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R&D LIFE CYCLES

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WHAT IS R&D?

R&D refers to the systematic ways businesses, universities, and other organizations seek new knowledge or discoveries. Businesses usually conduct R&D to develop new products or processes or improve existing ones, while universities usually do so to gain new knowledge for its own sake.

Businesses conduct basic and applied R&D. For example, a manufacturer might investigate how intense heat affects different types of metals to learn more about their properties (i.e., basic research) and then use that knowledge to develop parts that can better withstand heat and cold (i.e., applied R&D) (*Definitions of Research and Development: An Annotated Compilation of Official Sources*, National Science Foundation).

Businesses choose R&D projects based on the amount of time it would take them to recoup their R&D costs, which depend on several factors, including consumer preferences and competitive pressures.

ISSUE

Describe the average life cycles for researching and developing (R&D) new products or improving existing ones.

SUMMARY

There appears to be no average timeframe in most business sectors for researching and developing new products. The exception is the pharmaceutical sector, where, according to a 2006 Government Accountability Office report, it takes on average 15 years to discover, develop, and review new drugs (*New Drug Development: Science, Business, Regulatory, and Intellectual Property Issues Cited as Hampering Drug Development Efforts*, GAO 07-49). Attachment 1 illustrates the average timeframe for pharmaceutical R&D.

The period during which a business systematically conducts research with the aim of developing a new product or improving an existing one (R&D), is the initial phase of a larger multiphase "technology life cycle." The cycle's other phases include the periods during which sales of the new or improved product go up and down as customers choose among competing brands.

The time it takes to complete the R&D phase depends on many factors, which vary by business and business sector. Some factors concern the

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choices businesses make about whether to focus on developing new products (i.e., product R&D) or improving how they make existing products (i.e., process R&D). In the auto industry, for example, businesses focus on boosting productivity to lower prices. Consequently, it takes them longer to develop new products. The opposite is true in the electronics industry, where businesses are hard pressed to keep up with customers who demand new products.

Another factor that affects R&D timeframes is the tradeoff businesses make between funding improvements to existing products (i.e., near-term R&D) and developing new ones (i.e., early stage R&D). The tradeoff varies by industry sector. Software customers, for example, prefer improvements to existing products instead of a constant stream of new ones. Consequently, software makers focus mainly on improving near-term R&D.

The ability of a new business to enter and compete in a sector also affects the tradeoffs the established businesses make between product and process R&D. For example, a new business trying to break into the auto or aerospace sectors needs considerable capital to develop, make, and market new cars or planes. The time and money needed to develop new cars and planes discourage new businesses from doing so, thus insulating the established businesses from constantly having to develop new products. Instead, these businesses focus on improving their existing products or production processes. The opposite is true in the electronics sector, where relatively low "entry barriers" force established businesses to research and develop new products to compete with those offered by newer businesses.

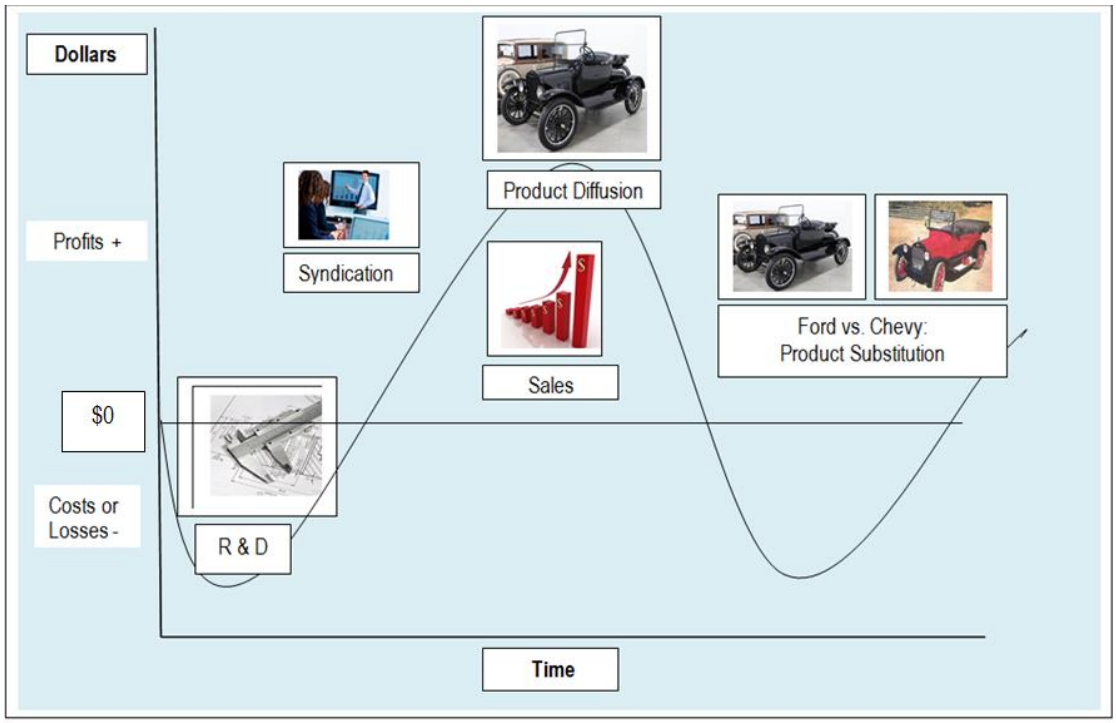
TECHNOLOGY LIFE CYCLE

As shown in Figure 1, the technology life cycle is a multiphase process that begins when a business starts researching and developing a new product and ends when the business improves the product or develops a new one. The time it takes any business to research, develop, and market a new product depends partly on how long the business believes it will take the new or improved product to generate enough sales to recoup the R&D costs (i.e., commercial viability). Those estimates or projections inform the choices the business makes about which R&D projects to fund and the funding level. The latter could affect the amount of time it takes to develop the product.

As Figure 1 shows, the business begins to recover the cost of researching and developing the new product after it proves to be commercially viable (i.e., syndication). But the extent to which it recovers those costs depends on the extent to which customers purchase the product (i.e., product diffusion) instead of competing ones. Regardless of the product's initial success, competing businesses

will improve their products or introduce new ones, giving customers more products from which to choose (i.e., product substitution). Consequently, profits could fall, forcing the business to improve its product or develop a new one.

Figure 1: Technology Life Cycle



Source: G.D.P Pretorius and N. du Preez, The Migration of a Knowledge Item through the Life Cycles of Technology, Product Development and the Enterprise, SAIIe 25 Proceedings, July 9-11, 2013, Stellenbosch, South Africa

FACTORS AFFECTING R&D TIMEFRAMES

Product v. Process R&D

A factor that affects R&D timeframes is the distinction businesses make about different types of R&D. According to business analyst Souresh Saha, a business must often choose between researching and developing new products, improving existing ones, or finding ways to lower production costs. The extent to which the business devotes R&D resources to lowering production costs (i.e., process R&D) could result fewer resources for creating new products or improving existing ones (i.e., product R&D) ("R&D Composition for the Product Life Cycle," *Discussion Paper 309*, University of Minnesota Center for Economic Research, December 1999).

According to Saha, product R&D often gives way to process R&D as the business seeks to expand its customer base. "People who buy a product when it is first introduced usually care primarily about the features or the quality of the product

and are willing to pay a lot for improvements in product quality," he explained. Over time, the business increases sales to customers who care more about price by finding ways to cut production costs and, consequently, sale prices.

The shift to process R&D reduces the business' capacity to conduct product R&D. "Production processes increasingly become more rigid (unable to accommodate changes in product design easily) but efficient (low cost). This continuing process results in depletion of opportunities for product innovation and leads to a shift in R&D effort towards process R&D over time," he stated.

Early Stage vs. Near-term Product Development

Another factor that affects R&D timeframes are the choices businesses make about researching and developing new products and improving existing ones (i.e., early stage v. near-term product development). Businesses not only apportion resources between product and process R&D projects, but also among different types of product R&D projects. A 2005 study found that R&D resources "have increasingly been focused on near-term product developments, leading to incremental increases in market share, in productivity, and product function" (National Institute of Standards and Technology (NIST), *Understanding Private-Sector Decision Making for Early-Stage Technology Development*, NIST GCR 02-841).

The reasons for the shift to near-term product development vary from industry to industry. Software customers expect new versions of existing products every two years and numerous enhancements to existing products after they purchase them, according to a software business executive quoted in the NIST study.

The opposite is true for chemical manufacturers. While software businesses serve consumer and business customers, many chemical companies serve mostly business customers. "Chemicals are an input into other manufacturing industries and are rarely a final product in and of themselves." Consequently, "there is less onus on the chemical industry to make the kind of engineering related or consumer related product development investments associated with industries such as manufacturing goods," NIST stated.

New Product Development (NPD) Clockspeed

The technology life cycle and the distinction between product and process R&D explain some of the internal factors that affect R&D timeframes. External factors that affect those timeframes include the rate at which competing businesses introduce new products (i.e., NPD clockspeed). The factors that increase an industry's NPD clockspeed include high or growing potential markets, relatively low R&D costs, and initially high net revenues. These factors may encourage businesses

to "invest in technology development to speed new product introduction," University of Florida business professor Janice E. Carrillo wrote ("Industry Clockspeed and the Pace of New Product Development," *Production and Operations Management*, Summer 2005).

The inverse of these factors decreases an industry's NPD clockspeed: low or shrinking markets, high R&D costs, and initially low net revenues. For example, Carrillo attributes the aerospace industry's relatively slow clockspeed to "exorbitant development costs, as a new model airplane can cost upwards of $10 billion to bring to market." Another factor that could slow an industry's clockspeed is the barriers facing a new business attempting to enter an industry dominated by mature businesses. Citing earlier research, Carrillo noted that "firms operating in such 'slow cycle' industries have created a unique set of resources (or core capabilities) which enable them to insulate themselves from competition," which effectively slows NPD clockspeed.

HYPERLINKS

U.S. Government Accountability Office, *New Drug Development: Science, Business, Regulatory, and Intellectual Property Issues Cited as Hampering Drug Development Efforts*, GAO 07-49, http://www.gao.gov/new.items/d0749.pdf, last visited October 18, 2015

G.D.P Pretorius and N. du Preez, "The Migration of a Knowledge Item through the Life Cycles of Technology, Product Development and the Enterprise," *SAIIe 25 Proceedings*, July 9-11, 2013, Stellenbosch, South Africa, http://conferences.sun.ac.za/index.php/saiie25/SAIIE25/paper/view/799/233, last visited October 18, 2015

Souresh Saha, "R&D Composition for the Product Life Cycle," *Discussion Paper 309*, University of Minnesota Center for Economic Research, December 1999, http://www.econ.umn.edu/library/mnpapers/1999-309.pdf, last visited October 18, 2015

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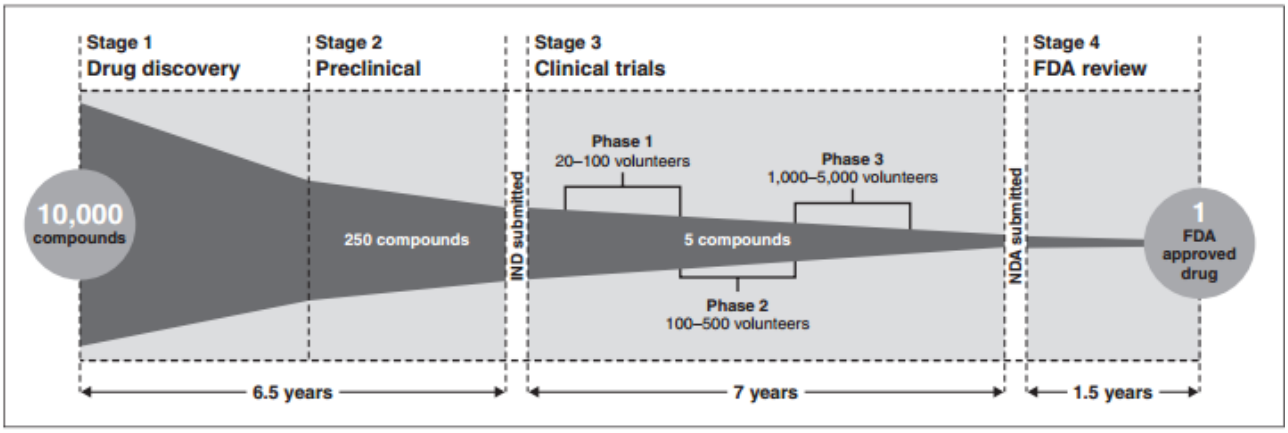
Attachment 1: Timeframe for Researching, Developing, and Commercializing New Drugs



Source: Pharmaceutical Research and Manufacturers of America