From R/D to International Marketing

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- President, North American Manufacturing Research Institution
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Outline

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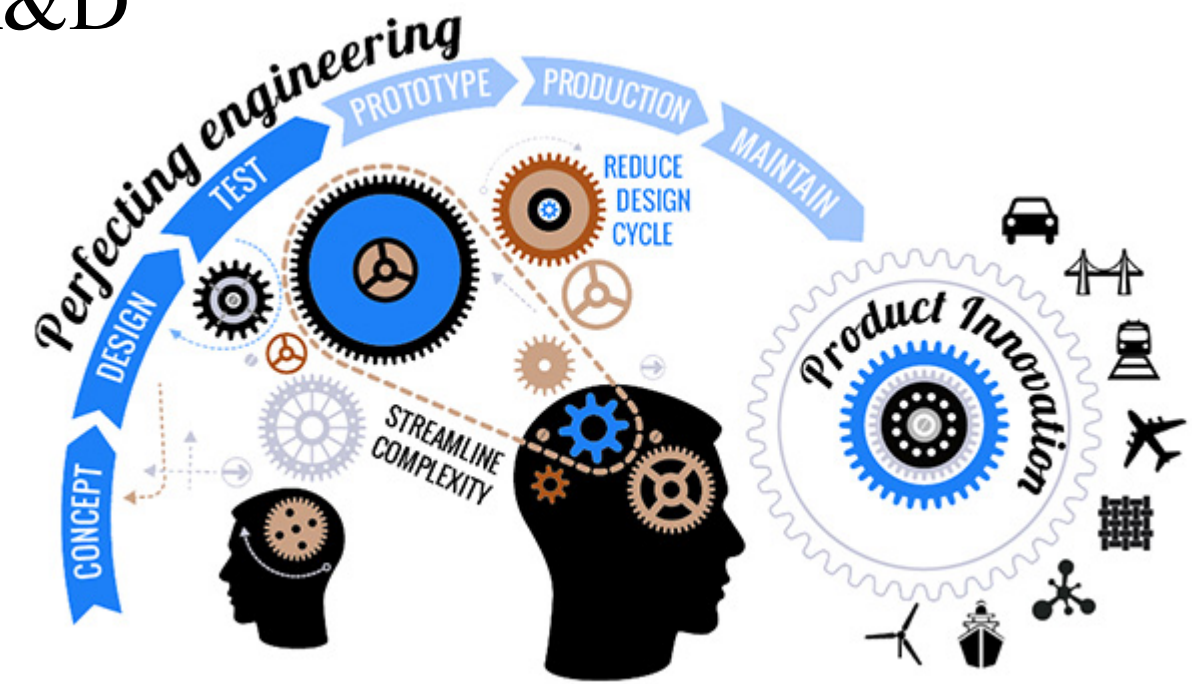
- Definition and Background of R&D
- Attributes of R&D
- Types of R&D
- Importance of R&D
- Implementing R&D Strategies
- Cases of R&D



Definition of R&D

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■ OECD Report

Research and development (R&D) comprise creative and systematic work undertaken in order to increase the stock of knowledge—including knowledge of humankind, culture and society—and to devise new applications of available knowledge.

Five core criteria of R&D activities:.

★ Novel ★ Creative

★ Uncertain ★ Systematic

★ Transferable and reproducible

Source: The updated Frascati Manual (7th ed., OECD

Definition of R&D

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- **U.S. Business Enterprise**

(1) Financial Accounting Standards Board

- ***Research*** is planned search or critical investigation aimed at discovery of new knowledge with the hope that such knowledge will be useful in developing a new product or service (hereinafter "product") or a new process or technique (hereinafter "process") or in bringing about a significant improvement to an existing product or process. Know-why.
- ***Development*** is the translation of research findings or other knowledge into a plan or design for a new product or process or for a significant improvement to an existing product or process whether intended for sale or use. Know-how.

Source: Definitions of Research and Development: An Annotated Compilation of Official

Definition of R&D

Steven Y. Liang, Ph.D.

Examples of R&D Activities

Included:

- Laboratory research aimed at discovery of new knowledge
- Searching for applications of new research findings or other knowledge
- Testing in search for or evaluation of product or process alternatives
- Testing in search for or evaluation of new product or process
- …

Excluded:

- Engineering follow-through in an early phase of commercial production
- Quality control during commercial production including routine testing of products
- Trouble-shooting in connection with break-downs during commercial production
- …

Source: Definitions of Research and Development: An Annotated Compilation of Official

Definition of R&D

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▪ U.S. Business Enterprise

(2) Business Enterprise

◆ ***Research and Experimental*** comprise creative and systematic work undertaken in order to increase the stock of knowledge and to devise new applications of available knowledge.

Product includes:
- Any pilot model
- Process
- Formula
- Invention
- Technique
- …

NOT include expenditures for (No why, No how):
- The ordinary testing or inspection of materials or products for quality control
- Efficiency surveys
- Management studies
- Consumer surveys
- …

Definition of R&D

Steven Y. Liang, Ph.D.

- **U.S. Business Enterprise**

(3) U.S. Code of Federal Regulations

- ***Research and Experimental expenditures*** means expenditures incurred in connection with the taxpayer's trade or business which represent research and development costs in the experimental or laboratory sense.

Activities Include:
- Acquiring new knowledge
- Solving a specific problem
- Systematic work
- Pre-competitive knlowledge

NOT include expenditures for:
- Cost for routine product testing, quality control, and technical services
- Market research
- Efficiency surveys or management studies
- Literary, artistic, or historical projects
- Prospecting or exploration for nature resources

Background of R&D

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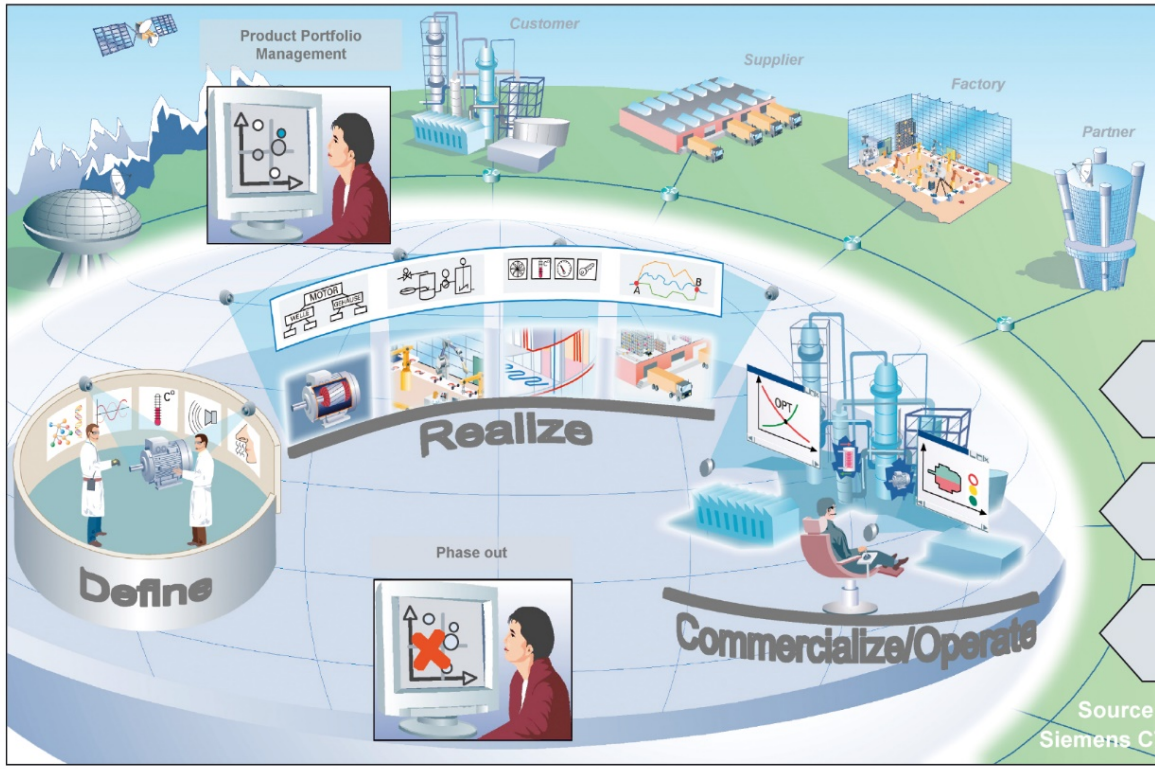

- **From Understanding to Creating customer** & market needs. How?
- **Culture** of innovation > vision, leadership & support. Commercial imperatives to innovate, flexibility. Archival vs flexible management
- **Open** innovation
- **Funding**. Willingness to invest in R&D, balance current and future needs. 30% Rule
- **Execution**. Commit resources, continuous improvement, benchmark, goals, strategy.
- **Creativity**. Skills, knowledge base, learn, change
- **Intellectual property**. Manage and protect

Background of R&D

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Funds spent for business R&D in the United States, 2015-2016

(Millions of U.S. dollars)

Selected Characteristic	2015		2016
Domestic R&D performance	355,821	Increase →	374,685
Paid for by the company	296,677		317,731
Paid for by the others	59,144	Decrease →	56,954
federal	26,990		23,772
Other	32,154		33,182
Size of company			
Micro companies	2,988		1,581
Small companies	15,929		14,620
Medium companies	25,111		24,173
Large companies	311,793	Increase →	334,344

Source: National Center for Science and Engineering Statistics, September 2018

Background of R&D

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Funds spent for business R&D in the United States by industry 2016

(Millions of U.S. dollars)

Selected Characteristic	2016	
All industries	374,685	
manufacturing	250,553	(Process)
chemicals	73,575	
Machinery	12,585	
Computer and electronic products	77,385	(Product)
Electrical equipment, appliance, and components	4,771	
Transportation equipment	51,275	
information	70,748	
Finance and insurance	7,331	

Source: National Center for Science and Engineering Statistics, September 2018

Background of R&D

R&D in Pharmaceuticals

Research = basic Fundamental knowledge

- Eg identification of possible chemical compounds
- Theoretical mechanisms
- Universities
- Better understanding

Development = exploitation of discoveries

- Mainly private sector
- Proof of concept
- Safety testing (eg drugs)
- Delivery mechanism (eg how to administer a drug)
- Better product

Background of R&D

R&D in Business

- Critical for marketing
- Better Q, C, D, S
- Competition has made R&D important
- Consumers trends, needs, demands
- No guarantees that higher spending on R&D will lead to
  - Higher profits
  - More creativity
  - Better products and services
  - Greater market share

Attributes of R&D

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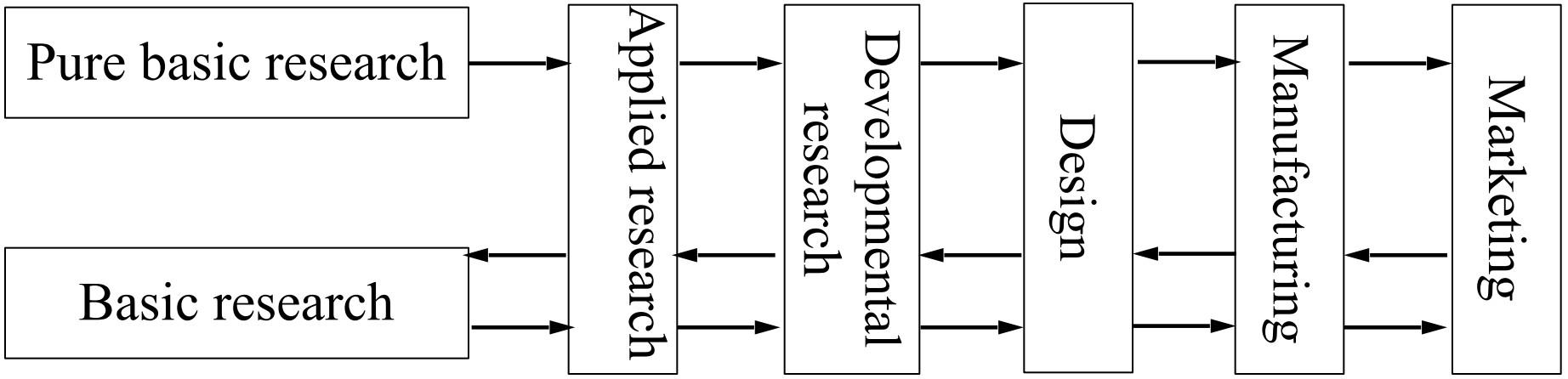
1. R&D as a Set of Activities
2. R&D as a Paradigm of Innovation
3. R&D as vs Design and Development (D+D)
4. R&D as a Source of Idea

R&D as a Set of Activities

- R&D is a method of investigation where it is assumed new scientific knowledge is discovered due to a series of linear and sequential stages that consists of Basic Research, Applied Research and Developmental Research:



The overall process of R&D activities

R&D as a Paradigm of Innovation

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Five main paradigms of innovation

1. **Trial and Error (Semi-Systematic) Invention**: such as the steam engine.
2. **Systematic invention**: such as the light bulb and electricity, Taguchi, Regressional Analysis
3. **Research and Development – R&D**: such as the A-bomb, rockets and main-frame computes.
4. **Technology and Market Development – T&C**: such as the personal computers, and smart phones
5. **User- Created Contents**: such as the Wikipedia, You-Tube, and Face-book.

- ✓ **Research and Development – R&D is one of the five main Paradigms of Innovation, since the start of the Industrial Revolution**.
- ✓ **Paradigms of Innovation are NOT mutually exclusive!** During the same time span, different types of industries may follow different paradigms of innovation.
- ✓ **Previous paradigms may be influenced by more recent paradigms**.

Source: https://www.nsf.gov/

Design versus Science

- To have a better understanding of Design we first my look at Science. (Why for How)
- Science is systematic investigation to have a better understanding of an existing phenomenon.
- Design is about systematic thinking about, before or as part of, making a new product.
- Science pursues and applies analytic methodologies, as the goal is to figure out the structure of an existing phenomenon.
- Design follows synthetic (non-analytical) and integrative approaches, as the goal is to create a new product.

R&D vs Design and Development (D+D)

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R&D versus D&D

- Three examples serve to underline the main difference between R&D versus D&D: Photovoltaics, Airplane, and Light Bulb.
- The photovoltaic cell is the best example of an R&D invention. Basic research was done by Albert Einstein, who had no clue about it final application.
- Penicillin by Alexander Fleming in 1928 for research, and by Howard Florey for mass production in 1940.
- The invention (design) of Aircraft is a good example of D+D. The Wright Brothers, from day one knew the final goal, a heavier that air aircraft and they did everything to get it.
- The invention of the Light bulb by Edison is another example of a D+D case. The idea was to make a electric-base light source (bulk) that can compete with gas-base light source.
- Coring's gorilla glass eventually used on i-phone 50 years later.
- D+D always starts with a product in mind and going back to get it.

D+D Model

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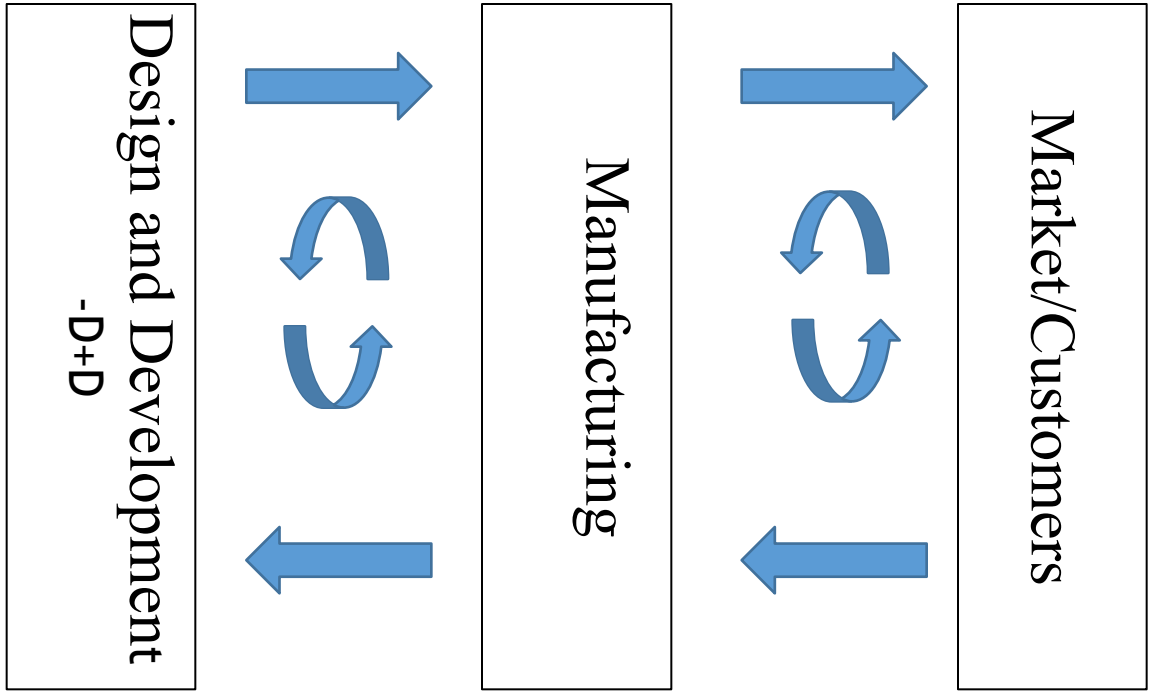
Design and Development – D+D is one of the key aspects of Technology Innovation/Development



D+D aims at product realization, and intends to satisfy or to create Market/Customer needs.

Three Types of R&D

- The R&D model makes a linear and one-way outlook between three consecutive stages:

  Basic Research, **Applied Research** and **Developmental Research**

The triple Helix Model for technology development (Academy, Business and Government) is also based on the R&D outlook toward innovation.

Basic Research

- Aka **fundamental research** (sometimes **pure research**) for study carried out to increase understanding of fundamental principles
- Many times the end results have no direct or immediate commercial benefits
- Basic research can be thought of as arising out of curiosity.
- Pre-competitive
- However, in the long term it is the pillar for many commercial products and applied research.
- Basic research is mainly carried out by universities/national labs
- TRL 1~3

Applied Research

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- **Applied research** is a form of systematic inquiry involving the practical application of science. It accesses and uses some part of the research communities' (the academia's) accumulated theories, knowledge, methods, and techniques, for a specific, often state-, business-, or client-driven purpose.
- Establish thresholds.
- TRL 4~6

Applied Research

Research Methodology

Developmental Research

- Focuses on products and commercialization
- Several prototypes may be developed
- Design improvements occur
- Trails, modifications and improvements occur
- TRL 7~9

Importance of R&D

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Don't think R&D is only reserved for big corporations!
It starts small…

For instance:

The explosive development of the oil industry in the XIXth is due to the invention of an effective kerosene lamp by Michael Dietz in 1859. Dietz ran at this time a small lamp production business as oil drilling began in earnest to support such lighting applications. An unwanted residue of kerosene refining was nothing more than gasoline, that Dietz didn’t know what to do about, until the first cars came along.

Importance of R&D

Why invest in research and development? Here are five reasons:

1.Proven Sales Growth.

2.Competitive Advantage by technology thresholds.

3.Innovation.

4.Tax Credits

5.Furthering Your Company's Mission. Reputation. Intangible assets

Importance of R&D for Int'l Marketing

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- **Why is R&D important for international marketing?**
  - ➢ Crucial to survival in a global village
  - ➢ Fast changing environment world wide
  - ➢ Continuous technology change by many talents
  - ➢ Changing consumer preferences across various cultures
  - ➢ Advantage in international marketing come from:
    - Better understanding of markets needs
    - Better Q, C, D, S

Importance of R&D for Int'l Marketing

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- **R&D offers a global edge:**

  - ➢ Chinese companies are still in what George Yip, a professor at the China Europe International Business School, calls the "fit for purpose" innovation. "Fit for purpose" products satisfy domestic market preferences and often cost less, but pale in quality and features when compared to international brands innovating at a global standard
  - ➢ R&D is a slow and arduous process that can take decades to pay off. That can be daunting for Chinese companies operating in an ever-shifting competitive environment that values quick results. China has come a long way from being merely a "copycat nation" in terms of innovation.
  - ➢ Needs 5-10 years of R&D reserve pipeline.

R&D Strategies for Int'l Marketing

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- Three strategies are helpful for the international marketing

(1) R&D should maximize the advantage of enterprise's innovation result, and pursue the profits of the enterprise. It can take on the following types:

➢Export high-tech products

➢License technology exportation patent

➢Produce innovative products at overseas

R&D Strategies for Int'l Marketing

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- Three R&D strategies are helpful for the international marketing

(2) R&D should make full use of resources on a global scale. R&D should track the globe technology, and take advantage of the resources at host country. It can be achieved by the following aspects:

➢Decentralize R&D, with global collaborators

➢Establish local R&D centers to accurately capture consumer needs and expeditiously introduce new products into the market.

➢Transnational merge which acquired the technology. When Lenovo bought Motorola Mobility from Google in 2014, it immediately acquired Motorola's R&D and marketing platform.

➢Watch for export control regulations

R&D Strategies for Int'l Marketing

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- Three strategies are helpful for the international marketing

(3) R&D should work together globally. R&D should strengthen the economic and technical cooperation, and make use of the "overseas brain". It can be showed in the following types:

➢Establish Strategic Alliance among different enterprises

➢Cooperate with universities and foreign research institutes

➢Purchase technology through international market

Effects of R&D Globalization on Host Country

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Advantages:

- Improve technology
- Attract the human capital
- Play the demonstration effect
- Attract FDI

Disadvantages:

- Improve original technology, but develop no further, so the enhancement is limited
- Decrease the developing capability of host country and lead to the hollowing of science and technology

Implementing R&D Strategies

Four core elements of an R&D strategy:

- Architecture: how and where are you going to organize your R&D activities both organizationally and geographically?
- People: despite the growing use of robotics and automation the people you hire, remain obviously a highly important aspect of your strategy.
- Portfolio: refers to the selection of different R&D projects and the resources you are going to allocate to them simultaneously.
- Processes: refers to how you are going to lead your R&D activities, your project management decisions, the milestones, the timing of reviews, etc.

Implementing R&D Strategies

Selecting your R&D Portfolio:

The size of one R&D project may vary from a part-time effort of one researcher for a few months to a major five years project with large, multidisciplinary teams of researchers and high budget. Select your R&D projects carefully having in mind of:

- Maximize the long-term return on investment
- Make optimum use of your resources (physical, human and capital) geographically
- Maintain a balanced R&D portfolio by preserving a reasonable risk

Global R&D Distribution

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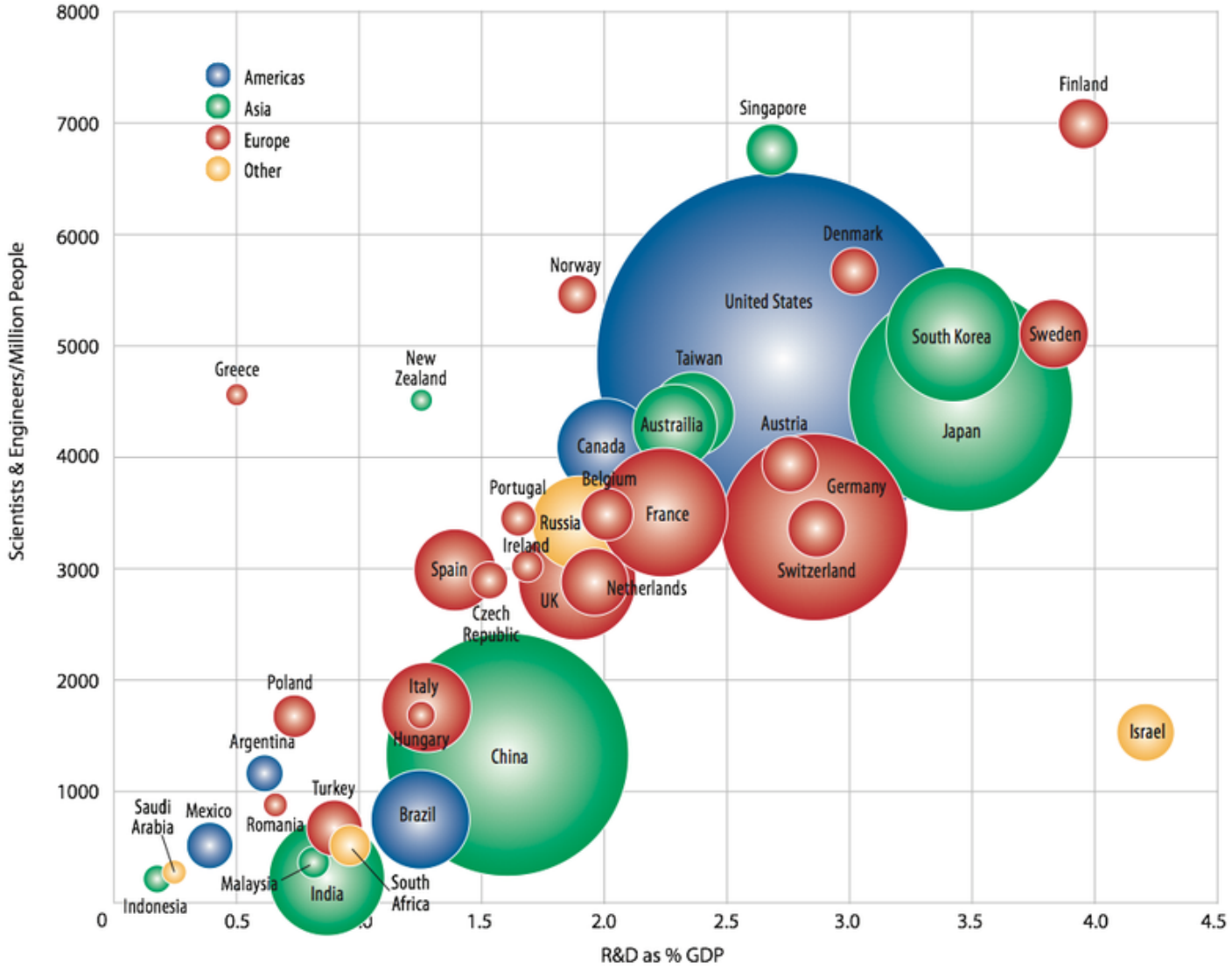

- R&D spending in Europe will be essentially stagnant
- R&D spending in Asia is supposed to drive future growth

Source: NewEnergy & Fuel, 2018

Examples of R&D-based Products

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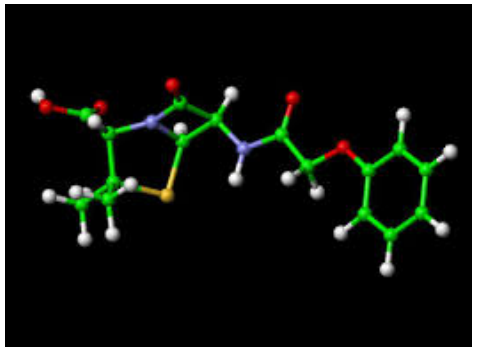
- The R&D model assumes that science has a monopoly over knowledge, technology is an outcome of science, and economic development follows technology development. The R&D model confines innovation to technology and then technology to R&D:



Penicillin

A bomb

Nuclear power plants

Case 1: R&D @ Siemens

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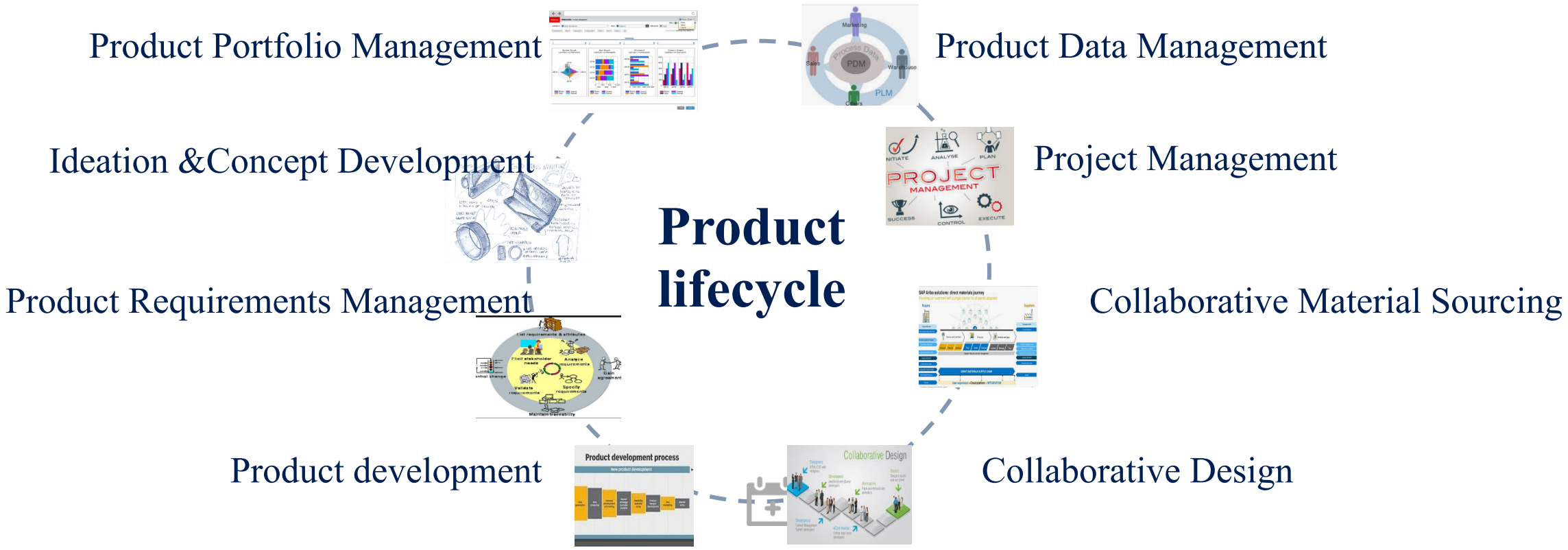
- **Background**



Case 1: R&D @ Siemens

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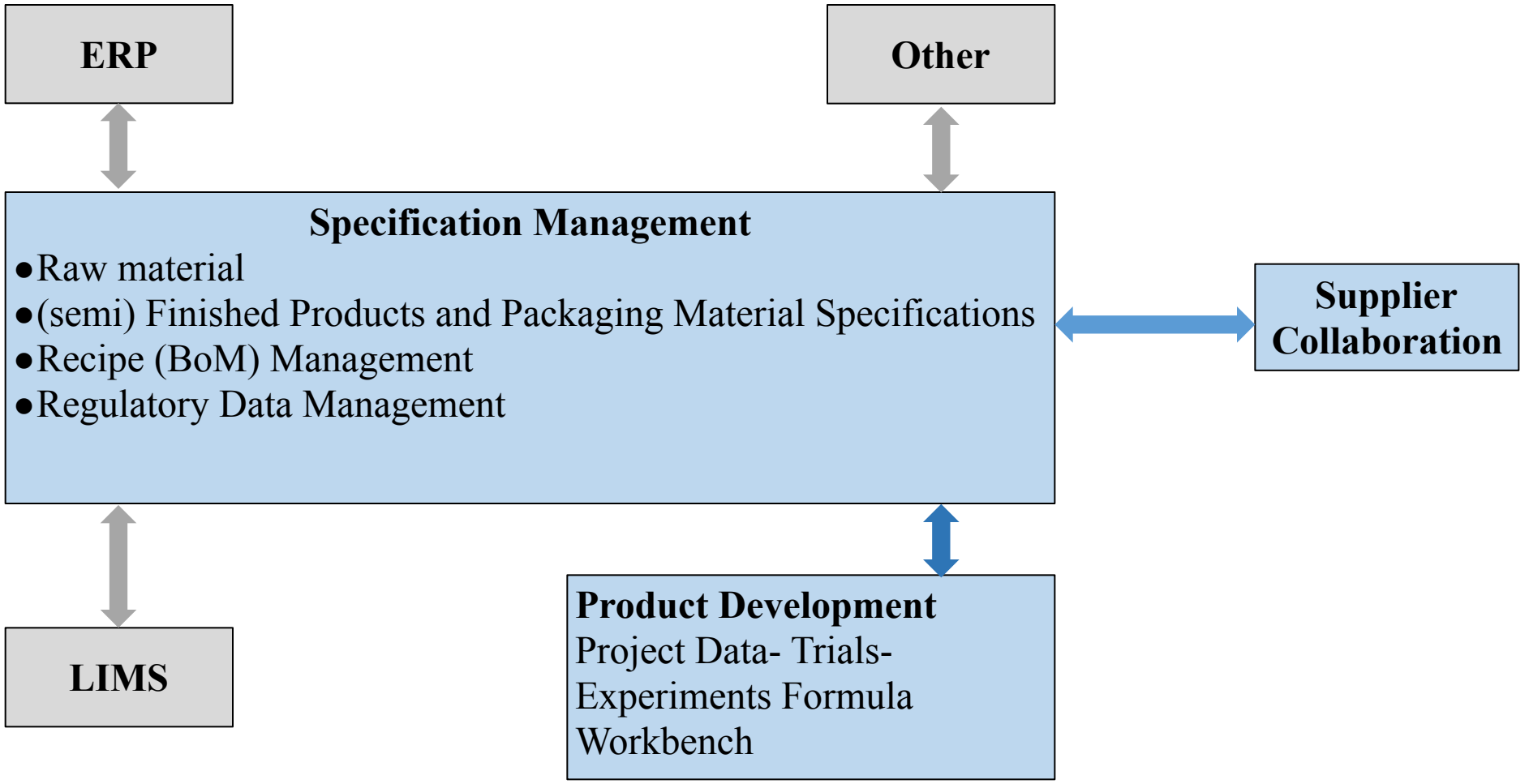
- **Solution**



Case 1: R&D @ Siemens

Service

Siemens follows a well defined methodology in its services offering

➢PLM consulting services cover the following areas :

- ✓ PLM Assessment : investigate current processes, identify bottlenecks, define improvements and ROI
- ✓ Specification Management
- ✓ Regulatory Data Management
- ✓ Product development business process

Case 2: Innobarometer Survey

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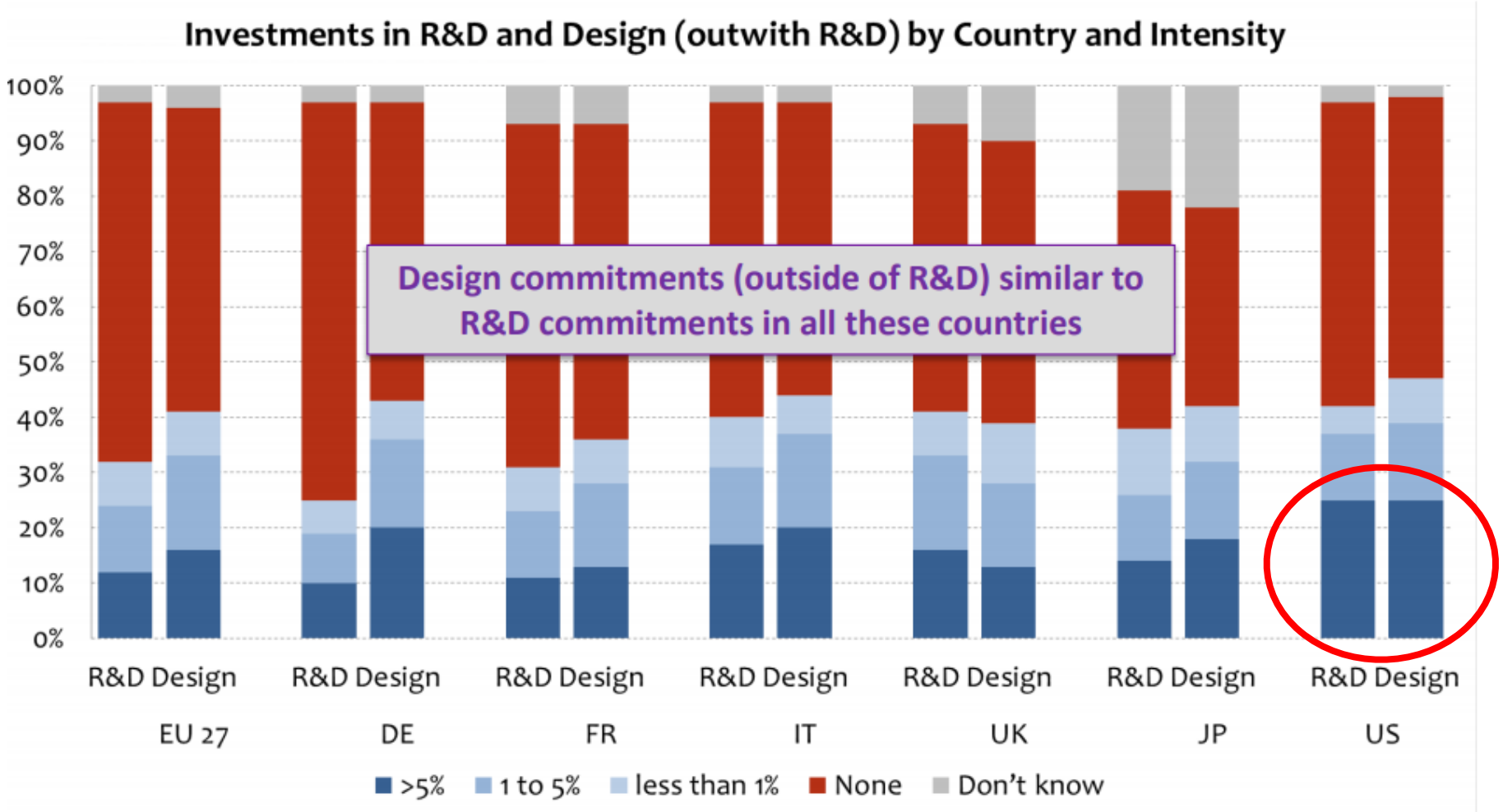

Case 2: Innobarometer Survey

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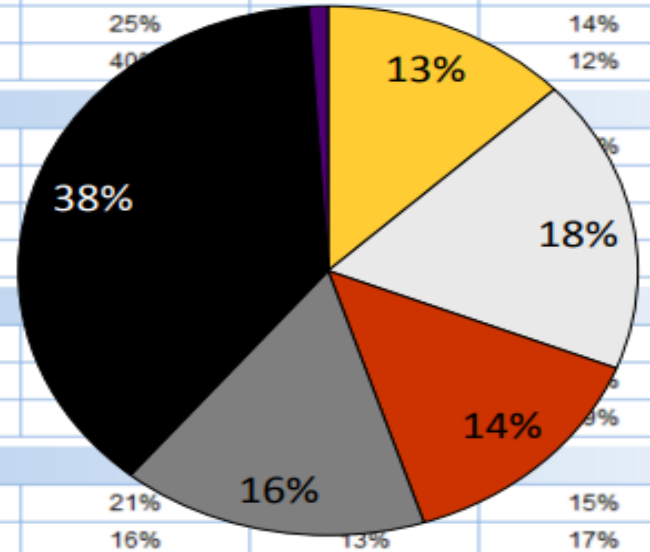
Q1 Which of the following statements best describes the activities of your company with regard to design?

Innobarometer, 2015	Design is a central element in the company's strategy	Design is an integral, but not central element of development work in the company	Design is used as last finish, enhancing the appearance and attractiveness of the final product	The company does not work systematically with design	Design is not used in the company	Don't know
EU28	13%	18%	14%	16%	38%	1%
Company size						
1 - 9 employees	12%	17%	14%	16%	40%	1%
10 - 49 employees	12%	22%	13%	19%	33%	1%
50 - 249 employees	23%	25%		14%	28%	2%
250+ employees	19%	40		12%	17%	1%
Sectors grouped (NACE)						
Manufacturing (C)	15%			%	33%	1%
Retail (G)	12%				39%	2%
Services (H/I/J/K/L/M/N/R)	15%				36%	1%
Industry (D/E/F)	7%				45%	1%
Company age						
Before 2009	12%				40%	1%
Between 2009 and 2014	13%				33%	2%
After 2014	16%			9%	27%	4%
Company's turnover since 2012						
Risen by 5% or more	17%	21%		15%	30%	1%
Remained approximately the same	10%	16%	13%	17%	42%	2%
Fallen by 5% or more	11%	16%	12%	17%	43%	1%



A Central Element
Integral, not Central
Used as last finish
Used, but not systematically
Not used
Don't know

Case 3: R&D @ HKZM Bridge

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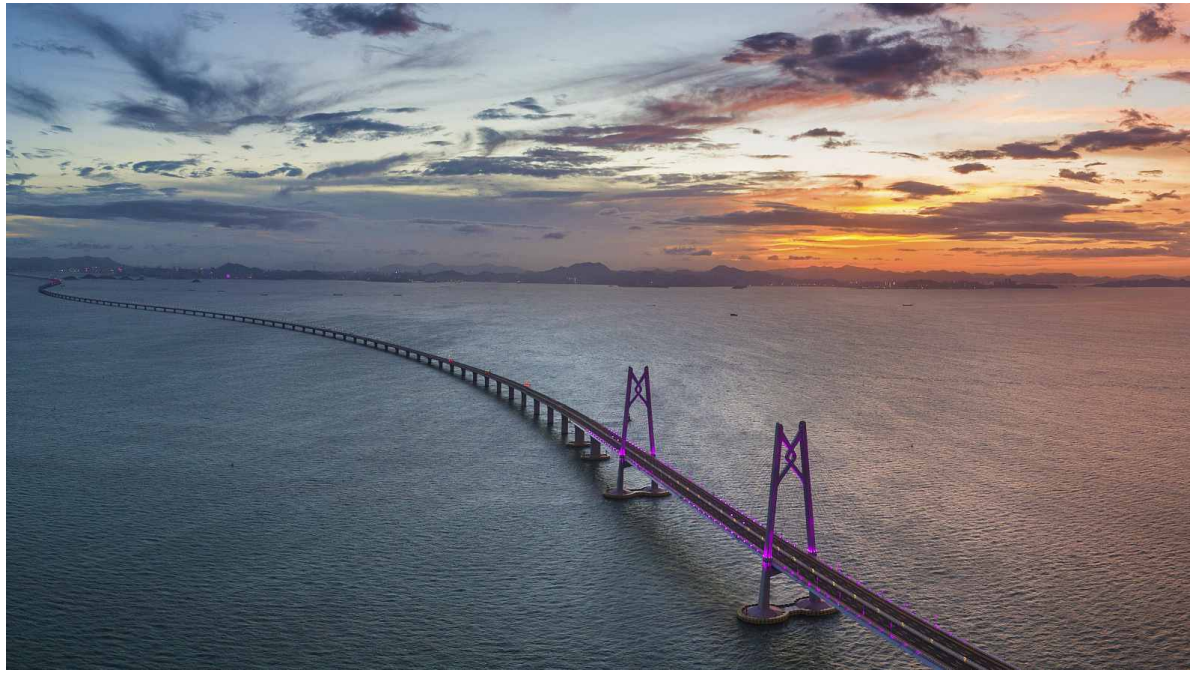
- With the devotion of over 200 R&D institutions and thousands of sci-tech personnel, the project has been granted over 1,000 patents, pushing the boundaries of possibility over and over again.



Thank You
for Your Attention!