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Rethinking industrial research, development and innovation in the 21st century

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ABSTRACT

Solving problems related to energy, water, food supplies, health and the environment requires breakthrough innovation and the fundamental research that underlies it. Enhanced governmental funding in research is critical, but industry also needs to step up. This article focuses on the ways Google, Edwards Lifesciences, Tesla Motors, and Space X are making investment in far sighted research a priority, and have developed processes that ensure that scientists and engineers remain central to the organization even as it grows. Their leaders demonstrate a passion for using science and technology to solve major problems, and view companies as vehicles for inventing the future.

1. Introduction

The gravity of 21st century problems is daunting. Exploding global development threatens our energy, water, and food supplies, our health and environment. Numerous studies, as well as observations in our daily lives, warn us that the pace of science and technology-based solutions is not keeping up [1,2]. This article addresses the need to transform the role of industry in research, development and innovation. It begins with an overview of trends in funding for research and development (R&D), and demonstrates that industry can and should contribute more to the fundamental research that leads to breakthrough innovation. The bulk of the article then focuses on a handful of companies – Google, Edwards Lifesciences, Tesla Motors, and Space Exploration Technologies (SpaceX) – that are leading the way in employing research to solve big problems. These four companies are in very different industry contexts. However, they share success in R&D based breakthrough innovation. What pattern of behavior contributes to this success? Using case methodology, evidence was gathered from multiple published sources as well as interviews. Analysis of the data showed that these companies exhibit some common approaches. First, they invest amply and consistently in research, and cultivate organizational structures that intentionally focus on breakthrough innovation both internally and in collaboration with external institutions. Second, they have developed processes that keep the balance of power in the organization from drifting too much towards the business functions that support the company in important ways, but can also destroy the creative fire that fosters breakthroughs. And, third, their leaders inspire ambitious thinking with their own intrinsic passion for solving meaningful problems and by ensuring the environment for innovation is sustained. The concluding section addresses how we will know if rethinking industrial research, development and innovation on a broader scale in the future has helped drive the virtuous cycle of innovation.

2. The need for change: overview of R&D trends

Investment in research and development (R&D) by the private and public sectors, especially in basic research, has

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historically led to finding cures for major diseases, made air transportation safe and affordable, and created the technology that underlies modern telecommunications and computing power. In the business sector, notes the National Science Board, "involvement in basic research can help boost human capital, attract and retain talent, absorb external knowledge, and strengthen innovation capacity" [3]. The Science Coalition's 2010 study of research supported by the National Science Foundation (NSF), Department of Defense (DOD), Department of Energy (DOE), National Institute of Health (NIH) and National Aeronautics and Space Administration (NASA), makes a compelling argument for the long term economic and social returns that have resulted from federally funded basic research [4]. But times have changed. While the total annual investment in R&D the world over has increased to more than $1.5 trillion, the pattern of the nature of the research has shifted from longer term publicly funded research to more short sighted industry-supported development and improvement of existing products and processes [5]. In the U.S., which leads the world by investing nearly $420 billion per year in R&D, funding has *decreased* in real terms over the past few years, and the outlook for fundamental research is not encouraging [6,7]. Investment in basic research in the U.S. is about 19% of total R&D (Fig. 1) [8]. Around 53% percent of this is funded by the federal government; another 22% is funded by industry, which dedicates only about 6% of its R&D budget to basic research (Figs. 2 and 3). Federal support for research is likely to continue to stagnate. Companies, which fund about two thirds of the total R&D in the U.S. are sitting on the side lines until economic conditions are more certain when – even in R&D based industries – many are holding unprecedented levels of cash [9].

The need for a major in shift in thinking is not lost on the global research community which, in a survey reported by Battelle in 2012, identified the top challenges to the future of R&D as limited external and internal funding, lack of a long term budget perspective, and lack of time to be creative and innovative [5], (p.32). China invests the second highest level in the world in R&D (about $220 billion) and, assuming continuation of flat governmental and industrial investment in the U.S., it may well reach the top spot within the decade. Even China appears to be shying away from the higher risk research that often underlies technological breakthroughs. As in the U.S., about 65% of the R&D is funded by industry; and a mere 5% of China's R&D total budget is dedicated to basic research [5], (p. 29).

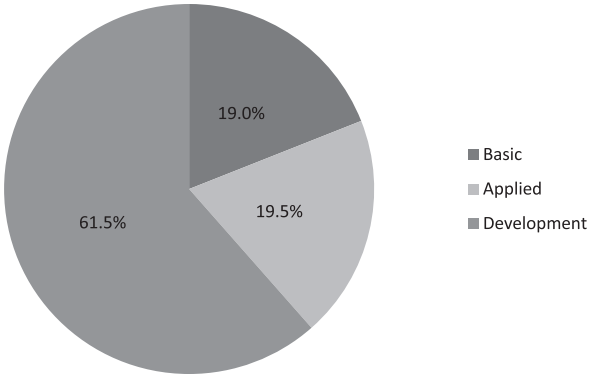

Fig. 1. Breakdown of investment in research and development in the U.S. (2011). Source: [8]

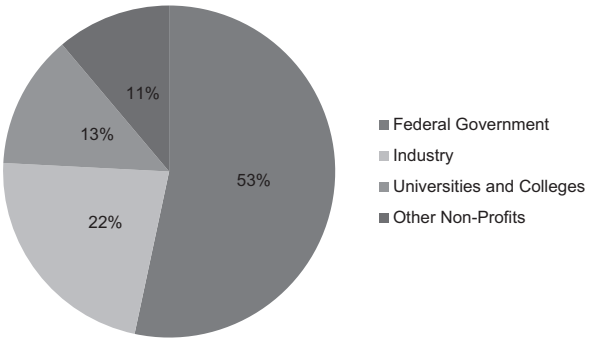

Fig. 2. Breakdown of funding of basic research in the U.S. (2011). Source: [8]

Increased government funding for fundamental research is unquestionably important, but industry needs to step up. Fortunately some companies are rethinking industry's role in R&D and innovation. Google, Edwards Lifesciences, Tesla Motors and Space X are exemplary in their commitment to investing in bold research initiatives, and implementing processes for balancing creative research and business performance. Moreover, their leaders view these companies as vehicles for investing in and inventing our collective future.

3. Bold research, breakthrough reward

Innovation blossoms or withers as knowledge accumulates or deteriorates. Google, Edwards Lifesciences, Tesla Motors, and SpaceX invest heavily and consistently in research, and have developed organizational structures dedicated to breakthrough research internally as well as through external collaborations with academic, not for profit, and government laboratories.

3.1. Substantial and consistent investment in R&D

In spite of worldwide economic uncertainty, Google's investment in R&D since 2009 more than doubled to about $6.8 billion in 2012. It is now the third top investor in R&D

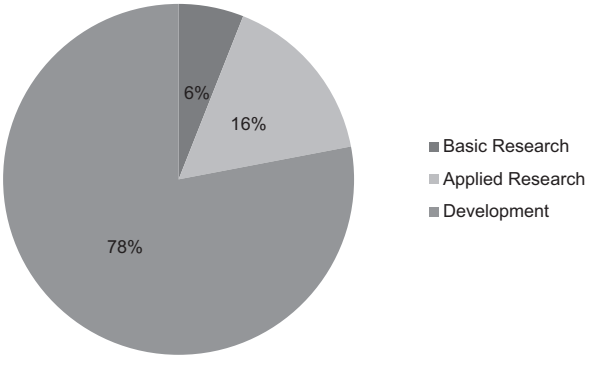

Fig. 3. Breakdown of use of R&D funding in industry (2011). Source: [8]