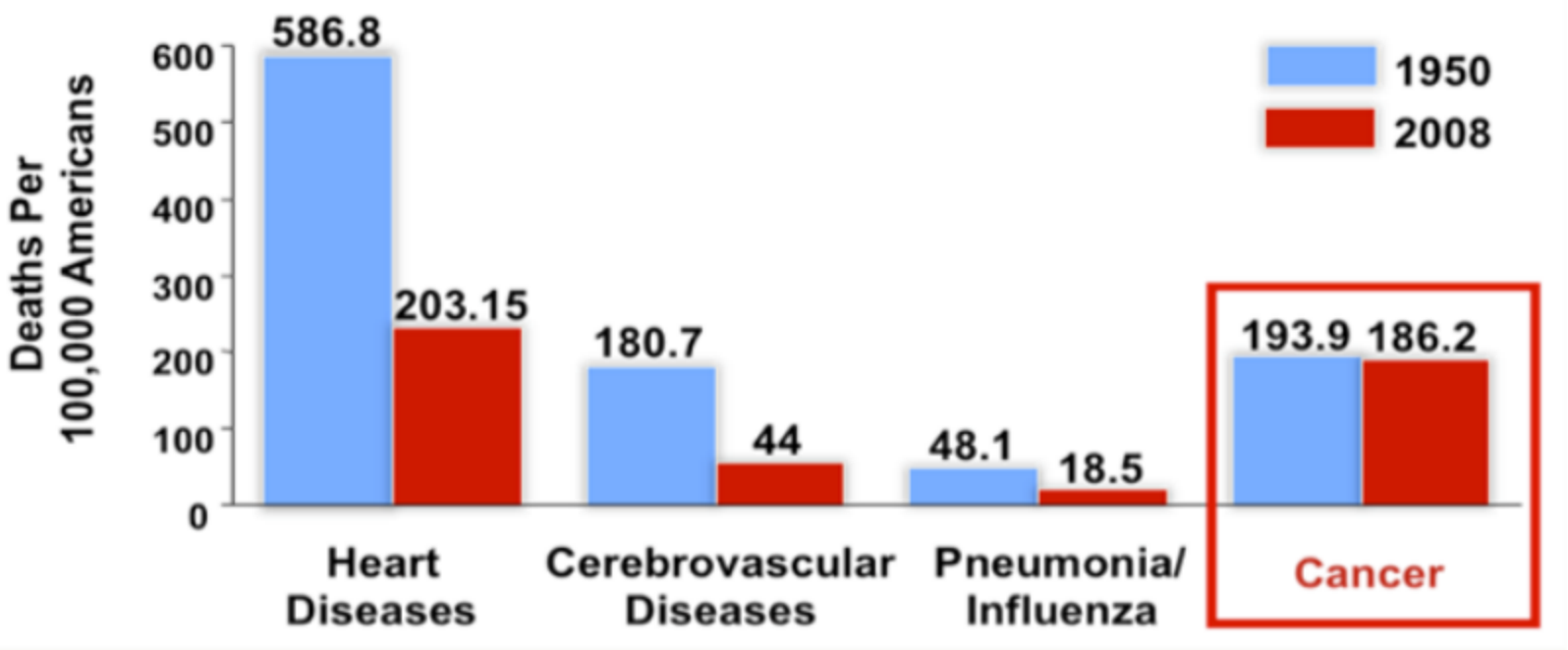
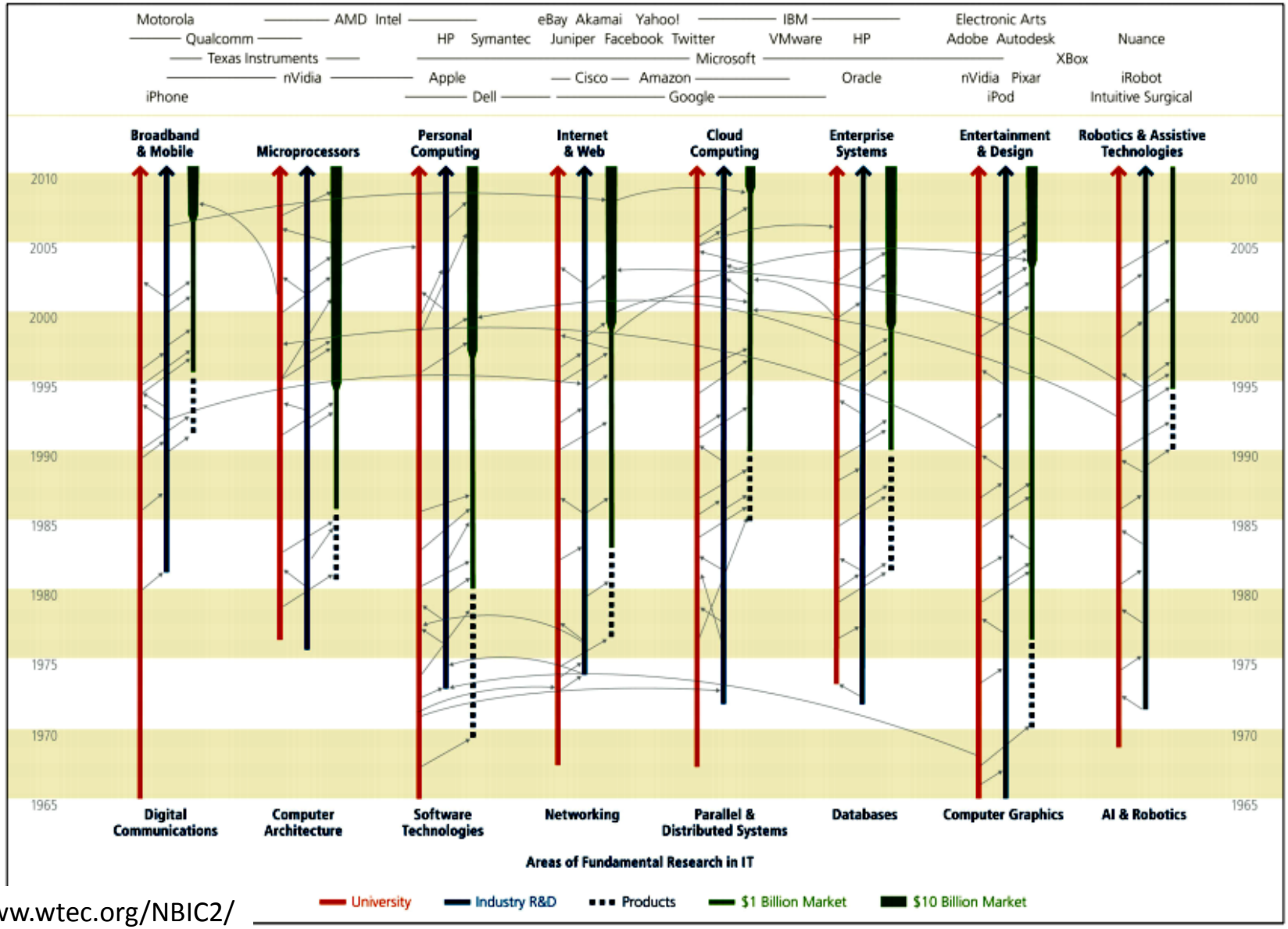


Figure 5.2 Evolution of death rates in the last 60 years for different diseases. (Source for the 1950 and 2008 age-adjusted death rates is NCHS 2008, http://www.cdc.gov/nchs/hus/contents2011.htm#024, available for public use.)

http://www.wtec.org/NBIC2/

กว่าจะออกสู่ตลาดในวงกว้าง



http://www.wtec.org/NBIC2/

Figure 5.7 Examples of academic/government-sponsored and industry-sponsored IT research and development efforts in the creation of commercial products and industries (NRC 2012, Fig. 1, p. 3; © 2012, The National Academies Press, used by permission).

การบูรณาการเพื่อความสำเร็จของการหลอมรวมกันระหว่างเทคโนโลยีและวิทยาการ

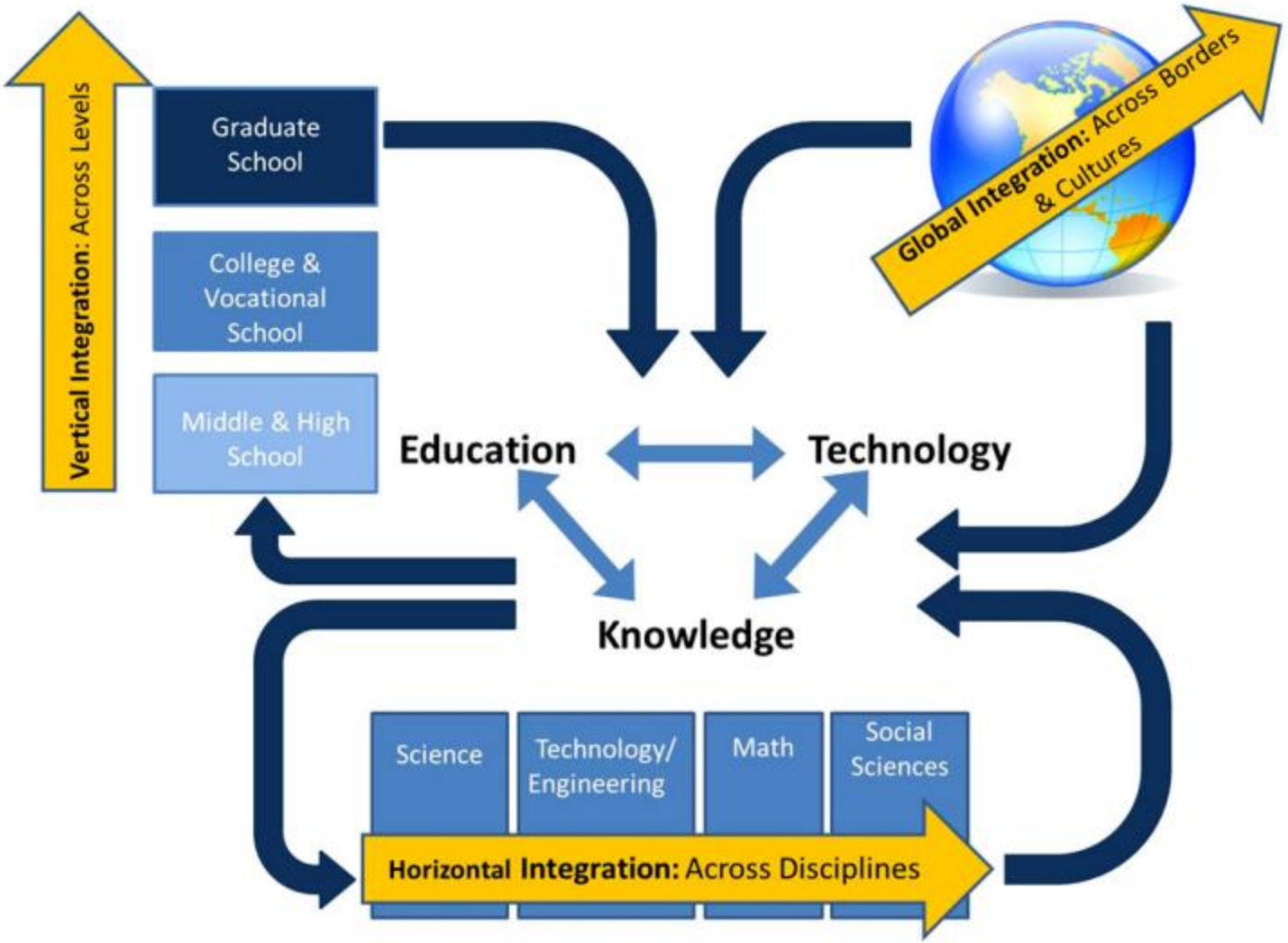


Figure 8.1 Schematic highlighting the axes of integration required for maximal success in the convergence of technology and knowledge to further education (courtesy of Robert Chang).

Convergence สู่คณะวิทยาศาสตร์และคณะวิศวกรรมศาสตร์ในมหาวิทยาลัย

Table 8.1 University departments and their involvement in converging technologies

Converging Tech.	Report Chap.	Illustrative Science Departments				Illustrative Engineering Departments			
		Phys	Chem	Bio	Psych	ChE	EE	CSE	MSE
Nanotech		x	x	x		x	x	x	x
Biotech		x	x	x		x	x	x	x
Infotech		x	x	x	x	x	x	x	x
Adv Prosthetics	5	x	x	x	x	x	x	x	x
Cancer therapy	5	x	x	x	x	x	x	x	x
Cognition	6	x	x	x	x	x	x	x	x
Social Networking	6				x		x	x	
Assistive Robotics	7	x			x		x	x	x

Key: Phys–Physics, Chem–Chemistry, Bio–Biological Sciences, Psych–Psychology, ChE–Chemical Engineering, EE–Electrical Engineering, CSE– Computer Science and Engineering, and MSE–Materials Science and Engineering

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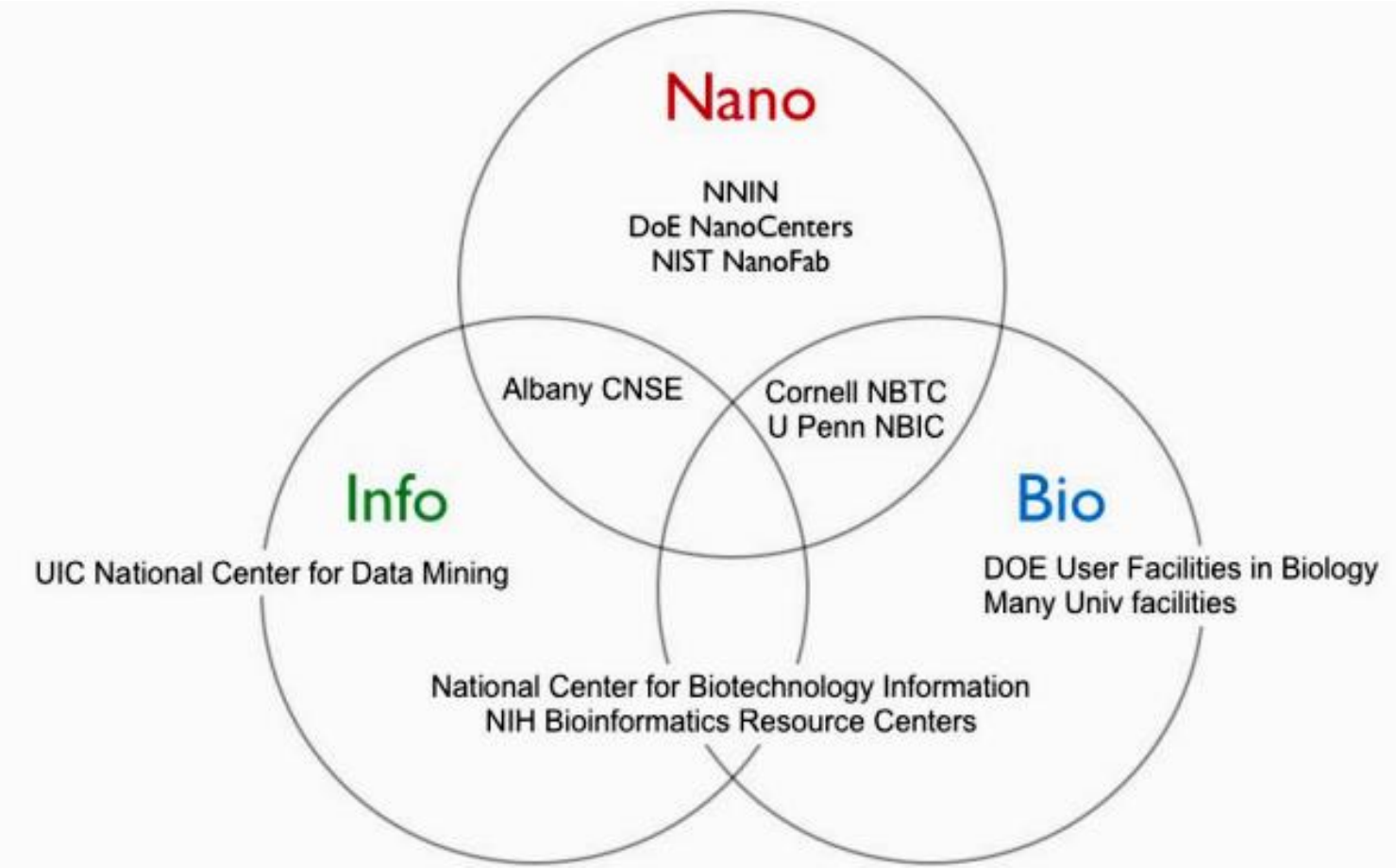
โครงสร้างพื้นฐานของสหรัฐฯที่ดำเนินงานแบบหลอมรวมวิทยาการ



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ตัวอย่างไต้หวัน

Example 2: Taiwan. Taiwan is an island much smaller than Japan. In many ways it is very similar to Japan in its economic development strategy. Over the past 50 years through a focused industrial development plan led by its government, Taiwan has become a leader in high-tech electronic products. With initial government subsidies, Taiwan built Hsinchu as its first convergence city with a science and technology park,[27] along with a powerful Industrial Technology Research Institute (ITRI; http://www.itri.org.tw/) surrounded by several leading national universities. Again, the main route to success has been high-level and in-depth education at universities coupled with training in the local industries for the strong workforce that is needed. Many of the researchers from ITRI, and university professors and their students, have launched start-up companies. Taking the knowledge gained from their economic success, large manufacturing plants have been launched in China by Taiwanese business leaders.

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ตัวอย่างประเทศจีน

Example 3: China. In the early 1990s China took the above convergence models to another level of sophistication and grandeur. A partnership between the Singapore and Chinese governments was established in 1994 to launch a China–Singapore Suzhou Industrial Park (CS-SIP) with area of 288 km^2.[28] In addition to government-sponsored research labs and industrial labs, there are many satellite campuses of top universities from other parts of China. In May of 2006, the SIP was the first location for the joint China–UK university known as the Xi'an Jiaotong–Liverpool University (http://www.xjtlu.edu.cn/en/), which offers degree courses in Architecture, Electronics, Computer Science, Communications, and Management. Today, similar models have been used throughout China to establish regional and sometimes international high-tech convergence hubsites.

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ตัวอย่างประเทศเกาหลี

Seoul University

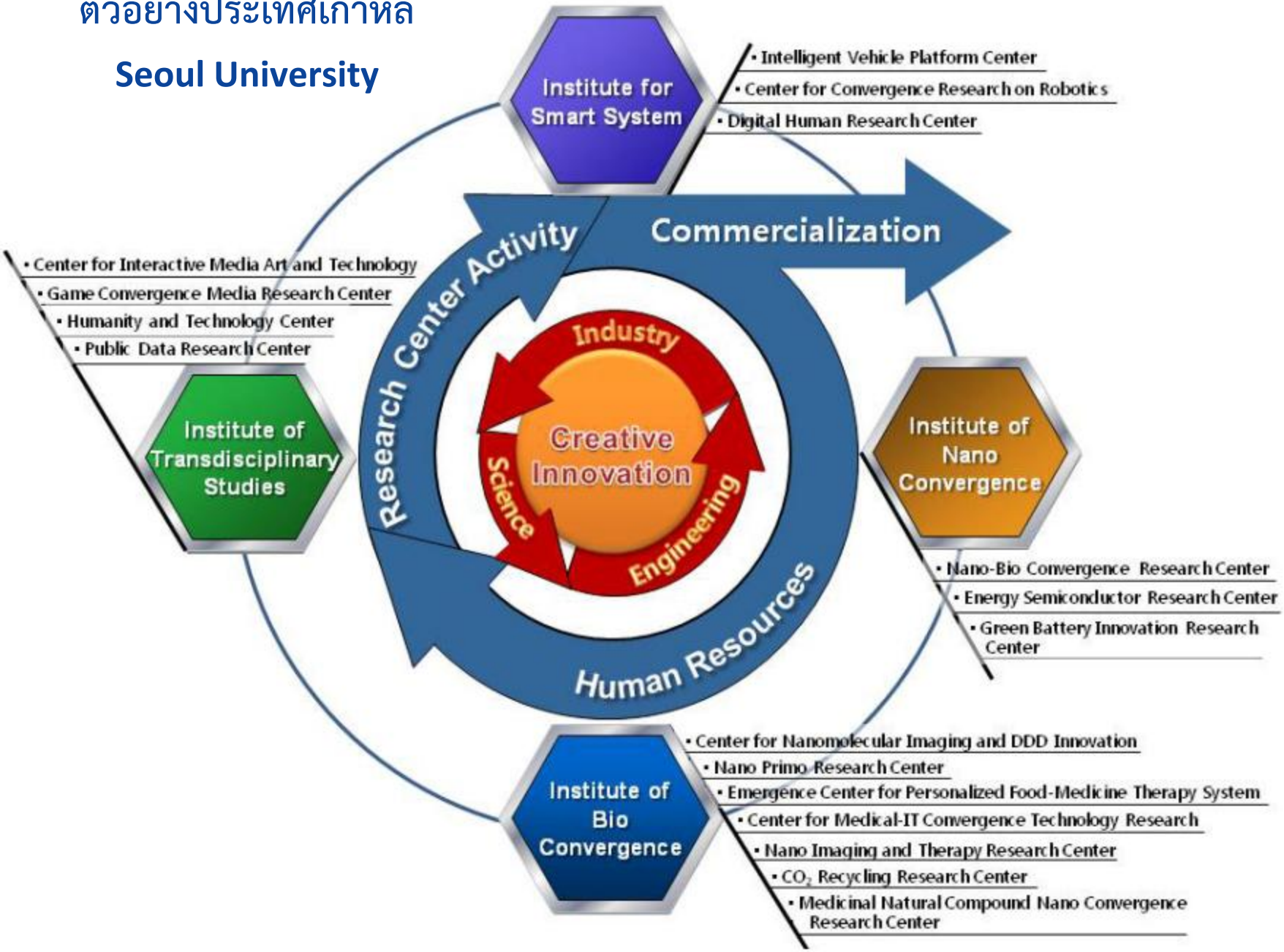
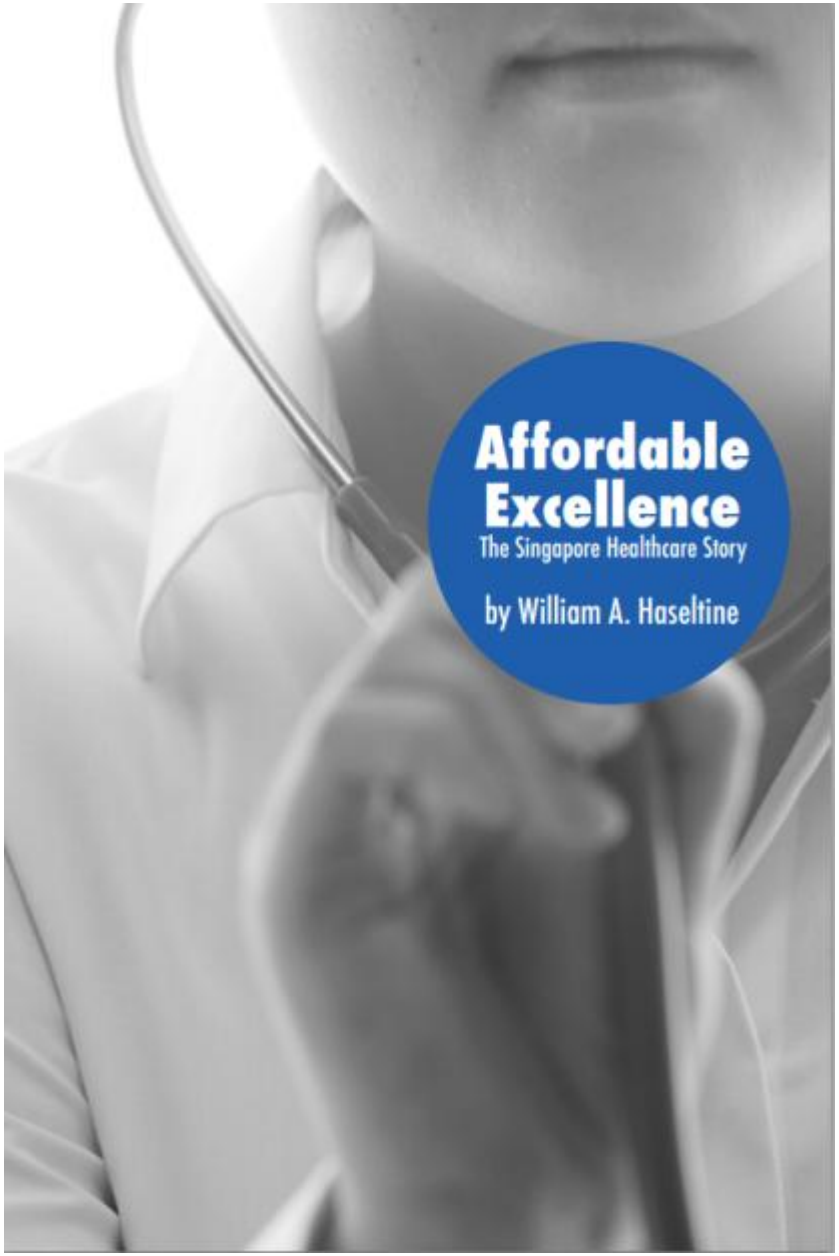


Figure 8.16 Diagram illustrating the concept of AICT (courtesy of Y. E. Pak).



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I am pleased to see, continues to spend less than four percent of GDP for healthcare, by far the lowest figure among all other high-income countries in the world.

The United States, by contrast, spends almost 18 percent of GDP annually—a huge price to pay that is currently causing bitter controversies and political battles as the nation debates its future approach to care.

When it comes to prices of specific procedures, one can immediately see the differences that exist in Singapore's costs vs. the United States. For example, the cost of an angioplasty in the United States is almost $83,000, while in Singapore the cost is about $13,000. A gastric bypass in the United States is almost US$70,000, while in Singapore the cost is $15,000 (these figures are in US dollars and include at least one day of hospitalization).[11] See Table 2.6a for more cost comparisons.

Singapore's total national health expenditure as a percentage of GDP is comparable to that of the upper-middle (China–Malaysia), and lower-middle-income countries (India–Philippines), but the health outcomes achieved are on par with those delivered by the highest-income countries in the world.

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Singapore - Biomedical Sciences Initiative

Biomedical sciences account for six percent of Singapore's GDP, and manufacturing output in this sector is over S$23 billion. Singapore launched its biomedical sciences initiative in 2000. It was a bold step with the intention of making Singapore the biomedical research and manufacturing hub of Asia.

The initiative was designed to invest more than S$3 billion over five years to accelerate development of the program. Incentives were created to bring health-related manufacturers to Singapore.

Research institutes focused on genomics, bioinformatics, bioengineering, nanotechnology, molecular and cell biology, and cancer therapies also received support.

- Biomedical Research Council of A*STAR funds and supports public research initiatives.
- Economic Development Board's Biomedical Sciences Group promotes private sector manufacturing and research and development activities while Bio*One Capital functions as the biomedical investment arm of Board.
- Ministry of Health's National Medical Research Council funds and supports public research initiatives, as well as awards medical research fellowships for the development of medical research manpower.

Initiatives that have come out of this approach include establishing research infrastructure, providing venture capital support, and strengthening manpower capabilities.

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สรุปและข้อสังเกต

- วิกฤตของโลกกำลังจะมีขึ้นแน่นอนในหลายด้าน
- วิทยาศาสตร์จำเป็นต้องหลอมรวมกัน เพื่อให้ได้สิ่งใหม่ที่มีประโยชน์
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Figure 10.1 Estimated timeline for progress in converging knowledge and technologies for society. The 2001–2002 study report is Roco and Bainbridge 2003. (Figure courtesy of M. C. Roco).

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