September 2007

Advantage Business Media

2008 Global R&D REPORT

CHANGES IN THE R&D COMMUNITY

- R&D Spending Increases Globally
- Offshore Outsourcing Continues to Redistribute R&D
- China's R&D Expands Rapidly
- R&D Funding Comes from Home & Abroad

Battelle
The Business of Innovation

CEO's Message: R&D International

Welcome to the third edition of the Global R&D Report updated for 2008.

The long-standing alliance between Battelle and *R&D Magazine* has produced annual in-depth analyses of domestic trends in federal government and industrial research and development. Three years ago we began viewing similar data through an international lens.

Since then a discernable pattern has emerged and is gaining momentum: World-wide R&D activities will no longer be focused in the traditional centers of North America, Europe, and Japan. R&D in the future will grow and prosper around the globe, and Battelle is well positioned to continue as an influential participant.

Battelle has maintained an international science and technology presence in world business centers for decades, including Geneva (since the early 1950s), Mexico City (1998), the United Kingdom (2000), and Rome (2005). Battelle has also enjoyed a nearly 40-year collaboration with the Mitsubishi Corporation in Japan, and we helped establish the Korea Institute of Science and Technology (KIST) in 1966. Both of those relationships are poised for growth through the opening of Battelle offices in Tokyo and Seoul last year. Battelle, in other words, is no stranger to the world's R&D stage.

The script directing the action on that stage, however, is undergoing significant revision. To ensure our long-term growth and success, Battelle plans to leverage its comparative advantage with a measured, strategic approach to the international R&D marketplace.

Toward that end, we are recalibrating our operational elements into three primary functions: Global Laboratory Operations, Global Businesses, and Battelle Ventures.

- **Global Laboratory Operations** – We will continue to manage laboratories and major science and technology programs with a renewed emphasis on adding value for our customers. These include our own private labs and the six national labs we manage or co-manage for the U.S. Department of Energy: Pacific Northwest National Laboratory, Oak Ridge National Laboratory, Brookhaven National Laboratory, Idaho National Laboratory, National Renewable Energy Laboratory, and Lawrence Livermore National Laboratory (contract begins October 2007). Battelle also manages the National Biodefense Analysis and Countermeasures Center for the Department of Homeland Security.

- **Global Businesses** – We will continue integrating science and technology and intellectual property into solutions for our customers through three distinct global businesses in the areas of Energy Science and Technology, Health and Life Sciences, and National Security and Defense.

- **Battelle Ventures** – We have increased the capital available to help create even more spin-out products and companies for our clients through the licensing of intellectual property, product co-development or value-sharing, joint ventures, and seed or early-stage funding.

These refinements take into account the increasingly global nature of research and development; they will also enable Battelle to acquire additional know-how, access an even broader range of intellectual property and, in turn, elevate our ability to serve clients and communities around the world. We'll be able to do more of what we do best – helping the world solve significant problems, target and deliver on opportunities, and build on our tradition of innovation and global R&D leadership.

Carl F. Kohrt

Carl F. Kohrt
President and CEO, Battelle

Globalization Distributes More of the R&D Wealth

Former Third World countries are assuming major roles in the sourcing and performance of R&D, while offshore outsourcing forces a more even distribution of effort throughout the world.

It's no secret that R&D spending continues to expand on a global basis. Worldwide spending (and performance) exceeded $1 trillion in 2006 and continues to expand at a substantially higher rate than most countries' inflation rates. This year's edition of the Global R&D Report, a collaboration between Battelle, Columbus, Ohio, and *R&D Magazine*, forecasts that global R&D spending will reach $1,210 billion in 2008, 7.6% higher than in 2007. Much of this growth continues to be fueled by a rapid expansion of R&D in China, whose spending is expected to grow by nearly 24% in 2008 to $216.8 billion—about 18% of global spending, up from 14% just two years ago.

Global R&D Spending

	GDP 2006 Billions U.S.$	R&D % GDP 2006 Percent	R&D PPP 2006 Billions U.S.$	R&D PPP 2007 Billions U.S.$	R&D PPP 2008 Billions U.S.$
Americas	15,155	2.47	374.9	387.0	401.1
U.S.	12,416	2.76	343.0	353.0	365.0
Asia	19,203	2.02	387.2	436.2	494.4
China	8,815	1.61	141.7	175.0	216.8
Japan	3,995	3.40	136.7	143.5	150.4
India	3,779	1.03	38.8	41.8	45.0
Europe	14,072	1.88	264.3	276.3	288.8
Rest of World	2,073	1.11	23.0	24.4	25.9
Total	**50,503**	**2.08**	**1,049.4**	**1,123.9**	**1,210.2**

Share of Total Global R&D Spending

	2006	2007	2008
Americas	35.7%	34.4%	33.1%
U.S.	32.7%	31.4%	30.1%
Asia	36.9%	38.8%	40.8%
China	13.5%	15.6%	17.9%
Japan	13.0%	12.8%	12.4%
India	3.7%	3.7%	3.7%
Europe	25.2%	24.6%	23.9%
Rest of World	2.2%	2.2%	2.1%

Outsourcing as a driver

R&D growth continues in all geographical regions as well, although at less inflated rates than China. Much of the present attention is given to the very significant growth of the offshore R&D outsourcing practices involving activities throughout Asia—in China, India, South Korea, and Singapore. This outsourcing, however, goes back many years. The U.S. Dept. of Commerce (DOC) has published reports related to offshore outsourcing by U.S. companies, with the first of these having been published in 1995, with a follow-up report in 1999[i]. In these reports, extensive accounts were provided relating to the support of R&D, primarily in Western Europe and Japan. They were generally confined to discussions of the work that was performed at facilities that were, for all intents and purposes, subsidiaries of the home (funding) organizations.

While the DOC reports concentrated on such "captive" laboratories, it is well known that additional relationships were developing between U.S. companies and independent R&D performers throughout the world. Efforts were undertaken to test the waters relative to contracting with independent industries and academic institutions in India, including agreements with the National Chemical Laboratories in Puna and with software firms—both large and small—in Bombay, Bangalore, Hyderabad, and other cities.

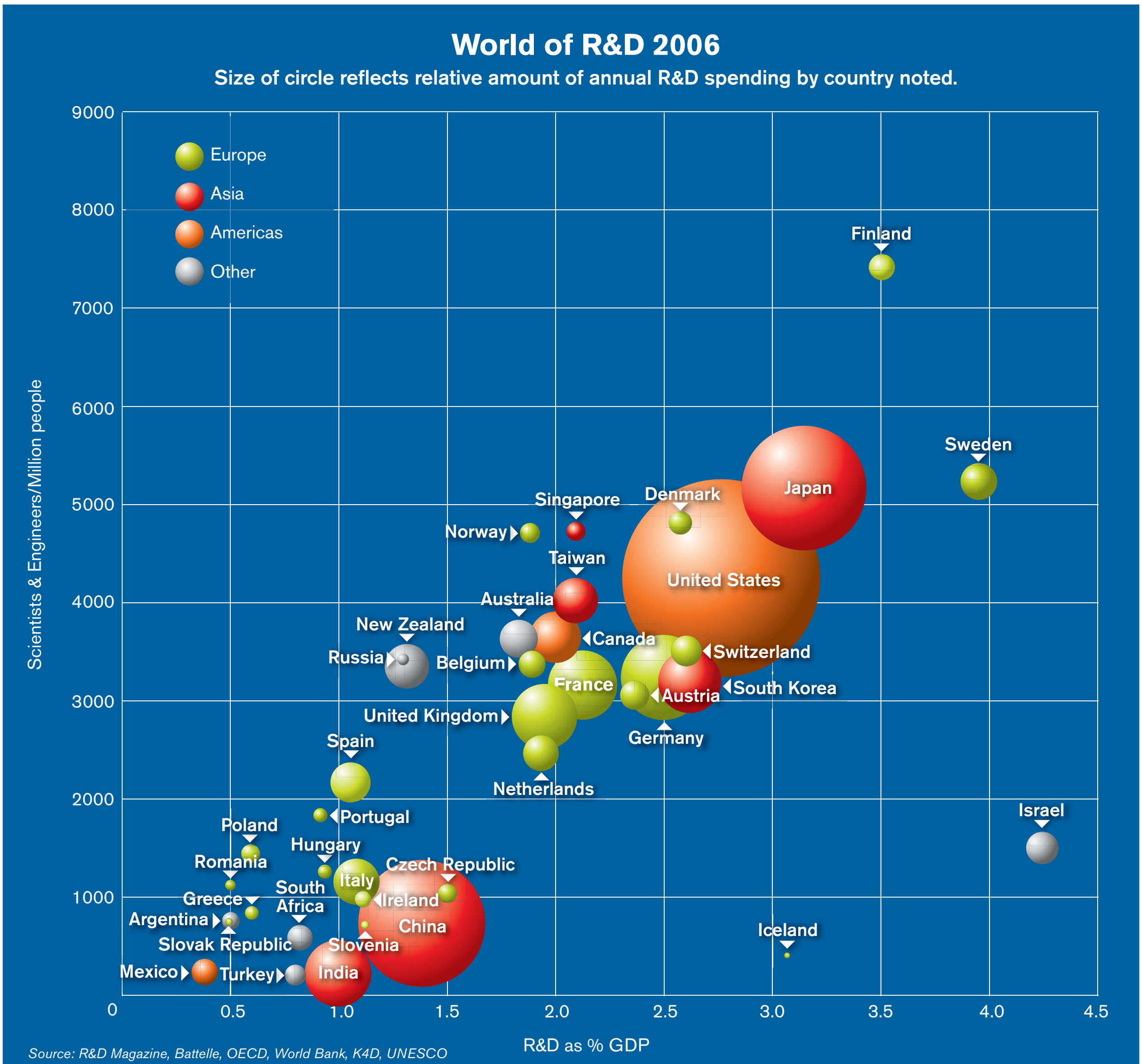
In the intervening years, the practice of offshore outsourcing of R&D has increased considerably and has been driven by a number of different factors including, but certainly not limited to:

- As markets have been expanding in response to demands, there is little question about the desirability of having on-site or near-site technological support for manufacturing and distribution centers.
- Products made for different environments may need to be modified in content, design, function, and process, so as to accommodate local cultures, customs, regulations, raw materials, and manufacturing/distribution support structures.
- Local conditions related to manufacturing and other operating licenses may contain "local content" clauses that extend to the intellectual input of the manufacturing or distribution process, i.e., a requirement that includes the establishment of local technical support or research facilities.
- In some geographical locations, there may be significant cost savings that accrue from using the resident talent, even if the associated technical/research support is not directed toward products for local consumption.

Larger driving forces

There is a long history of R&D interactions among the U.S., Western Europe, and Japan. It is only in relatively recent times that the linkages have spread—and then multiplied almost exponentially—to include the rest of Asia and Eastern Europe. Current literature is replete with reports on the expanding R&D activities in China and India.

Each day sees additions to the literature, much of which includes reports on the establishment or expansion of R&D facilities and programs that are designed to take the best advantage of highly qualified resources. As has been noted in earlier writings by the Battelle/*R&D*



Magazine author team in this continuing series of R&D analysis papers, the growth has been unlike any other in recent years, and it foretells the approach to a new equilibrium in global scientific and technological practice.

This change has been spurred by a number of different factors on both the supply and the demand sides of the R&D enterprise. On the supply side, the expansion of the education system and the sheer numbers that go through the system have produced a rapidly growing population of scientists and engineers, created to satisfy the requirements and aspirations of both domestic governments and industries. Throughout India and China, the production of scientists and engineers has accelerated in response to, or is being driven by, major needs and incentives.

On the demand side, both China and India have experienced major changes in government attitudes and practices as applied to trade, openness of markets, and desires and necessities of becoming stronger participants in a world-class technology-supported global economy. Perhaps one of the most significant changes in both India and China has been the relaxation of policies aimed at preventing major foreign ownership and the general reduction of state control over guaranteed markets. These changes have had a major impact in India over the past two decades and in China over a shorter period of time.

As a result of these changes in government postures and philosophies and the corresponding creation of commercial opportunities, strong incentives were created to:

- Sell to that market
- Obtain ownership in that marketplace
- Utilize the human resources within that market, and
- Establish and/or expand both the operations and the brick and mortar aspects of research.

One should not infer that all barriers to participation in these newly opened areas have been lifted or have not come with different sets of problems. There are also still questions regarding intellectual property rights and the diversion of dual-use technologies. There are concerns

Gross Domestic Expenditure on R&D (GERD)

	2006 GDP PPP trillions, U.S.$	2006 R&D as % GDP %	2006 GERD PPP billions, U.S.$	2007 GERD PPP billions, U.S.$	2008 GERD PPP billions, U.S.$
United States	12.416	2.76	343.000	353.000	365.000
China	8.815	1.61	141.706	174.958	216.824
Japan	3.995	3.40	136.692	143.501	150.379
Germany	2.430	2.50	63.541	64.608	65.694
France	1.850	2.20	42.143	43.977	45.898
India	3.779	1.00	38.850	41.810	44.996
United Kingdom	2.002	1.90	37.540	40.084	42.819
South Korea	1.064	2.60	34.726	37.733	41.000
Canada	1.078	2.00	23.058	24.529	26.000
Taiwan	0.681	2.20	17.913	19.852	22.000
Italy	1.672	1.10	18.592	19.040	19.500
Russia	1.552	1.30	17.334	18.000	18.692
Spain	1.179	1.10	14.120	15.030	16.000
Australia	0.646	1.70	12.971	13.714	14.500
Sweden	0.294	3.90	11.831	12.402	13.000
Netherlands	0.533	1.90	11.160	11.952	12.800
Israel	0.179	4.50	9.247	10.124	11.000
Switzerland	0.265	2.60	8.262	8.623	9.000
Austria	0.277	2.30	7.371	8.036	8.760
South Africa	0.521	0.80	5.687	6.416	7.250
Mexico	1.108	0.40	6.100	6.580	7.100
Finland	0.169	3.50	5.996	6.366	6.700
Belgium	0.337	1.90	6.392	6.495	6.600
Denmark	0.184	2.60	4.709	4.906	5.110
Turkey	0.606	0.70	3.868	4.078	4.300
Norway	0.192	1.80	3.510	3.628	3.750
Czech Republic	0.210	1.51	3.184	3.385	3.600
Singapore	0.130	2.20	3.187	3.310	3.439
Poland	0.528	0.60	3.109	3.203	3.300
Argentina	0.553	0.50	2.707	2.849	3.000
Ireland	0.170	1.10	2.320	2.519	2.736
Hungary	0.180	0.90	1.739	1.818	1.901
Portugal	0.215	0.80	1.755	1.826	1.900
Greece	0.260	0.63	1.640	1.679	1.720
New Zealand	0.093	1.30	1.213	1.256	1.300
Romania	0.196	0.50	0.954	1.070	1.200
Slovenia	0.045	1.29	0.580	0.600	0.620
Slovak Republic	0.089	0.52	0.461	0.484	0.508
Iceland	0.010	3.10	0.313	0.326	0.340

Source: Battelle, R&D Magazine, OECD

regarding the quality of research efforts as opposed to the quantity of technically trained staff.

What does the other side look like?

Regardless of the rationale for entering an R&D environment, there is little question that there is a need for an understanding of the environment and the structure of the local enterprise.

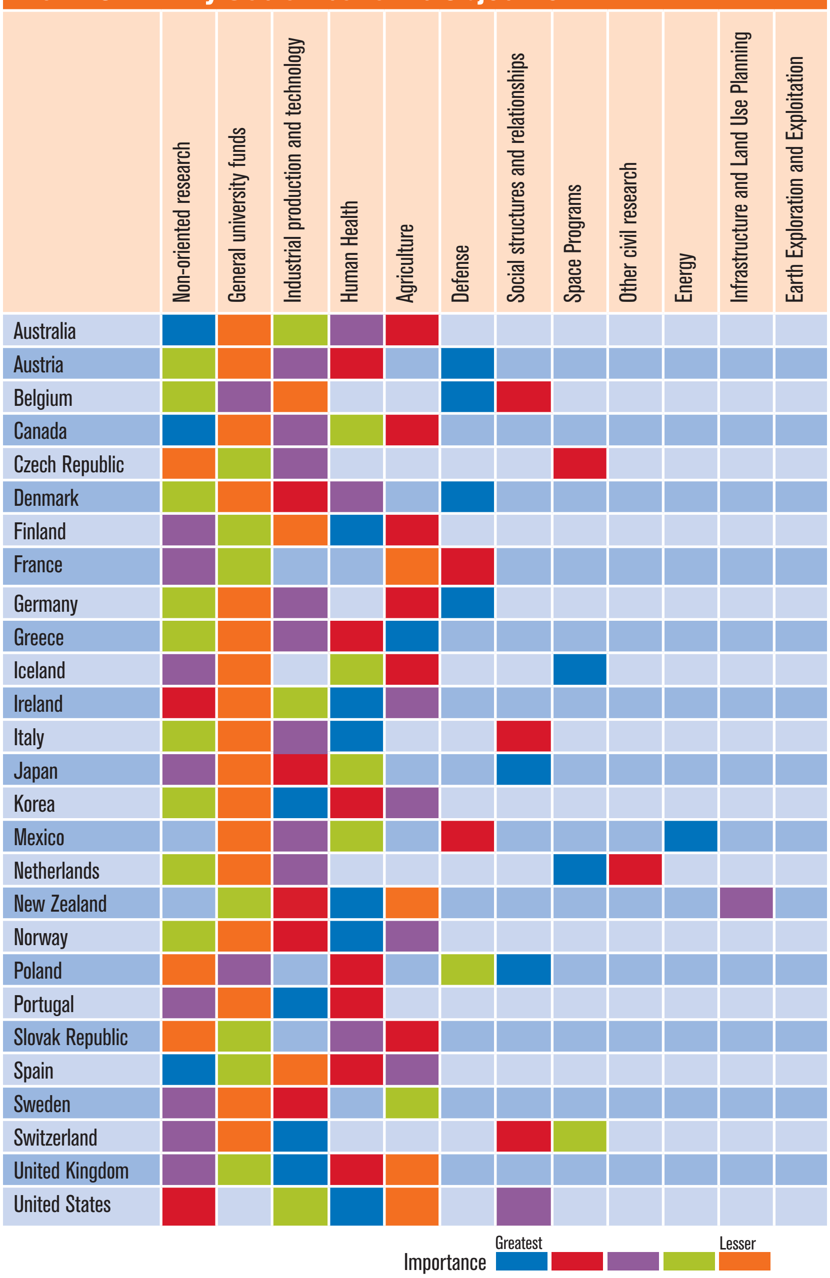
While there is much information available regarding, for example, the total amounts of R&D that are spent in any given country, it is insufficient to base decisions on such gross figures as total R&D or the ratio of R&D to gross domestic product (GDP).

While R&D as a percent of GDP figures are bandied about as indicators of the strength of the national commitment to scientific research, they have relatively little meaning in terms of just how that investment contributes to the growth and welfare of the country. R&D/GDP may be useful from the point of view of the historian, but it has little to offer as a tool for the planner.

It is important to note that the data on the total R&D that is performed in a given country will actually tell you everything while at the same time telling you nothing. The more important data are those that tell you who is providing the funding, who is doing the work, how is the money is being spent, and what the priorities, thrusts, and directions are. In brief, it is the internal structure of the R&D enterprise and the roles and interplays among the different sectors that have a bearing on the manner in which the investment in R&D has the desired societal benefit outcomes of economic security, improved health care, and the like.

With that in mind, we have chosen this year to concentrate on the rudiments of the structure of the R&D system throughout those countries that are participants in the Organization for Economic Cooperation and Development (OECD).[ii] The analyses and forecasts in this report are derived largely from data obtained through OECD, with selected information augmented with data from The European Commission.[iii]

Government Budget Appropriations or Outlays for R&D – GBAORD – By Socio-Economic Objective



The overall trends

Much of the available data on R&D expenditures in the OECD member countries cover the period from 1981 through 2004 or 2005. In general, the data on total R&D expenditures are generally consistent in that there are few precipitous changes in either the raw data for performance and support or in the distribution of resources among the funding or performing sectors. To be sure, there are occasional irregularities, many of which may be caused by changes in definitions and scope. However, in those countries where a formalized and accountable R&D system has been in place for quite some time, the relative stability and inertia permits making reliable estimates of the expected year-to-year behavior.

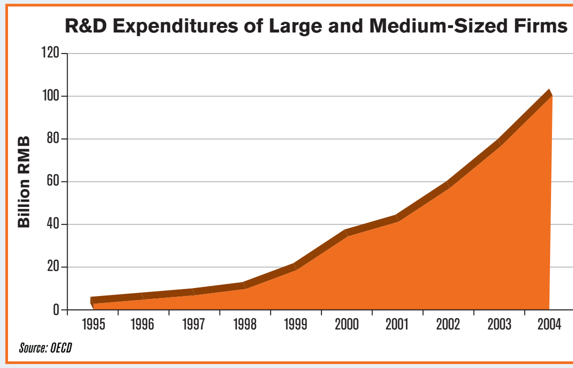
China's R&D Still Has a Long Way to Go

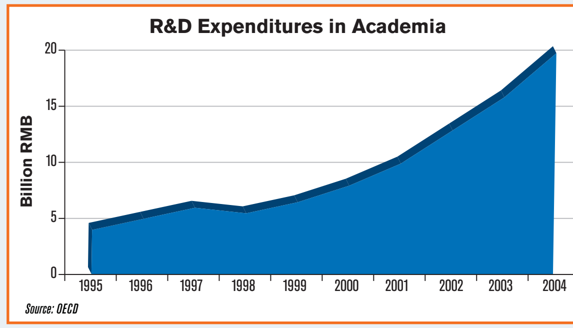
China's rapid economic growth over the past several decades is now mirrored by a similar rapid growth in R&D funding and performance. This growth has been underpinned by economic reforms as well as by international openness to foreign trade and investment. China's "open door" policy—adopted in 1978—has been an integral part of its economic reform, which culminated in its accession to the World Trade Organization in 2001.

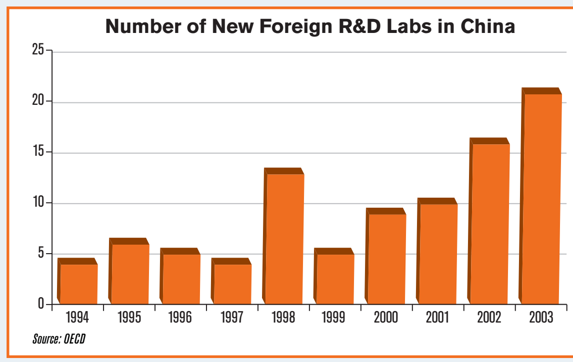
China has built up its economy and its tremendous balance of trade surpluses with mostly low-cost consumer goods. However, the country has recently greatly increased its high-technology exports as well, increasing from just 5% in the early 1990s to over 30% in 2005—heavily concentrated in office machinery, TV, and radio and communication equipment. Foreign-owned firms are the dominant and increasing source (25% in 1996 and about 70% in 2005) of these high-tech exports, but they are generally less R&D-intensive than domestic exports. In the communication, computer, and other electronic equipment area, for example, Chinese domestic firms have an R&D intensity that is about seven times greater than that of foreign-owned firms.

China's government has taken on the responsibility to support its industries' growth in the R&D area due to:

- The greater inclination of its small- and medium-sized companies to fail as compared to those in more mature economies
- Lower innovation capabilities due to lower productivities
- Distortions of incentives for R&D
- Uncertainties regarding the interpretation of legislation
- Incomplete adaptation from a national innovation system to a market-based innovative economy
- Insufficient interaction between businesses and public research organizations
- Incomplete interaction between different levels of the government
- Shortage of an advanced specialized infrastructure







China has focused its support of its innovation policies in five areas:

- Promoting basic research in scientific fields that have a perceived impact on social progress and economic development
- Promoting R&D in high-technology areas of national priority—biotech, IT, space technology, energy technology, and new materials
- Promoting commercialization of technology innovations
- Supporting the construction of a scientific research infrastructure—National Key Laboratories Program
- Development of human resources in science and technology, with rewards for demonstrated excellence, with support from the Chinese Academy of Sciences

Despite these highly organized policies and the substantial amount of resources being expended, there have been some shortcomings, according to an analysis by the OECD. The program design is characterized by a top-down picking-the-winner-approach, which has little involvement by other stakeholders. There's also a lack of differentiation in the programs and, as a result, a duplication of priorities and confusion regarding program duration and funding. The OECD analysis also found that the Chinese innovation programs need to be more open, fair, and transparent to be more successful, with an improved evaluation process.

The OECD's analysis concludes that China still has a long way to go to build a modern, high-performance national innovation system. It will require a continued high level of R&D investment and education to overcome the remaining institutional, structural, disparate, and efficiency weaknesses of its current innovation system, which can be obtained by observing international best practices.

The Rapidly Changing World of Biotech

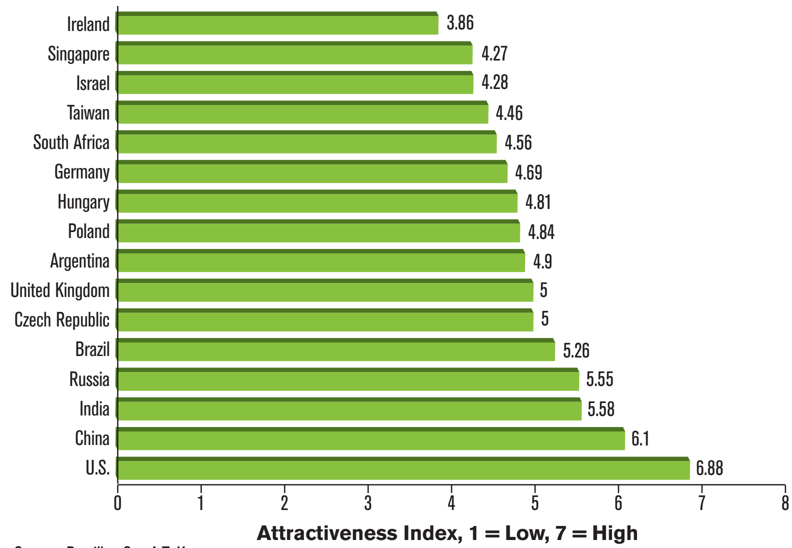
While biotechnology was the technology realm of Europe and the U.S. for many years, it has now become a global industry. The maturing of the industry and the competition for resources (both human and technological) is accelerating as the number of countries now supporting viable and growing life science industries grows. China and India are among the leaders in this new growth. Changes in the global financial markets have also created opportunities for companies to look outside their borders for financing their R&D activities.

Similarly, while biotech may have initially described specialized companies, with Amgen and Genentech as the leaders, the involvement of large pharmaceutical companies in biotechnology, rather than just chemical-based drug development, necessitates their inclusion in this technology industry as well. With 2006 sales of just under $14 billion and R&D investments of $3.4 billion, this relegates Amgen to a number 12 ranking among pharmaceutical giants that include Pfizer with sales of $45 billion and R&D investments of $7.6 billion. Other giants involved in biotech that surpass Amgen include European-based GlaxoSmithKline, Sanofi-Aventis, Novartis, AstraZeneca, and Roche, and U.S.-based Johnson & Johnson, Merck, Eli Lilly, Wyeth, and Bristol-Myers Squibb.

One of the leading biotech opportunities has been in stem cell research, which has been limited in some countries due to political restrictions demanded by religious activists, but supported vigorously in others. In Europe, the European Parliament recently approved the Seventh Framework program with a provision, albeit small, for stem cell work. In the U.S., a number of academic researchers have found ways around the government-funding limitations on embryonic stem cell research by developing methods that transform adult stem cells into the embryonic types. Fraudulent stem cell research in Korea by Hwang Woo-Suk has also shaken this area for the past two years from which it is just now recovering to its previous standing.

In the rapidly changing R&D arena, pharmaceutical companies are increasingly taking their clinical trials offshore to emerging markets, a move that continues to save overall drug development costs, since more than two-thirds of those costs are in clinical testing. London, UK-based AstraZeneca, for example, has been conducting clinical studies at its East Asia Clinical Trial Center in Shanghai, China, since 2003. Novartis, Pfizer, Wyeth, and Roche all currently have plans to build $100 million of R&D centers in China.

Biotech Country Attractiveness



Source: Burrill & Co., A.T. Kearney

Biotech R&D Investment

Country	Biotech companies	R&D/ company kU.S.$	Total R&D kU.S.$	AGR	Employees	R&D/ employee kU.S.$	Market cap mU.S.$
EU-27	57	29,387	1,676	11.1%	25,312	66.2	23,754
Switzerland	4	214,799	859	- 0.8%	6,491	132.3	10,962
Japan	2	196,198	392	12.9%	12,366	44.0	6,266
U.S.	44	221,299	9,737	23.2%	97,143	139.0	253,551
Other	4	69,949	280	26.0%	10,215	38.0	9,524

Source: 2006 EU Industrial R&D Investment Scoreboard

Value of World Pharmaceutical Market
(based on Top 50 Pharmaceutical Companies)

Region	Number of companies	Sales Billions, U.S.$	R&D Billions, U.S.$
U.S.	19	$200.46	$40.096
European Community	21	$219.51	$38.250
Asia	10	$35.61	$6.083

Source: Pharmaceutical Executive

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Source of Funds

Country	General Observations on Sources	Estimated Projection for 2008 *		
		Industry	Government	Abroad
Argentina	Growth in government spending will abate, along with industry decreases. Insourcing to remain small while other domestic funds decrease slowly.	31%	65 %	1%
Australia	Relatively steady patterns of funding are shared among all supporting sectors.	51%	39%	5%
Austria	Small increases in government and industrial share of funding, with corresponding decrease in insourcing share.	46%	37%	17%
Belgium	Industrial share to decrease slightly with insourcing and government portions to increase.	58%	26%	13%
Canada	Following a period of significant shifts in industrial and insourcing support, these sectors are returning to earlier trends, with government support increasing.	46%	34%	9%
China	See Special Note	70%	25%	
China–Taiwan	Small increases in industrial funds, with corresponding decrease in government share. Remainder of support from other domestic sources.	41%	55%	
Czech Republic	Government support is slowly declining, while industry and insourcing are steadily increasing. (Compare with trends in the Slovak Republic.)	55%	40%	5%
Denmark	Slowly declining shares of industry and government funding result from a steady increase in both insourcing and other domestic support.	56%	27%	13%
Finland	Increases in insourcing will be accompanied by deceases in industrial share of R&D support, with the government share remaining essentially constant.	63%	27%	10%
France	Industrial and government shares to increase and decrease, respectively, while insourcing continues a long steady growth.	52%	37%	9%
Germany	General slow increase of industrial funding offset by decrease in government support. Slow steady growth of foreign funds.	66%	30%	4%
Greece	Government dominance is in steady decline, industry slowly rising, and strong growth in foreign funds.	25%	46%	25%
Hungary	General rise in government funds, with decrease in industrial support. Insourcing is fairly steady.	42%	46%	11%
Iceland	Steady decline in government support with slow rise from industry; general growth in foreign support.	50%	41%	9%
Ireland	Government rising after long-term decline; industry slowly declining; and foreign sourcing on slow steady increase.	60%	29%	9%
Israel	Small increases in government support after slow decline; industry tapering off as other domestic and foreign sources increase.	65%	25%	3%
Japan	General slow growth of industry portion, with corresponding decline in government and other funds.	77%	16%	7%
Korea	Both industry and government funds to remain relatively flat.	75%	22%	3%

As we look at the R&D structures in the various countries that are covered in this report, there are several measures that are useful in describing the systems and in making projections as to the near-term directions in R&D support and performance. At the highest level of description—the total R&D expenditures—the long history of most of the participating countries provides a basis from which to estimate the near-term trends in support and performance.

Over the past 20 to 25 years, total R&D has been composed almost exclusively of funds that are provided by the government (at different levels) and private industry. In addition, non-governmental domestic organizations such as private foundations and not-for-profit entities also provide support for scientific and technical research. Except in cases of severe disruption, the trends in these sources are relatively stable, tempered by short-term disruptions in government budget changes and industrial spikes or downturns.

Over this period, the one major new participant on the funding side is the introduction and expansion of significant amounts of "funds from abroad", a catch-all term adopted by the OECD. These funds appear to include R&D support from multinational corporations that are stationed in the host country but are headquartered elsewhere, as well as support of research that is conducted by independent entities. It is likely that the funds from abroad will undergo greater year-to-year fluctuations, especially as they relate to the support of independent laboratories. However, these variations represent a small fraction of total R&D performance and should not significantly impact the trends in the total national R&D effort.

Based upon historic patterns in R&D, the support and performance of R&D in the OECD countries, and assumptions regarding inertia of the overall enterprise, estimates have been made of the total size of the enterprise and are presented in this report. To maintain an equivalency among costs and exchange rates, these estimates are made in terms of purchasing power parity (PPP).[iv]

The projections, presented in order of expected total R&D support in 2008, demonstrate what has been suggested throughout the literature: namely, the remarkable growth of the Chinese R&D enterprise.[v] This growth is expected to continue, although at a decreasing rate, over the next few years.

Various reports indicate that the pure numbers relative to the inputs to R&D (such as investment and growing numbers of graduate scientists and engineers) are most impressive, but there are underlying concerns about the effectiveness of the initiatives and the quality of the output. However, one must caution against relying on the observations of temporary (and conquerable) product or material deficiencies. One need only recall the disdain relative to Japanese output only 30 to 40 years ago and observe the manner in which world market demands for quality resulted in the growth of, and respect for, Japanese electronic and automotive products.

The character of the data

As noted in the introductory comments, the total R&D effort that is commonly reported tells everything about the overall level of activity, yet sheds no light on the manner in which the various components of the enterprise interact. Furthermore, the gross figures don't provide much of a clue as to the nature of the R&D effort or the manner in which the total research activity will contribute to the general welfare.

At the next level of specificity, it is necessary to look at the breakdown of the sources of funding, the distribution of overall performance, and the interaction between sources and performers. Ideally, an inspection of the time-series of relationships within a source/performer matrix will provide a basis from which one can better understand the total interactive workings of the research establishment and, further, to appreciate the differences between national attitudes, postures, and initiatives.

This year's Battelle/*R&D Magazine* Global Forecast addresses two of the three components that are necessary for a deeper understanding of the enterprises within the

Source of Funds

Mexico	Steady government decline and industrial increase over the past 15 years. Slow decline in other domestic support.	47%	46%	Minimal
The Netherlands	Slow decline in government funds and increase from industry over the past 15 years. Insourcing is strengthening.	53%	34%	13%
New Zealand	Steady government decline and industrial growth; strengthening insourcing and significant other domestic funding.	40%	43%	8%
Norway	Industrial and government funds have been oscillating around a median for 20 years. Steady growth in insourcing.	44%	46%	8%
Poland	Slow decrease in government funds that is offset by industry and foreign sources. Relatively strong other domestic support.	36%	53%	7%
Portugal	Government and insourcing settling after 10-year surge. Industry funding is rising to new plateau.	58%	32%	6%
Romania	Industry and government shares have fluctuated over the past 10 years, but are presently diverging with fairly healthy share of insourcing and other domestic funding.	33%	62%	5%
Russian Federation	Government share is returning as insourcing levels off after a short spike. Industry share slowly declining.	29%	63%	8%
Singapore	Industry continuing steady growth of share, with decreases in all other sectors.	62%	34%	4%
Slovak Republic	Government funding shows a steady gain with significant increases in insourcing share, offsetting a decline in the industrial portion.	35%	57%	8%
Slovenia	Industrial share continues growth with drop in government support. Insourcing is fluctuating around 5% to 6%.	69%	23%	6%
South Africa	Significant increase in share of insourcing with big decline in domestic industrial support.	40 %	37 %	23 %
Spain	All support sectors are relatively stable, with small increases in government and offsetting decreases in industrial support.	47 %	43 %	7 %
Sweden	Industrial support dominates, but with a slowly declining share; there are stronger relative increases of insourcing.	56 %	29 %	12 %
Switzerland	Industry funding share has been remarkably stable, with small decreases in government and other domestic shares and steady growth of insourcing.	70 %	22 %	6%
Turkey	Steady increase in industrial funding, with the government support share tapering off. Relatively small role of insourcing.	70 %	29 %	
United Kingdom	Generally strong long-term growth of insourcing, with steady decline in domestic industry funding and small recent increases in government support.	40 %	33 %	21%

* Where estimates do not add to 100%, the remainder is derived from "Other National Sources" (e.g., foundations, academia). It is assumed that "pass-through" funds, such as those that are awarded to non-governmental organizations from international banking or development agencies (United Nations, World Bank, etc.) are classified as "Funding from Abroad".

Special Note

The rapid and significant changes in the R&D patterns of China present challenges for the analyst who is comparing the behavior with that of other countries. China's spectacular surge–especially that which is influenced by central government policies and funding–creates problems in interpretation. Over the recent past, the government has established a significant number of research institutes that are devoted to various areas of science and technology. In some cases, these are designed to pursue specific scientific areas that are germane to government agencies' objectives. In other cases, emphasis is placed upon dual-use technologies, with the government and the consumer.

countries that are included in the most recent OECD databases.

What are the sources of funds?

A brief historical outline of the patterns in R&D funding for 36 countries included within the OECD database is provided in this report. In addition, we provide estimates of the distribution of the sources of R&D support for 2008.

One must use caution in the interpretation of the observations that are included in this data, since this is essentially a zero-sum expression of the distribution of funding sources.

For example, there are cases where it appears that one sector's funding is in decline, and it could be concluded that this sector's actual investment is decreasing. Quite to the contrary, the decline in share may only be a reflection of the increase in amount of another sector's anticipated funding. Shifts within the funding pattern may be a reflection of the changes in national policies, priorities, and budgets as they affect government or industry.

Furthermore, one should not look at the projected funding patterns for Greece and conclude that the strong growth in funds from abroad indicates an absolute major increase in such in-sourcing. The total projected funding of R&D in Greece is estimated to be less than 10% of that expected in any of the top ten countries in this sample.

In any description of the patterns of R&D funding, caution must be used when classifying the different types of funding entities. In the U.S., we tend to think of "government funding" in terms of that which is provided through the federal government. For quite some time, the statistics provided through the National Science Foundation (NSF) reflected or even fostered that perception.

However, in more recent years, NSF data take into account that sub-federal units of government—such as states or municipalities—fund R&D, although at a much smaller, though growing, level. Similarly, the sub-national units of government in other countries provide direct support to research institutes that are established to perform various functions.

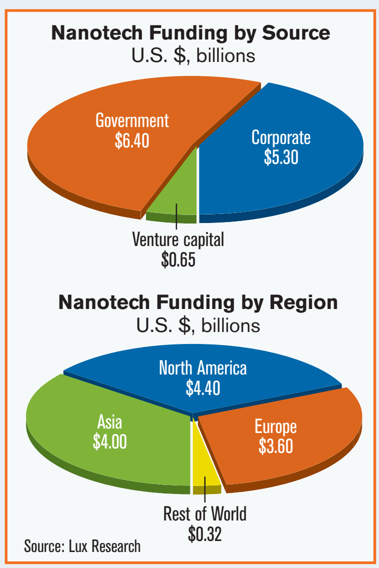
In some cases, a research institute may be established to concentrate on technology areas that are particularly germane to local needs and conditions.

Small Topic, Big Attention

More than $12 billion was invested in nanotechnology R&D worldwide in 2006, according to a recent report by market intelligence company Lux Research. From this research, more than $50 billion in nano-enabled products were produced and sold. The growth rate in this area is expected to impact $2.9 trillion worth of products across the value chain by 2014. The study of nanotech includes nanomaterials, nanointermediates, and nano-enabled products.

Nanomaterials include ceramic nanoparticles for structural composites, catalysts, and coatings; metal nanoparticles for catalysts and sensors; nanoporous materials for insulation, optics, and electronics; and carbon nanotubes in a plethora of applications. Smaller markets include dendrimers, quantum dots, fullerenes, nanowires, and polymer nanoparticles. A leading application area is also in drug delivery with about $9 billion in products by 2010.

The Lux study found that government spending on nanotech grew to $6.4 billion in 2006, up 10% from $5.9 billion in 2005. To this, U.S. federal and state governments contributed about $1.8 billion leading the contributions by governments of other countries. Japan's government contributed just under $1 billion, followed by Germany with just over $560 million. China's nanotech R&D investment, when adjusted for purchasing power parity (PPP), was just over $900 million.



Global corporations spent a combined $5.3 billion on nanotech R&D in 2006, a 19% increase over what they spent in 2005. U.S. companies again led the way with about $1.93 billion in spending, followed by Japanese firms with $1.70 billion (PPP). China's corporate nanotech investment grew 68% from its 2005 total to $165 million (PPP) in 2006.

In the intellectual property arena, the U.S. continues to lead the way with more than 43,000 nanotech science and engineering articles published since 1995, with China in second place with more than 25,000 nanotech articles published. China added 6,000 articles to its cumulative total in 2006 alone, more than twice as many as third-place Japan. China's actual annual article production exceeded that of the U.S. in 2005. The number of U.S. patents issued covering nanotechnology grew by more than 30% in 2006 to 10,105. U.S. individuals created 6,801 of these, with Germans in second place with 773.

Overall, the U.S., Japan, Germany, and South Korea lead all other countries in their use and implementation of nanotechnology. China is a close fifth in this ranking with a much faster growth rate than all other countries. China already has nanotech programs in more than 50 universities (30 more planned by 2010), 20 Chinese Academy of Sciences facilities, and 300 industry enterprises, with more than 3,000 researchers.

Immigration Rules and Growing Economies Threaten U.S. R&D Workforce

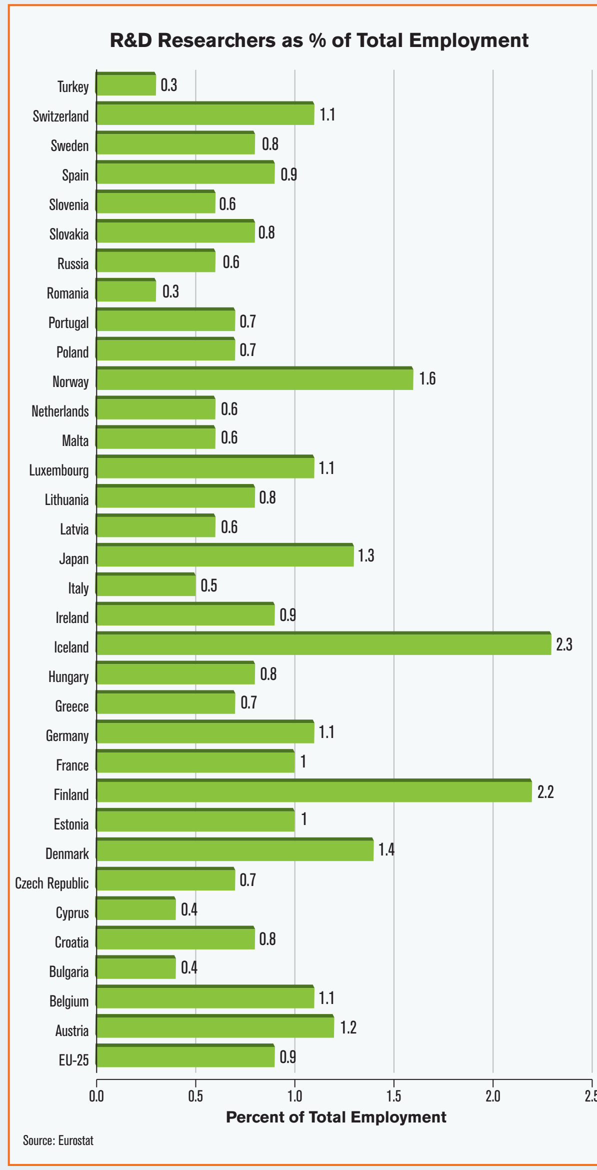
There continue to be concerns about shortages in many research categories that are not being met by immigrant researchers as they were before the 9/11 attacks. Of potentially larger concern is the overwhelming number of scientists and engineers that are being produced by China, India, and Japan—let alone other Asian countries. The combined total of these three Asian countries is projected to be five times larger than the combined European Union (EU) and U.S. total from 2000 to 2020, according to a recent report by the National Science Foundation—"Asia's Rising Science and Technology Strength: Comparative Indicators for Asia, the European Union, and the U.S."—NSF-07-319 (issued 8/2/07).

China's college-age cohort (18 to 23 years) in 2020 is forecast to be 109 million, India's will be 139 million, and Japan's will be a little more than 7 million. The U.S. cohort is expected to be about 26 million—relatively flat growth over the 20-year study span. Engineering bachelor's degrees in China are currently nearly double that in the EU and the U.S. combined, and are continuing to grow, further widening the gap.

Asian countries did confer fewer doctoral degrees in the sciences in 2003 (the latest year data is available) than in the U.S. or the combined total of France, Germany, and the UK. However, they conferred about twice as many doctoral degrees in engineering than in the U.S. and about 15% more than the combined total from France, Germany, and the UK.

Foreign students earned about 40% of U.S. science and engineering (S&E) doctorates from 1989 to 2003, with Asian students representing about 55% of this group. Stay rates after degree conferral, especially for those from India and China, has been about 80% in the U.S. since 1992.

Immigration rules that were tightened immediately after 9/11 have been loosened slightly for S&E students, but not to the point at which they were immediately before the attacks. This frustration and the realization of expanding economies in their home countries continues to apply pressure to the tight job supply in R&D labs in industry, government, and academia.



In other cases, "centers of excellence" may be established as magnets for the encouragement of ancillary economic development. In either case, these funds are normally treated as being "government sources".

Who are the performers of R&D?

A brief historical outline of the patterns in R&D performance for 36 countries included in the OECD database is similarly provided in this report, along with estimates of the distribution of the R&D performing sectors for 2008.

As in the case of funding patterns, the upward and downward trends do not necessarily reflect actual increases or decreases in real values of performance, but are merely changes in the share of total performance.

Just as there are concerns regarding the definition of the sources of funding, as noted in the preceding section, there are also some concerns relative to the classification of the performing sectors. Here again, we draw upon practices that have been observed in the U.S. and draw some cautious analogies to situations that may occur in other countries.

Performance of R&D

Country	General Observations on Performing Laboratories	Estimated Projection for 2008 *		
		Government	Industry	Academia
Argentina	Government performance relatively steady, with 5-year cyclic tradeoffs between academia and industry.	40%	33%	23%
Australia	General increase of industrial role and decrease of government portion of performance. Academic portion relatively constant over the long-term.	14%	54%	28%
Austria	Long-term smooth and steady shift from academia and government to industrial share.	5%	68%	27%
Belgium	Distribution of performance among major sectors remains relatively constant over the past 20 years, with a recent small decline in industrial labs.	9%	67%	23%
Canada	Recent strong increase in the academic share, largely at the expense of industrial performance.	10%	50%	39%
China	Over past 10 years, major shift with increasing industry share of performance and associated decrease of government portion.	21%	70%	9%
China – Taiwan	Increase in industry share, with corresponding decrease primarily in government performance, and small decreases in academic share.	19%	71%	9%
Czech Republic	Industrial performance relatively stable, while academia (increasing) and government (decreasing) are converging.	19%	64%	17%
Denmark	All sectors' distributions remaining relatively stable over the past five years. Minimal non-profit performance.	8%	69%	23%
Finland	All sectors' distributions remaining relatively stable over past eight years. Minimal non-profit performance.	9%	71%	19%
France	All sectors' distributions remaining relatively stable over past seven years, although with small steady growth in academic sector. Minimal non-profit performance.	17%	61%	20%
Germany	All sectors' distributions remaining relatively stable over past decade.	15%	68%	17%
Greece	Academic performance share is growing at the expense of industry, with government facilities remaining essentially constant (albeit with small growth).	23%	27%	50%
Hungary	The reported distribution of R&D performance has been fluctuating for much of the past 20 years, but the long-term trends are suggesting an emerging stability.	27%	45%	25%
Iceland	Industrial share has increased substantially and suggests saturation, accompanied by a steady decrease in government share. Academia and non-profits are stabilizing.	24%	52%	22%
Ireland	Long-term monotonic growth in industry is offset by academic growth during last decade, with government showing a roughly steady share.	7%	68%	25%
Israel	Industrial share continues long-term steady growth, although rate of growth has slowed. Government and academic shares are essentially constant for past decade.	5%	76%	14%
Japan	Following steady industrial growth with short-term loss to government, the present smaller increases for industry will be offset by almost equal decreases for government and academia.	7%	78%	12%
Korea	Slight increases for industry are offset by a government decrease. Non-profits and academia are maintaining a generally constant in share of total performance.	11%	78%	10%

Specifically, the performing institutions that are known in the U.S. as the federally funded research & development centers (FFRDCs) are entities that have been established by various agencies of the federal government but which are managed and operated by other contractors, such as industry, academia, and non-profit organizations. In the accounting of the R&D performance of the FFRDCs, the R&D figures are assigned to the sectors represented by the managing contractor.

Thus, the R&D performed by those FFRDCs that are managed by private industry is counted as being R&D performed by that industry. In cases where the management of an FFRDC is transferred from one class of operating institution to another, such as resulting from the awarding of a new management contract, there is a sudden shift in the accounting of the patterns of R&D expenditures.

To the extent that similar events occur in other countries, these will be reflected in changes in R&D performance by the affected sectors, with these changes being above and beyond that which might be the result of normal variations that could be attributed to purely business decisions.

As one examines the trends of performance within various economies, one should bear in mind those cases where research institutes may be established by governments in a move toward enhancing national capabilities and then transferred to management and operation by private industry. Such transfers would not be uncommon in cases where such an institute is committed both to the mission support of a government agency and the dual-use concept that leads to private economic development.

The missing link

In part, data are available for the construction of time-series elements of a more nearly complete source/performer matrix, a step that will be desirable in order to gain a better appreciation of the R&D enterprise in selected countries. This level of detail provides the kind of background that is useful in assessing the impacts of both government and industrial decision-making.

The development and analysis of more nearly complete data on the national source/performer matrices provides a special benefit to those who are looking toward the strengthening of technical liaisons that support new market opportunities. In pursuit of that supportive role, subsequent analyses of data that are available through the OECD, the European Union, and other sources will be directed toward obtaining a better understanding of the patterns of funding and performance within various countries.

Where are the government priorities?

Throughout the countries covered by the OECD statistics, governments support a broad range of activities in pursuit of their basic missions. Almost all governments provide support to general higher education and "non-oriented research" (the effort that is generally equivalent to basic research and the establishment of a scientific baseline for further development), to the conduct of industrial technology, and to programs that deal with human health and agriculture. However, the priorities shift from one country to another.

A depiction of the major thrust areas for support by the individual governments is provided in this report. It is color-coded by importance. While definitions and classifications may vary from one country to another, most of the areas noted in the table are believed to be self-explanatory and leave little room for misinterpretation. Given that observation, it is especially surprising to see that the general field of energy received only one reference as a priority item (from Poland). Furthermore, this area was found to be at the bottom of the list of the five priority R&D concentrations.

Where do we go from here?

Given the history of the past twenty years, there is every reason to believe that the globalization of R&D will continue to grow and that the competition for research funds will become more intense. In addition, it is expected that greater emphasis will be placed upon

Performance of R&D

Country	General Observations on Performing Laboratories	Estimated Projection for 2008 *		
		Government	Industry	Academia
Mexico	Year-to-year data suggest a rapid change and instability, but the overall trends suggest continued growth of industrial performance and decreases elsewhere.	19%	51%	27%
The Netherlands	As with other mature R&D enterprises, all sectors appear to be achieving relative stability in the performance shares of total R&D.	14%	59%	26%
New Zealand	Recent data not available, but trends indicate a continued steady growth of industrial share, with government and academia maintaining almost equal decreasing shares.	25%	50%	25%
Norway	Academic share has been increasing slowly, balanced by a decrease in industrial research activity. The government sector is relatively steady.	16%	53%	31%
Poland	Approaching a relatively even distribution across all sectors following a spike in the government share (offset by industry).	36%	24%	22%
Portugal	Academic and non-profit sectors remain relatively constant over the past 10 years, with a significant shift from government to industry.	13%	38%	39%
Romania	The industry share has dropped to 50% of the level it had 15 years ago, with generally steady increases in all other performing sectors.	34%	41%	18%
Russian Federation	A relatively stable distribution of performance has been reported over the past 15 years.	27%	67%	5%
Singapore	There are general increases in the industrial share, with offsetting decreases in government and academic performance.	9%	68%	23%
Slovak Republic	A potential stability follows several years of tradeoffs between government and industry, superposed on a relatively steady academic performance share growth.	30%	50%	20%
Slovenia	Generally steady growth of industrial sector performance with steady declines in other sectors.	19%	75%	6%
South Africa	Following a 10-year shift from government to academia and a return, these two sectors are essentially at equilibrium, with small increases in the industry share.	20%	58%	20%
Spain	Generally constant share of performance among all sectors, but with recent increases in the government portion.	19%	54%	27%
Sweden	All sectors' shares have remained relatively constant over the past 10 years, but with a recent small increase in government work and an offsetting decrease in academia.	13%	74%	13%
Switzerland	All sectors' shares have remained relatively constant over the past 10 years.	2%	74%	22%
Turkey	Academia is recovering after a period of tradeoffs with industry, as the government share remains relatively constant.	7%	24%	68%
United Kingdom	The academic sector shows steady share growth over the past several decades. The industrial sector is declining in share, with a small increase in government performance.	11%	61%	26%

* Totals may not add to 100%. The remainder of performance is conducted by the non-profit sector, as applicable. While more specific data are required in order to account for the observed and anticipated changes, it is likely that increases in the share in some of the countries are tied directly to general increases in foreign direct investment. Source: Battelle, R&D Magazine, OECD

assessment of the long-term effectiveness of research activities, regardless of where the moneys come from and where they are spent.

The interaction between the industries and research facilities of the U.S., Western Europe, and Japan have many years of experience behind them, with a long track record of activities and accomplishments. It would appear that most of the general questions and issues have been resolved, even though continuing detail on the structure and evolution of the R&D enterprise is both useful and necessary.

Conversely, it is too early at the present time to do a parallel evaluation of the R&D process, utility, and consequences associated with the relations between Asia and the West. Ten years of experience does not provide sufficient time to have amassed information about downstream impacts of actions that have been taken or actions that are planned. Efforts should be directed toward a continued monitoring of events in the sphere of R&D interactions and the development of a rationale for assessing the impacts of decisions and actions taken by all types of participating sectors.

To date, most of the discussion on R&D in Asia, and the role of Asia in the global interactive R&D sphere, has concentrated on activities in China and India. However, one cannot overlook the

Pharma, Auto, and ICT Dominate Industrial R&D

More R&D is performed by the world's industrial companies than the combined total of government and academia. On average, about two thirds or more of any country's R&D work is performed in an industrial setting—in the U.S., it is 72% and in China it's 70%.

Three industries—pharmaceutical, automotive, and information and communication technologies (ICT)—constitute all but one of the top 25 global R&D spending commercial companies in the world. The other one, Microsoft, could almost be considered an ICT company for its involvement in ICT areas. ICT companies are the most dominant with 10 of the top 25 companies and 36% of the overall $136 billion in R&D spending. Pharmaceutical companies follow close behind with eight of the top 25 and a 32% share. There are six automotive manufacturers.

Japan and the U.S. account for about two-thirds of the overall spending in the top 25 list, since most of the leading pharmaceutical and automotive manufacturers reside in these countries.

From a strict R&D standpoint, it's somewhat questionable to count the two-thirds of the pharmaceutical spending that is dedicated to the execution of clinical testing. Clinical tests are expensive, being performed on large quantities of individuals to collect statistical information about the variability of specific drugs on a wide distribution of people.

Similarly, nearly 85% of automotive spending is principally dedicated to the development of tooling for the year's new models. These development funds have historically been included in a company's general R&D funding program and difficult for analysts to financially separate from the company's total research effort. The data for these items are generally unavailable from any company documentation but are interpreted from the type of work involved and the industry's annual product requirements.

When combined, clinical trials and automotive production tooling account for about 45% of the total spending of the top 25 companies. But while they're essential to the execution of the overall product development program, the actual costs are for mostly low- or non-technical items.

Top Global R&D Spending Companies

	Company	Country	2006 R&D Billions U.S.$	2007 R&D Billions U.S.$	2008 R&D Billions U.S.$
1	Toyota Motor	Japan	7.896	8.329	8.761
2	Pfizer	U.S.	7.600	7.300	6.900
3	Ford Motor	U.S.	7.200	7.110	6.854
4	Microsoft	U.S.	6.901	7.431	7.961
5	GlaxoSmithKline	U.K.	6.549	7.073	7.639
6	General Motors	U.S.	6.500	6.400	6.100
7	Siemens AG	Germany	6.434	6.674	6.913
8	Volkswagen	Germany	6.055	6.400	6.810
9	Intel	U.S.	5.873	6.333	6.812
10	Sanofi-Aventis	France	5.844	6.311	6.816
11	IBM	U.S.	5.682	5.853	6.037
12	Novartis AG	Switzerland	5.474	5.894	6.436
13	Matsushita Electric	Japan	5.406	5.583	5.761
14	Nokia	Finland	5.143	5.735	6.376
15	Johnson & Johnson	U.S.	5.000	5.450	6.049
16	Roche Holdings	Switzerland	4.948	5.334	5.720
17	Merck & Co.	U.S.	4.783	5.090	5.431
18	Honda Motor	Japan	4.758	4.944	5.131
19	Nissan Motor	Japan	4.707	5.118	5.529
20	Cisco Systems	U.S.	4.264	4.619	4.975
21	Sony	Japan	4.162	3.959	3.757
22	Motorola	U.S.	4.139	4.594	5.062
23	AstraZeneca	UK	3.902	4.211	4.528
24	Hitachi Ltd	Japan	3.709	3.756	3.803
25	Hewlett Packard	U.S.	3.693	3.922	4.151

Source: Schonfeld & Associates, R&D Magazine

The Globalization of Innovation

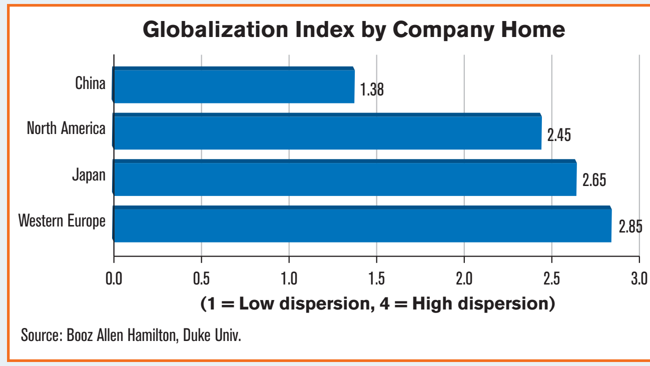
Offshoring is growing throughout Europe and the U.S. at double-digit rates and across all industries and all major business functions, including R&D. As a result, R&D in a number of mostly—at present—isolated areas has become a 24/7 environment as work continues through the world's 24-hr time zones. This has been readily apparent in the ICT (information and communication technology) area—IBM is now said to have more researchers in India than it has in the U.S. ICT is reaching a maturity stage (or stabilization of growth) for offshoring. Other industries are continuing to evolve.

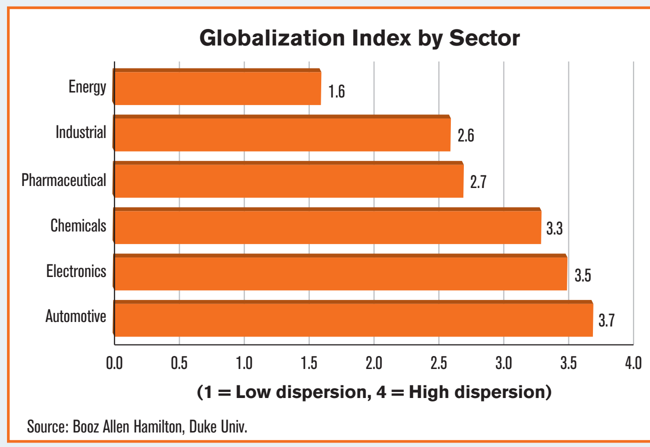
According to a recent report by Booz Allen Hamilton, New York, N.Y., and Duke Univ., Durham, N.C., "Next Generation Offshoring", there is 50% annual growth in the offshoring of core innovation practices (engineering design and services, product development, and R&D).

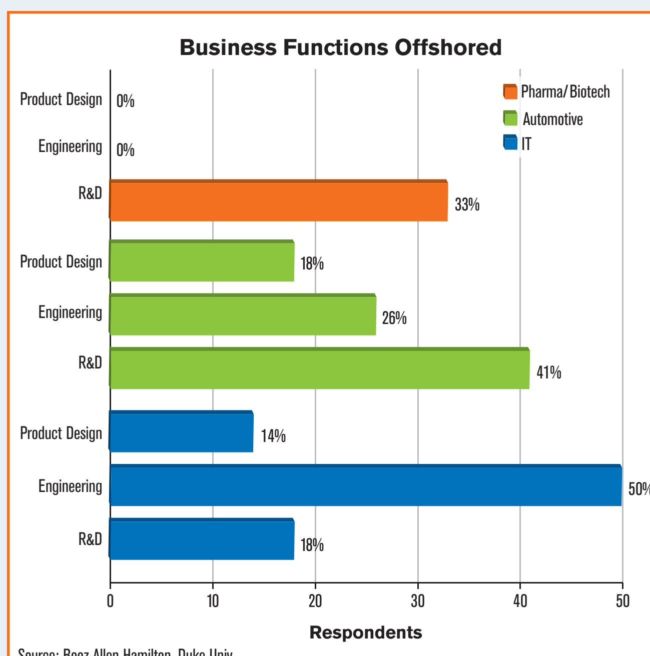
This practice is not completely unique to European and U.S. organizations. Asian producers are also beginning to establish near-shore delivery capabilities to meet their customers' needs and gain additional market share. A number of Japanese automotive manufacturers have or are establishing substantial R&D facilities in the U.S. Honda, for example, has a large new automotive testing site in Ohio, and Toyota is building a large R&D facility in the Detroit, Mich., area.

The offshoring of innovation has both "push" and "pull" factors that act to implement change, with positive and negative mitigating factors. "Push" factors for western companies include an increasingly severe talent shortage, competitive pressures, and experience with offshore companies who are increasingly capable of sourcing global talent. "Pull" factors include local grants and incentives for companies, incentives for highly skilled nationals to return home, and the experience of service providers to work better with traditional organizations. Positive mitigating factors that affect offshoring can include advances in ICT and Internet technologies, along with improving standardization policies. Negative mitigating factors include language and cultural differences, wage inflation and turnover, and infrastructure deficiencies.

It is becoming apparent that the leading incentive for offshoring is becoming a race for talent. Deficiencies in the number of S/E (scientists and engineers) produced to satisfy U.S. demand has been apparent for several years. But even in China and India, where the annual production of S/E is several times that of the U.S., there is a noticeable lack of adequate supply. Unfortunately, the rate at which Chinese students are entering S/E fields is declining, which obviously is exacerbating the problem.







research capacities and initiatives that are resident in other Asian countries, including Korea, Singapore, Malaysia, Indonesia, Thailand, and even Australia. These countries have defined science and technology policies that are aimed at providing an environment that will lead to the technology-based economic benefits that can accrue from proper investment. Continuous monitoring of those initiatives and an assessment of the manner in which their resources can be integrated within and between the different regions will permit the establishment of a better framework of understanding.

There is little question about the fact that knowledge of the existing milieu for science and technology, coupled with an appreciation of the history, the policies, the institutions, and the downstream implications, will serve both the host and investor countries well.

—Jules Duga
—Tim Studt

About the Authors

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References and Resources

The following web sites are particularly good sources for information relative to the R&D enterprises in selected countries that are included in this report. The listing is representative and certainly not inclusive.

- **American Association for the Advancement of Science**
  www.aaas.org
- **Battelle**
  www.battelle.org
- **Booz Allen Hamilton Global Innovation 1000**
  www.boozallen.com/publications/article/18054973?lpid=66005
- **China Ministry of Science and Technology**
  www.most.gov.cn/eng/index.htm
- **Chinese Academy of Sciences**
  http://english.cas.cn
- **Economic Intelligence Unit**
  www.eiu.com
- **European Commission Research**
  http://ec.europa.eu/research/index_en.cfm
- **European Industrial Research Management Association (EIRMA)**
  www.eirma.org
- **European Union Community R&D Information Service (CORDIS)**
  http://cordis.europa.eu/en/home.html
- **Industrial Research Institute**
  www.iriinc.org
- **Japan Ministry of Education, Culture, Sports, Science & Technology**
  www.mext.go.jp
- **Japan Science and Technology Agency**
  www.jst.go.jp/EN
- **KPMG Competitive Alternatives**
  www.competitivealternatives.com
- **McKinsey Global Institute**
  www.mckinsey.com
- **Organization for Economic Cooperation & Development (OECD)**
  www.oecd.org
- **RAND National Security Research Division**
  www.rand.org
- **Shonfeld & Associates, Inc.**
  www.saibooks.com
- **The World Bank**
  www.worldbank.org
- **Thomson Scientific**
  www.thomsonscientific.com
- **U.S. National Science Foundation**
  www.nsf.gov
- **World Economic Forum**
  www.weforum.org

Footnotes:

[i] *Globalizing Industrial Research and Development, October 1995 and September, 1999; U.S. Department of Commerce, Office of Technology Policy, Asia-Pacific Technology Program.*

[ii] *For an overview of the OECD, its history, programs, and activities, see the OECD 2007 Annual Report at http://www.oecd.org/dataoecd/1/53/38484866.pdf*

[iii] *A variety of R&D data may also be obtained at the European Commission site found at http://epp.eurostat.cec.eu.int/portal/page?_pageid=1996,45323734&_dad=portal&_schema=PORTAL&screen=welcomeref&open=/science/research/r_d&language=en&product=EU_science_technology_innovation&root=EU_science_technology_innovation&scrollto=132*

[iv] *A straightforward explanation of purchasing power parity has been published by the Univ. of British Columbia, Sander School of Business (http://fx.sauder.ubc.ca/PPP.html). In that paper, the authors make reference to the annual "Hamburger Index" reported by The Economist, which is a simple expression of the different costs of purchasing a typical commodity in different countries. But the costs of a single item do not present a true picture of the overall purchasing power as applied to a broader basket of goods and services. It is perhaps more appropriate to take into account the differences in wage scales as well, and define PPP in terms of how long it takes a person to work to acquire sufficient funds to obtain that basket of goods.*

[v] *Remarkable by its absence is detailed information relative to the R&D enterprise in India. There are rather extensive data on some of the characteristics of the Indian system, such as enrollment in science and engineering programs at various levels in the education system and some of the output measures (patents, degrees, papers). However, the parallel detail on sources of funding and the performance of R&D in different types of institutions is not readily available. For a discussion on the Asian R&D enterprise and various indicators, see National Science Foundation, Div. of Science Resources Statistics, 2007. "Asia's Rising Science and Technology Strength: Comparative Indicators for Asia, the European Union, and the United States." NSF 07-319. Arlington, Va.*

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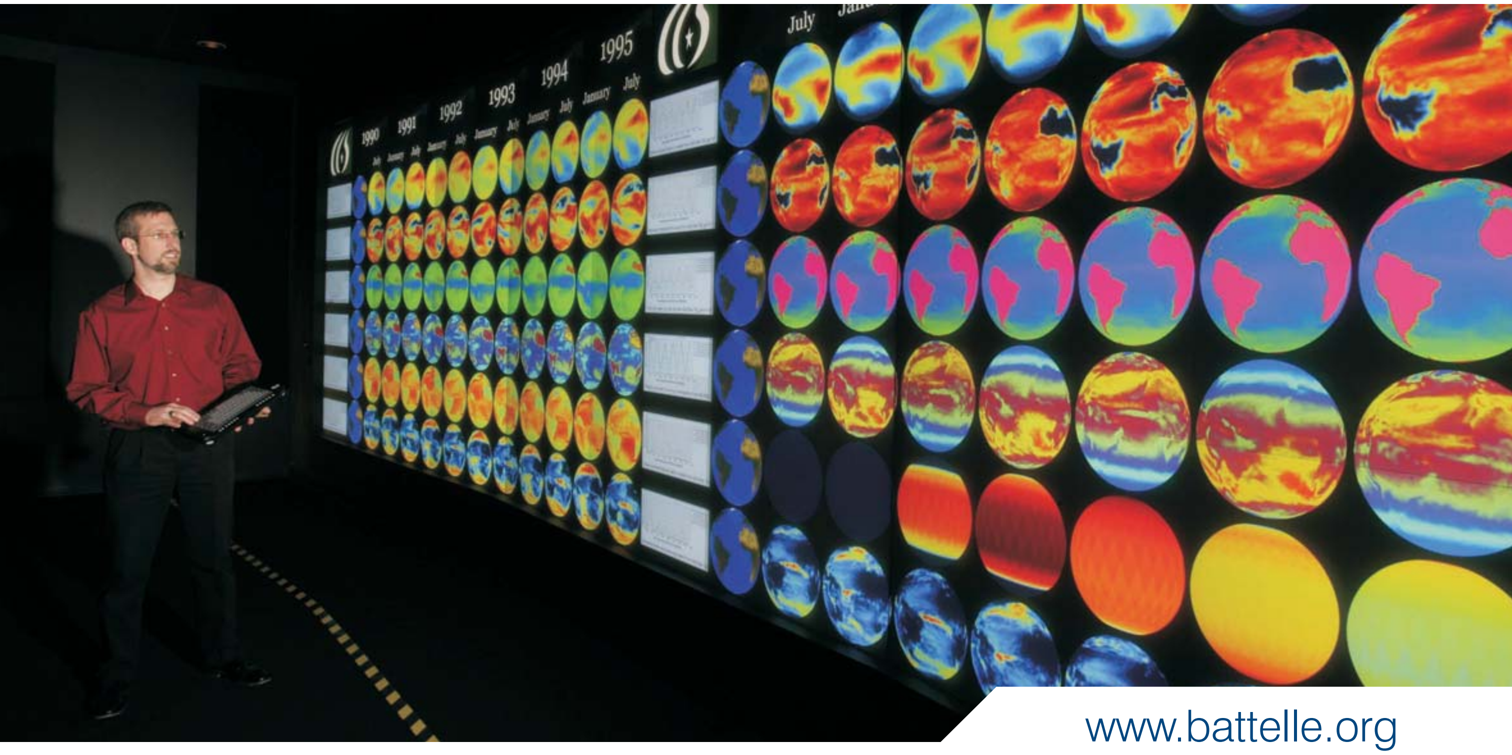

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