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R&D and Innovation in Industry

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HIGHLIGHTS

- Although R&D investment by U.S. industry surpassed inflation in 2004, 2005 will most likely mirror the preceding two years, with a small but less-than-inflationary increase. There will again be wide variation depending on industry. Pharmaceuticals, software, computer and component makers, and a few profitable biotechnology companies are increasing their R&D. Auto, aerospace, networking equipment manufacturers, chemical and process-related industries will be mixed but with small total sector increases likely. Telecommunications companies are still closely controlling spending. With sales performance generally improving, R&D intensity—R&D as percent of sales—will decrease.

- Internally generated business growth opportunities, either within existing product lines or based upon newly employed platforms, will command the largest proportion of the budget. R&D spending for new business opportunities, mergers, and acquisitions will increase, as will capital spending to support R&D. In contrast to the recent past, there will be some increases in technical work force.

- Other countries and regional governments continue to plan for, invest in, and build innovation capacity as a driver for economic growth and competitiveness. The United States government, with its high military and homeland security spending and other priorities, is finding it difficult to continue its support of technology growth at historical levels.

- Industrial R&D, while still dominated by in-house development work, is increasingly turning to collaborative programs around the world with supply chain partners, universities, federal laboratories, and even competitors. Contract research is also increasing. Such joint efforts are now viewed as necessary to gain more rapid access to desired

technologies and the diverse talent to produce them, particularly in directed basic research programs.

R&D INVESTMENT

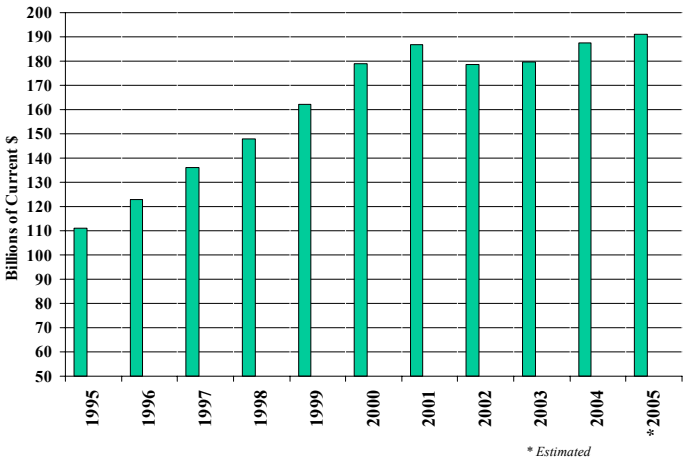

Figure 1. R&D Investment by Industry, 1995-2005

R&D funding by industry grew at a rate slightly above inflation for the first time in three years. The Battelle R&D Magazine[1] study has estimated that the increase for 2004 was 4.3 percent over 2003, taking industry's R&D investment to $187.4 billion last year. Battelle projects an increase in industry R&D funding of 1.9 percent for 2005, to $190.9 billion. For comparison, between 1992-2001 industrial R&D spending grew steadily, with half of those years recording near or above double-digit percentage increases. IRI's Trends Forecast for 2005[2] shows 80 percent of companies will increase spending year-to-year. Comparing previous forecasts to actual, this information supports a slight increase in spending to $191.2 billion. The estimate is supported by anecdotal evidence gathered more recently in meetings with industrial research

[1] Studt, Tim and Duga, Jules, *Continued Defense Spending Offsets Flat Industrial R&D,* R&D Magazine—January 2005, pp. F1-F15.
[2] *Industrial Research Institute's R&D Trends Forecast for 2005*, RESEARCH-TECHNOLOGY MANAGEMENT, January-February 2005, pp. 18-22.

leaders and the advantage of seeing actual business performance and employment trends for a number of months. The economy shows signs of modest growth, but a large predicted federal budget deficit, a growing trade imbalance, record high energy costs, and inevitable reduction in government support for non-defense/security basic research moderates any optimism by industrial management. These estimates are reflected in Figure 1, which tracks R&D investment by industry over 10 years through 2005. Year-to-year change percentages are shown in Figure 2.

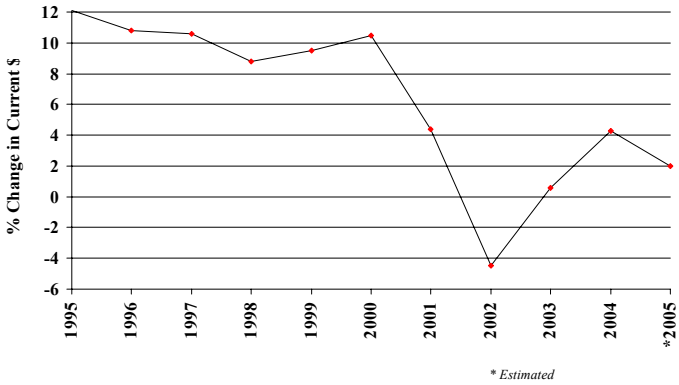

Figure 2. Change in Industrial R&D Investment, 1995-2005

Industry's performance of R&D in 2004 was $205.0 billion, up 4.5 percent from $196.1 billion in 2003. Battelle projects that this figure will increase 2.0 percent during 2005, bringing industry's total R&D effort to $209.1 billion this year. Using the revised estimates for the proportion funded by industry, and recognizing that government funding for industrial research is not as volatile, we estimate that this value of R&D performed by industry will be closer to $209.4 billion or up 2.2 percent. Thus, industry will **fund** more than 61 percent and will again **perform** some 67 percent of the total of $311.9 billion we estimate will be invested in R&D in the U.S. during 2005. This decrease of one percent from last year for both indicators continues the downward drift seen each of the last several years.

R&D TRENDS FOR 2005

The Industrial Research Institute (IRI) R&D Trends Forecast, based on replies from 99 IRI member companies during the third quarter of 2004, continues to forecast a minor retreat from the historical pattern of continued growth, above inflation, in R&D of the late 1990's. However, results suggest a modest increase of support of both new and existing businesses and an arrest of the previous decline for directed basic research, all in current dollars. There will be hiring growth, more contracts with federal laboratories and universities, continued mergers and acquisitions as a route to quickly access desired technologies, and increasing capital spending in support of R&D.

As implied also with the 2004 survey, businesses continue to recognize that initiating totally new businesses within an existing corporate structure (crossing the "valley of death") is extremely difficult. More companies will spin out new business ventures spawned by their technology platform development successes.

U.S.-based and foreign-headquartered companies recognize that the pool of talented scientists and engineers is now global and accessible by outsourcing work, by setting up remote wholly-owned laboratories, or by offering bounties over the internet for solutions to well-defined technical challenges. The need for U.S. companies to look beyond home borders is heightened by declining production of its own graduate scientists and engineers and by stricter limits on immigration. In addition to U.S. and European companies siting labs in each others' territory, both are looking toward India, China, and former Soviet states. India has particular strengths in chemical synthesis, software development, and clinical testing of drug candidates. The People's Republic of China is strong in software, computational analysis, value engineering of products, and product development. Eastern Europe is particularly strong in directed basic research. However, these locations and others carry a real potential to lose intellectual property.

GLOBAL INNOVATION STRATEGIES

Countries all over the world are taking a close look at their innovation systems in order to insure economic security. Those that recognize and plan for a global economy are most likely to thrive.

United States: Over the past ten years, a new informal innovation system evolved in the U.S., with support from government and industry for basic research in universities, nurtured by rapid growth in venture capital, and implemented by industrial firms through strong investments in R&D, capital equipment, and information technology. This highly complex system of innovation is also based on close collaborations and increasing alliances among industry players, universities, and government labs. There are now stresses in this proven formula that must be addressed.

The major discontinuity in venture capital funding following the collapse of the Internet bubble is slowly being mended. But this method of support focuses on technologies for which proof of concept and a clear sense of market are at hand. High-risk projects and those with long incubation periods, like those that might transform an industry, are not usually attractive to venture firms. However, by comparison the U.S. still has a more robust system of early stage capital sourcing than many economies.

Unfortunately, defense and homeland security needs will put great pressure on government spending that could otherwise lead to new commercially important technologies, products, and services. Appropriate support is in doubt for the critical measurement and standards work of the National Institute of Standards and Technology (NIST), its world-class and widely-emulated Advanced Technology Program, and its very effective Manufacturing Extension Partnership. Funds for partnership programs between national laboratories and industry, and the offices to foster and manage such collaborations, have disappeared. The promised doubling of the National Science Foundation budget to support physical sciences and engineering programs in universities has been abandoned. Partnerships in math and science that could begin to rebuild a technically capable workforce have been reduced and redirected. The Technology Administration in the Department of Commerce is vulnerable. Continuing along this path threatens to undermine U.S. industrial competitiveness.

In response, an industry-led National Innovation Initiative sponsored by the Council on Competitiveness has engaged a broad coalition of industry and academe to address the whole **system** of innovation in the U.S. and its competitiveness opposite increasingly popular global venues for research. An implementation plan is being prepared and will be

launched shortly. This approach, to increase the attractiveness of the U.S. to both foreign direct investment and our own global companies, is far more likely to succeed than a retreat to protectionism.

Europe: The enlargement of the European Union, formation of a new Commission in Brussels, and serious examination by nations of (slow) progress towards the Lisbon objectives of greater competitiveness in the knowledge economy have led to examination of the role played by industrial R&D. The 2004 EU Industrial R&D Investment Scoreboard demonstrates that European companies remain strong in key sectors, notably automotives, and that there is a group of large companies that are very successful through their R&D, but the overall trend is still down.

There are plans to establish an independent European Research Council, with substantial budget devoted to funding frontier research according to competitive, international submissions. The Technology Platform initiative is advancing quickly, bringing together stakeholders from the public and private sectors under industry leadership to establish realistic medium term and longer term research agendas. At national level, there is lively debate concerning the relative merits of free markets and national champions in establishing competitive advantages in key areas dependent on R&D.

Latin America: Industry will increase its budgets for R&D in 2005, especially in the pharmaceutical and chemical sectors. Governments continue steady support to their national research laboratories but at a level below the demand to support many sound projects. Interaction between the research laboratories and industry is increasing. There is no movement in government circles to establish research toward advanced technologies. Some regional innovation strategies have encouraged formation of technology clusters. Private industry is greatly interested in building an international cooperation program for research, technology and innovation, such as the "Framework Program for the Americas" but investment support has not been identified. Joint programs with the United States and Canada are being sought. The few current examples of international cooperative projects, particularly in biotechnology, are still primarily academic.

Asia: The **Chinese** government views 2005 as a vital year to build its country's innovation capacity to support a harmonious, well-rounded, and prosperous society. A National Science and Technology Plan for

2006-2020 will be promulgated to: produce proprietary intellectual property by scanning the leading science and technology developments; strengthen national competitiveness by developing key technologies; focus on strategic high-tech products and projects; and build sustainable innovation capacity.

To support the Plan's goals, the government will play an active policy role, drastically increasing public expenditure on R&D. It will improve infrastructure and streamline the innovation system. A comprehensive set of national programs has been developed to manage various aspects of the Plan. Implementation of the Plan and supporting programs will be led by the Ministry of Science and Technology.

The economy of **Japan** is holding steady, supported by satisfactory exports and increasing domestic consumption. Deflation is a continuing concern. Recovery is being led by digital consumer products and the materials industries, especially steel. Although the National Budget of 2005 fiscal year will show decreased expenditures, the allocation for promoting science and technology will by increased by 2.6 percent to 1.3 trillion yen. This is aligned with the Japanese Government strategy to realize "an advanced science- and technology-oriented nation".

In spite of a blurry economic picture, **Korean** R&D expenditure will increase 22.2 percent in 2005, focusing on telecommunications, electronics, computers, machinery, chemicals, metals, and food & medicines. Over 80 percent of the companies surveyed will increase R&D expenditures in 2005.

Although some manufacturing facilities are moving overseas, mainly to China, few companies set up R&D centers there. At the same time, with governmental endeavors to make Korea a "R&D Hub of Northeast Asia", the number of foreign R&D centers established in Korea has increased.

The Korean Government has taken additional bold actions to strengthen the nation's S&T capabilities. It plans to build an "S&T-oriented Society." As a start, the S&T Minister is now a Vice Prime Minister position. The National Innovation System will be reworked to improve university research, seek globalization and to concentrate national S&T resources on the development of 10 new growth industries. To facilitate commercialization of public R&D results, the technology transfer budget was more than tripled.

Australia: Industrial R&D (IR&D) in 2005 appears to enjoy a more favourable climate than at any time since 1996. A recent survey suggested that the major issues are staff recruiting and development; team development; outsourcing and portfolio management, with an emphasis on emerging technologies. This is a marked turnaround from the days of downsizing, restructuring, globalisation and knowledge management. Business expenditure has doubled in constant dollars over thirteen years to $A5.9 billion (2002/03). The largest industry sectors are manufacturing at 46 percent and mining at 10 percent.

While the general innovation climate has improved since 2000 with the "Backing Australia's Ability Program," substantial increases in financial support for industrial research have not been forthcoming. This $A5 billion/five year program focuses on enhancing innovation across universities, public research agencies and business. The biggest winners have been universities and public sector research, with the support for business R&D reducing steadily and an increasing proportion of support going to the SME's. The major industry support program is a 125 percent tax concession for IR&D (increasing to 175 percent for IR&D increases that satisfy certain conditions). This support program has been often described by industry as "sustaining but not stimulating". Therefore the more positive climate for IR&D in 2005 must be viewed as largely self-funded by industry.

CONCLUSIONS

The year 2005 is a welcome minor improvement for the U.S. industrial research establishment. In spite of economic malaise, international threats, and the growing deficit, industry will initiate bold steps to prepare to thrive and to structure the nation to again be the premier R&D site for global technology-based companies.

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