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R&D and Innovation in Industry

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HIGHLIGHTS

- After a 10 percent increase in R&D investment by U.S. industry over a number of years, growth decelerated in 2001. There is likely to be little or no growth in real dollars in 2002 across the entire sector. There will be wide variation depending on industry, with pharmaceuticals, biotech, and genomics companies on the high end, chemical and process-related industries on the low end.

- The area of R&D in industry with the highest rate of growth over the past six years has been in directed basic research; there will be only modest increases in this area except in support of clearly defined business growth opportunities. Savings in R&D expenditures will be achieved by reductions in technical service work and by fewer external ventures in emerging technologies.

- Innovation and the effective management of technology have become a top priority for nations as well as companies, to stimulate economic development and strengthen their competitiveness.

- Allocation of R&D for the development of new businesses is seen as a key growth strategy by firms in most parts of the world.

INTRODUCTION

This chapter reviews the R&D investment made by industrial firms in recent years, indicates the projection for industrial R&D investment in

2002, describes recent initiatives by other countries to stimulate innovation, and summarizes results of the Industrial Research Institute's (IRI) annual R&D trends forecast for 2002.

R&D INVESTMENT

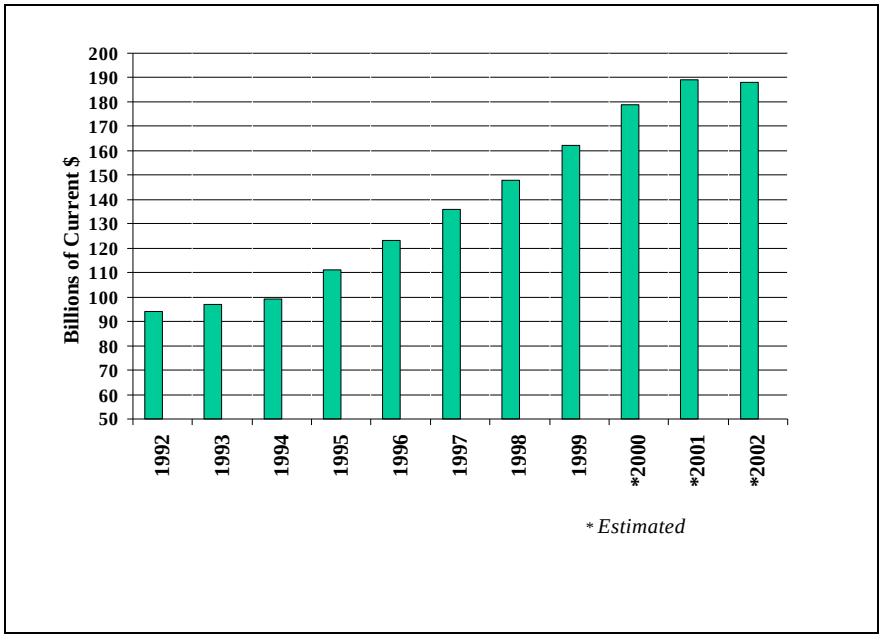

Figure 1. R&D Investment by Industry, 1992-2002

R&D funding by industry grew at a reduced rate in 2001 in comparison to the previous six years of near or above double-digit levels. The Battelle R&D Magazine[1] study has estimated that the increase for 2001 was 5.6 percent over 2000, taking industry's R&D investment to $189 billion last year. IRI's Trends Forecast for 2002[2], taken prior to the September 11, 2001 terrorist attacks, indicated that this growth would diminish considerably, with most companies reporting zero to less than 5 percent increase in spending year-to-year. The number of companies forecasting *reduced* spending rose significantly. This forecast was

[1] Duga, Jules, *Battelle-R&D Magazine Forecast Predicts Small Increase in R&D Expenditure for 2002* (draft copy).
[2] *Industrial Research Institute's Annual R&D Trends Survey for 2002*, RESEARCH-TECHNOLOGY MANAGEMENT, January-February 2002, pp. 16-20.

supported by Battelle, which projected an increase in industry R&D funding of only 3.2 percent for 2002, to $195 billion. Anecdotal evidence gathered more recently in meetings with industrial research leaders suggest, however, that with continued deterioration of the economy through the fourth quarter of 2001 and the lack of significant recovery in first quarter 2002, these figures are now too optimistic. It is quite possible that 2002 will be the first year of decreased investment in R&D by industry in more than 10 years. These revised estimates are reflected in Figure 1, which tracks or predicts R&D investment by industry over 10 years through 2002. Year-to-year percentage changes are shown in Figure 2.

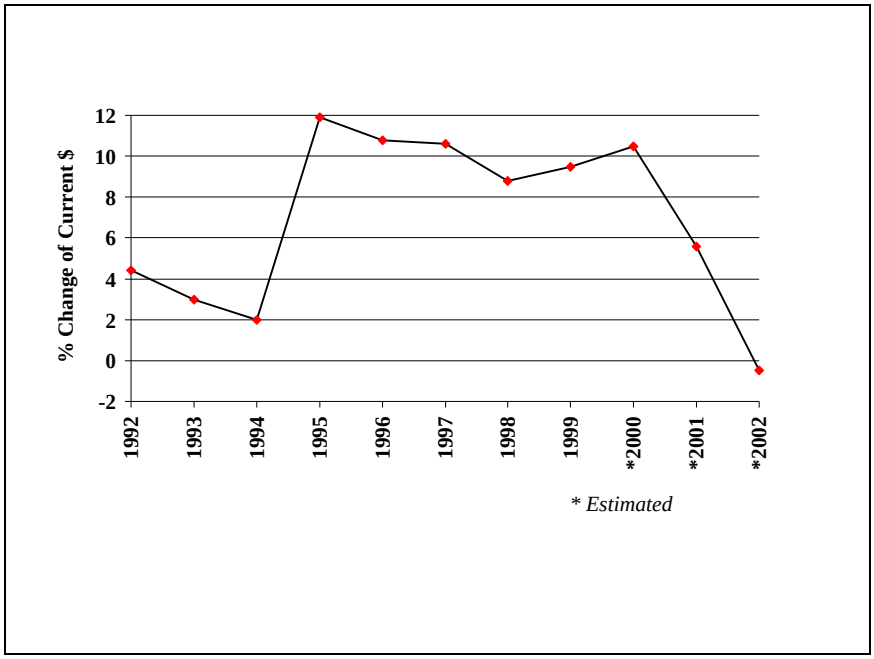

Figure 2. Change in R&D Investment by Industry over Previous Year, 1992-2002

Industry's performance of R&D in 2001 was $212 billion, up 5.0 percent from the $202 billion in 2000. Battelle projects that this figure will increase 3.5 percent during 2002, bringing industry's total R&D effort to $219 billion this year. Using the revised estimates for the proportion funded by industry, and recognizing that government and non-profit funding for industrial research are not as volatile, we estimate that this value of R&D performed by industry will be closer to $216 billion or up

only 2.1 percent. Thus, industry will *fund* more than 66 percent and will again *perform* some 77 percent of the total of $283 billion that we estimate will be invested in R&D in the U.S. during 2002.

R&D TRENDS FOR 2001

Unfortunately the National Science Foundation (NSF) was unable to complete its very valuable report *National Patterns of R&D Resources* for 2002. Thus the distribution of research effort among various types of research—directed basic, support for new business growth, support of existing business, and technical service—for 2001 is not available. However the Industrial Research Institute (IRI) R&D Trends Forecast clearly suggests a reduction in all categories, with the exception of a strong drive to create new businesses based on sustainable technological competitive advantage. The proportionate reduction in directed basic research must be tempered by the understanding that this data set does not include an appropriate proportion of respondents from the emerging biotechnology and genomics enterprises, which invest significantly in this category.

IRI's forecast for industrial research during 2002, based on replies from 77 IRI member companies during August and September 2001, forecasts a pause in the historical pattern of continued growth in R&D investment. In addition to support of new business growth, member companies will continue to invest in partnerships and new ventures, albeit at a lower growth rate. For those industries that have seen major restructuring of R&D over the past ten years, the opportunity to manage a cut in R&D investment will not be easily accomplished. Further staff reductions will affect their ability to remain competitive. From among these firms, those that have supplemented their internal staff with partnerships, venture investments, and programs with universities and federal laboratories, may relieve temporary downward fiscal pressure by scaling back on existing and new external relationships.

Seventy-five percent of respondents planned increases in R&D during 2002, essentially unchanged from the previous year. Sixty-seven percent expected their capital spending for R&D to increase, down lightly from seventy-six percent for 2001. However, the forecasts for professional staffing level and hiring of new graduates were significantly less than the previous year. Major emphasis on allocating R&D resources to new-business projects, using a "sea-change index," was indicated by IRI

member companies. Counterparts in Japan, Korea, Canada, and Europe confirm a strong interest in managing for growth, whereas Australia projects more balance between growth and support for existing businesses.

GLOBAL INNOVATION STRATEGIES

United States: Over the past ten years, a new global 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 closer collaborations and increasing alliances among industry, universities, and government labs.

A major discontinuity in innovation capacity was the 65 percent drop in venture capital funding in 2001 relative to the previous year, as reported by the National Commission on Entrepreneurship. Although 2002 will probably be similar to or slightly below the $36 billion invested in 2001, it is important to realize that this number is still incredibly competitive with the rest of the world.

Within the government, new directions are being foreshadowed, although major change may not occur in fiscal year (FY) 2003. While appropriations for the major science agencies such as the National Science Foundation (NSF), the National Institutes of Health (NIH), and the National Institute of Standards and Technology (NIST) have increased in recent years, a strong bias for the life sciences has emerged. Other Departments which traditionally are strong sponsors of industrial research—Energy and Defense—will be under pressure to reallocate appropriations to homeland defense programs. These may or may not involve their traditional industrial R&D partners. Collaboration programs such as the Advanced Technology Program (ATP) in NIST and government-wide cooperative research and development agreements (CRADAs) are being scaled back. Engineering centers and manufacturing extension programs will be under pressure.

The Department of Commerce is carrying out an extensive survey of industrial trends and stated needs in order to help prioritize existing and create new programs to maintain U.S. international economic competitiveness. It will be imperative that this effort look at the whole

system of innovation in the U.S. and its growing connections to global partners.

Europe: The 6th Framework program was instituted last year in response to a rising concern over the European Union's (EU) relatively weak leadership in science and technology, as well as a lag by European firms in commercializing new technology (the "European paradox"). This policy is designed to foster a culture of entrepreneurial risk taking; to improve the coordination of innovation policy across Europe; to improve the availability of venture capital; and to streamline the protection of intellectual-property rights in Europe. It has become apparent that the investment put in by the EU Directorate has not been driving the industrial establishment to begin its move toward the goal of 3.0 percent of Gross Domestic Product (GDP) spent on R&D (up from the current 1.9 percent). The implication is that the climate for innovation—25,000 borders with disconnected markets and regulation—must be addressed in the same successful way as the development of policy for telecommunications. A positive sign is that R&D was on the agenda of the recent Barcelona EU summit meeting and a commitment was made to the 3 percent goal.

In addition to EU activities, most European countries have their own complementary innovation policies, with strategies to enhance their local economic competitiveness.

China: China's political leadership is placing high priority on innovation as a key element in its transformation into a market-driven economy that will be subject to the competitive pressures of the World Trade Organization (WTO), which China recently joined. It is estimated that China must generate 200-300 million jobs in this decade. Its goal is to be in the top 10 most S&T competitive nations by 2010. China intends to raise the national R&D expenditure from 1.0 percent of GDP in 2000 to 1.5 percent by 2005, with half of that coming from private enterprises. It is doing so by encouraging investment in R&D by Chinese and foreign companies through tax credits, support of universities and institutes, establishing science/industry parks, and increasing funds to support small and medium-sized enterprises.

A recent report from the World Bank[3] suggests that China needs to improve the "rule of law" in business and intellectual property matters, support basic research to solve pressing problems in agriculture and environmental stress, encourage the private sector to do more of its own research while seeking internal and global collaboration, and strengthen the universities while regulating their relationships with the market.

U.S. companies continue to expand their Chinese laboratories to take advantage of the available highly-skilled workforce with its 30 percent lower cost. Caveats have been expressed about the difficulty in realizing published tax incentives through the maze of local and regional bureaucracies.

Canada: Canada has established a strong innovation strategy, through which it plans to greatly improve the climate for innovation. To start, it will double government's support of science and technology to $15 billion by 2010. It will support strong university basic research, collaborations among academia, national laboratories, and industry, skills training for workers, modern policy to promote innovation, and strengthening communities to attract both Canadian and foreign industrial investment. As one example, it intends to provide high-speed Internet access across Canada, reaching any town with more than 500 inhabitants. It will be strengthening support for small and medium-sized enterprises and trading upon its documented lower cost of research compared to the United States.

CONCLUSIONS

The year 2002 will, hopefully, be anomalous in the string of years showing increasingly stronger growth in industrial support for R&D. There is no doubt that industrial firms are more committed to the value to their businesses that can be added through growth in their core competencies and intellectual capital. They realize this will require continued steady investment in R&D to provide the future breakthroughs in science and technology which separate them from their competitors, both in the U.S. and abroad.

[3] Dahlman, Carl J., and Aubert, Jean-Eric, *China and the Knowledge Economy—Seizing the 21st Century*, World Bank Institute (ISBN 0-8213-5005-6)

Absent an unanticipated innovation strategy for the United States, industry and government will have to continue to work closely together to assure that its highly-effective innovation generator continues to run smoothly.