

R&D and Innovation in Industry

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HIGHLIGHTS

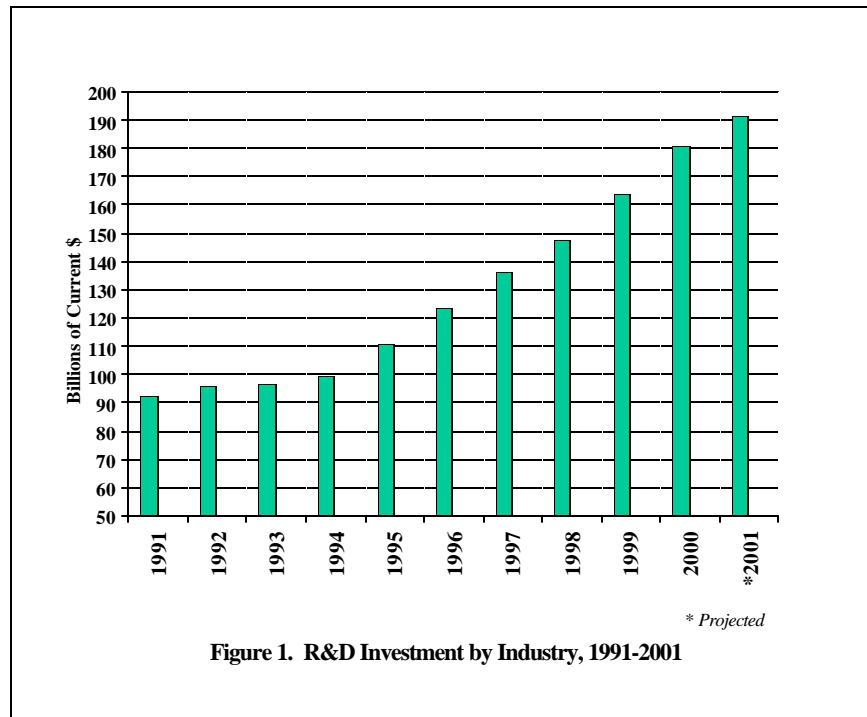
- R&D investment by U.S. industry has increased some 10 percent in each of the past six years; this growth pattern will decelerate in 2001.
- The area of R&D in industry with the highest rate of growth over the past six years has been in basic (or directed basic) research; it is expected that the rate of growth in this area will also be less in 2001.
- 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 2001, 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 2001.

R&D INVESTMENT

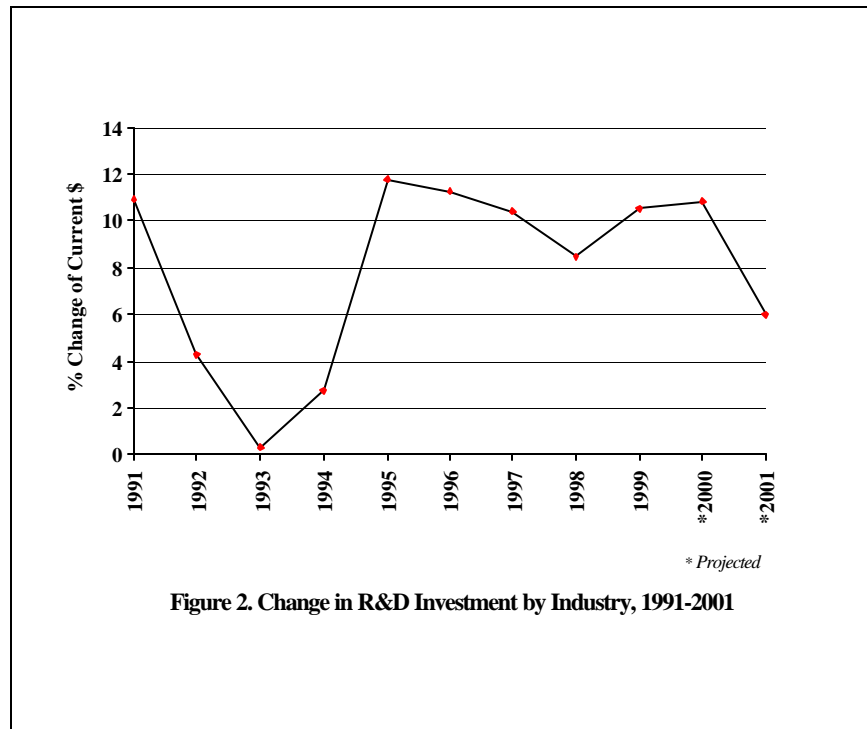
R&D funding by industry extended its recent pattern of healthy growth in 2000, making it the sixth consecutive year of increases above or near double-digit levels. NSF's Science Resources Studies Division has estimated that the increase for 2000 was 10.8 percent over 1999, taking industry's R&D investment to \$181 billion last year (see Table I-11). IRI's trends forecast for 2001 indicates that this growth will continue, but at a considerably lower rate of increase. This forecast is supported by Battelle Memorial Institute, which projects an increase in industry R&D funding of only 5.2 percent for 2001. R&D investment by industry over the past 10 years is shown in Figure 1. Year-to-year percentage changes are shown in Figure 2. A rapid deceleration of the U.S. economy in the last quarter of 2000 and into the first quarter of 2001 could result in even lower growth this year than that projected by Battelle.



Industry's performance of R&D in 2000 was \$197 billion, up 9.3 percent from the \$180 billion in 1999 (see Table I-11). Battelle projects that this

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figure will increase 8.3 percent during 2001, bringing industry's total R&D effort to \$214 billion this year. Thus, industry will *fund* nearly 69 percent and will *perform* some 77 percent of the total of \$278 billion that Battelle estimates will be invested in R&D in the U.S. during 2001.



NSF data for industry funding of basic research, applied research, and development show that basic research accounted for 9.0 percent of the total in 2000, with applied research at 20.1 percent and development at 70.9 percent. From 1995 to 2000, aggregate R&D investment rose 63 percent, but basic research increased 142 percent while applied research increased 49 percent and development increased 61 percent. The exceptionally strong rate of growth in basic research (or directed basic research) is a reflection of having more funds available from corporate profits and cash flows for risk taking, strong competition in global markets, and decreasing product cycle times. The top 20 R&D-investing firms during 2000 are listed in Table 1. Only four of the 20, Ford, General Motors, Delphi Automotive, and General Electric, are not directly in the

fields of life sciences or information technology, although all these firms have businesses that are related to or involved with these fields.

Table 1: Leading R&D Investors for 2000
(in billions of current dollars)

Company	R&D	Company	R&D
1. Ford Motor	\$7.23	11. Johnson & Johnson	\$2.86
2. Lucent Technologies	6.43	12. Merck	2.58
3. General Motors	6.33	13. Hewlett-Packard	2.52
4. IBM	4.84	14. Compaq	2.13
5. Du Pont	4.58	15. Eli Lilly	2.05
6. Intel	4.01	16. Bristol-Myers Squibb	2.02
7. Motorola	3.81	17. Delphi Automotive	2.00
8. Microsoft	3.76	18. Procter & Gamble	1.98
9. Pfizer	3.12	19. American Home Products	1.85
10. Cisco Systems	2.89	20. General Electric	1.75

Source: Estimated by Schonfeld & Associates, R&D Magazine

GLOBAL INNOVATION STRATEGIES

United States

As reported in the next section, “R&D Trends for 2001,” the current focus of industrial R&D in the U.S. and elsewhere around the world is to manage R&D for business growth. Over the past ten years, a new, global innovation system has evolved in the U.S., based on basic research in universities, nurtured by rapid growth in venture capital (up 73.5 percent in 2000, to \$103.0 billion, according to the National Venture Capital Association), 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. Recognizing the changes in this system due to the acceleration of technology development, shorter product life cycles, and strong global competition, the Industrial Research Institute issued a new position statement in 2000 on U.S. Economic and Technology Policy as a

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message to the Presidential and Congressional candidates. The statement called for the President and Congress to work together to promote economic and regulatory policies that will stimulate continued strong investment in R&D and information technology, to develop new technology policies that reflect the global nature of the marketplace and an increasingly knowledge-based economy, and to continue the critical role of government in funding undirected basic research in universities. The statement concluded that the President and Congress should forge closer linkages between our nation's economic and technology policies to carry out this agenda. It was reported recently by Lehman Brothers that microeconomic policies, which along with macroeconomic policies play a key role in economic performance, give the United States a decided edge over other countries in terms of overall economic health at this time.

Japan

Japan has initiated the study of a new national industrial technology strategy, to promote competitiveness and innovation in Japanese industry and improve its overall economic health. These strategies are intended to provide more emphasis on basic research in both universities and industry; to promote closer interaction between industry and universities; to provide more emphasis on the development of academic and industrial programs to improve the management of technology; to liberalize their academic faculties; to develop improved information-technology infrastructures; to reorganize national institutes and national universities; and to restructure radically the government's S&T organizations. The last initiative, which began January 6, 2001, will bring Japan's S&T structure somewhat closer to that of the U.S. government. Japan's new organization will have a Cabinet Office of S&T reporting directly to the Prime Minister, with support from a National Council for S&T (NCST) that is similar to the President's Council of Advisors for S&T (PCAST) and the National Coordinating Council for S&T (NCCST) in the U.S. A major difference, however, is that NCST will have ultimate authority on S&T policy recommendations. Under NCST will be a new Ministry of Education, Culture, Sports, Science, and Technology that will control three-quarters of Japan's government R&D expenditures and manage the national university system. Most of the balance of Japan's government R&D will be under a new Ministry of Economy, Trade, and Industry (METI). Even though R&D investment by industrial firms in

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Japan has actually decreased recently, government R&D investment under the new Basic Plan for 2001-2005 is slated to increase from 0.7 percent of GDP to 1.0 percent of GDP, a level comparable to other advanced countries. Japan's private sector has indicated its interest in technology development and innovation through the recent creation of a new Japan Research Center on Technology and Innovation Management.

Europe

In response to a rising concern over the EU's relatively weak leadership in science and technology, as well as a lag by European firms in commercializing new technology (the "European paradox"), the EU has created a new innovation policy. 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. Actions planned include optimization of resources allocated to European research in member countries; mapping of European centers of excellence; development of methodologies for assessing performance of national research systems and innovation capacities; creation of a trans-European data-communications network to link research institutes, universities, and the education system; improving the mobility of researchers; and creating a simple and inexpensive European patent system. To break out of a stagnant pattern of EU R&D investment since 1994, and to increase the number of researchers in the EU, the EU's 6th Framework Program calls for a 17.4 percent increase in science funding during 2002-2006.

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). Its goal is to be in the top 10 most S&T competitive nations by 2010. Strategies developed over the past two years and currently being implemented provide for larger investments in the S&T infrastructure, R&D (current total is less than 1 percent of GDP), and venture capital; new policies for taxation, loans, subsidies, and personnel; the transformation of state-owned R&D institutions into self-supporting enterprises; recruitment of foreign talent to China; establishment of a "top

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R&D award” comparable in value to a Nobel Prize; promotion of universities in developing new knowledge and transferring it to the commercial sector; and creating new techniques for distance learning. Other major initiatives are to attract foreign R&D investment and to place greater emphasis on basic research.

Australia

In January 2001, Australia’s Prime Minister introduced a sweeping plan for education and research to foster innovation. This plan, entitled “Banking Australia’s Ability,” proposes doubling the funding for national competitive research grants over the next five years, improving the infrastructure for research, creating world-class centers of excellence in key enabling technologies, increasing the R&D tax credit, expanding cooperative research centers, and new education initiatives.

R&D TRENDS FOR 2001

IRI’s trends forecast for R&D in industry during 2001¹, based on replies from 109 IRI member companies during August and September 2000, indicated more moderate growth in R&D investment than in recent years and a shift in emphasis toward growth through the creation of new businesses and partnerships. Seventy-six percent of respondents planned increases in R&D during 2001, down slightly from 79 percent expecting increases the previous year. Seventy-six percent also expected their capital spending for R&D to increase, down from 78 percent for 2000. However, the forecasts for professional staffing level and hiring of new graduates were virtually unchanged from 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 as well as their counterparts in Japan, Korea, Canada, Mexico and Europe, confirming a strong interest in managing for growth around the world.

¹ Industrial Research Institute’s Annual R&D Trends Survey for 2001, *Research-Technology Management*, January-February 2001, pp. 17-21.

CONCLUSIONS

In contrast to the recent double-digit increases in R&D investment by U.S. industry, the outlook is for a more moderate increase this year. This shift in the recent pattern of growth reflects lower corporate profits and higher interest rates during 2000, as well as uncertainties created by any Presidential election. Nevertheless, industrial firms are more committed than ever to the value that can be added to their core competencies and intellectual capital through continued investment in R&D that will provide future breakthroughs in science and technology.

Although R&D does not automatically translate into technological innovation, such innovation truly is the driver of economic growth for the U.S. and all developed nations. A vastly improved system of innovation has evolved in the U.S. over the past 10 years, brought about by a series of initiatives to enable industry to partner and collaborate more effectively with both universities and federal laboratories. These resources have collaborated more effectively than ever, but improvements can still be made.

Other nations are adopting a more aggressive stance to increase their R&D investment, to improve their climate for risk taking and venture capital, to modify their economic policies, and to accelerate their processes of innovation. A new era of global competition is under way, driven by new tools in information technology and a proliferation of technology in other fields.

The United States is clearly well positioned to deal with this new competitive environment. However, much needs to be done to keep our “innovation expressway” moving along at top speed in the future.