Scientific Research and Development Services Industries [About this section] [To Top]

Goods and services. From carbon nanotubes to vaccines, workers in the scientific research and development services industry create today the technologies that will change the way people live and work in the future. The importance of this industry is demonstrated by the considerable attention paid to it by the press, business associations, politicians, and financial markets. Major discoveries are heralded in both the technical and the popular media, and many studies monitor the pace of research and development. New technologies can quickly revolutionize business and leisure, as the Internet has.

Industry organization. Research and development (R&D) comprises three types of activity—basic research, applied research, and development. Basic research is conducted to further scientific knowledge without any direct application. This sort of research typically involves a high level of theory and is very risky; many projects fail to produce useful or novel results. Due to this risk, and because it is difficult to determine in advance what new products, if any will result, most basic research is funded by government, universities, or nonprofit organizations. Applied research is the bridge between science and business. It is directed toward solving some general problem, but may produce several viable options that all achieve some aspect of the goal. Development, which accounts for more than half of all R&D spending, according to the National Science Board, then

refines the technologies or processes of applied research into immediately usable products. Most development is done by private industry and is generally oriented toward manufacturing. Nearly everything consumers use, from antibiotics to zoom lenses, is a product of basic research, applied research, and development.

This industry includes diverse fields. The most fundamental division of the scientific research and development services industry is that between R&D in the physical, engineering, and life sciences and R&D in the social sciences and humanities. Important areas of research and development in the physical, engineering, and life sciences fields include biotechnology; nanotechnology; pharmaceutical; chemical and materials science; electronics; aerospace; and automotive. Important fields of research and development in the social sciences and humanities include economics, sociology, anthropology, and psychology.

Biotechnology is among the most active fields of research. Work in this area seeks to understand and use the fundamental processes of cellular life to develop more effective medicines, consumer products, and industrial processes. Advances in biotechnology have led to new drugs and vaccines, disease-resistant crops, more efficient enzymatic manufacturing processes, and novel methods of dealing with hazardous materials. Bioinformatics, a branch of biotechnology using information technologies to work with biological data like DNA, is a particularly vibrant new field. Much of the interest in biotechnology has derived from the medical applications of its basic and applied research.

Nanotechnology is perhaps even more of an emerging field than biotechnology, and they often overlap in their work on

the molecular level, such as with DNA tagging. Nanotechnology is the study of new structures roughly on the same scale as individual atoms, or one millionth of a millimeter. At this size, materials behave differently and can be made into new structures such as quantum dots, which are small devices that behave like artificial atoms and can be used to tag sequences of DNA. These materials can also be used to make nanoscopic switches for electronics, or produce extremely small lasers for communications equipment. Because basic and applied research comprise the bulk of work, there are fewer immediate applications of nanotechnology.

Pharmaceutical R&D involves the discovery of new drugs, antibiotics, and vaccines to treat or prevent a wide range of health problems. This field also has benefited greatly from advances in biotechnology, nanotechnology, and chemistry, allowing better models of biochemical processes and more efficient testing. Because a great deal of time is required to develop a new treatment, most companies have several major programs running concurrently, in what is sometimes referred to as the development "pipeline." Because many projects incorporate all aspects of R&D, the pharmaceuticals field tends to do more basic research than other established fields. (See the statement on pharmaceutical and medicine manufacturing.)

Chemical and materials science R&D focuses on the design and creation of new molecules or materials with useful properties. By researching and modeling the properties of molecules under various conditions, scientists in this field can develop new chemical structures that are stable or volatile, rigid or flexible, insulating or conductive. Since

include work on computer chip manufacturing, composite materials development, or pollution reduction through chemical treatment. Research on petroleum derivatives and substitutes continues to be an important part of this field. Chemical R&D also plays a large role in both biotechnology and nanotechnology R&D.

Electronics R&D incorporates a broad range of technologies, including computer hardware, telecommunications, consumer electronics, automated control systems, medical equipment, and electronic sensing. R&D in this field leads to advances that make electronic systems faster, and more reliable, compact, useful, powerful, and accessible. Development of new technologies and the integration of these technologies into new systems account for much of the R&D in this field. Basic research in areas like electromagnetics and photonics also is a significant part of the work.

Aerospace R&D relates to aircraft, spacecraft, missiles, and component parts and systems. A significant portion of aerospace R&D is federally funded, with the Department of Defense and the National Aeronautics and Space Administration (NASA) supporting most of the work. Civil aerospace R&D ranges from developing more efficient passenger aircraft to designing private spacecraft to launch satellites or transport humans into space.

Automotive R&D creates new vehicles and systems that are more efficient, powerful, and reliable. While automotive R&D may be directed toward the integration of new technologies into vehicles, much research also is done on improving the individual components such as LED headlights or fuel injectors. As electronic technology has advanced, so have

passenger aircraft to designing private spacecraft to launch satellites or transport humans into space.

Automotive R&D creates new vehicles and systems that are more efficient, powerful, and reliable. While automotive R&D may be directed toward the integration of new technologies into vehicles, much research also is done on improving the individual components such as LED headlights or fuel injectors. As electronic technology has advanced, so have automotive designs. The incorporation of computer systems both for monitoring performance and as separate features has added a new dimension to R&D in this field. With the demand for more efficient vehicles that provide more power while using less fuel, a good deal of time and many resources are devoted to developing new powertrains, such as those for hybrid-electric vehicles.

R&D in the social sciences and humanities is more closely aligned with specific occupations than it is in the physical, engineering, and life sciences. Economic research typically involves monitoring and forecasting economic trends relating to issues such as business cycles, competitiveness of markets, or international trade. Sociological research analyzes the institutions and patterns of social behavior in society, and the results are used mainly by administrators to formulate policies. Anthropological research focuses on the influence of evolution and culture on all aspects of human behavior. Psychological research studies human thought, learning, motivation, and abnormal behavior.