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Non-scientific/technical challenges in the field of control engineering

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Figure source: http://www.hamptoninstitution.org/academia-and-class.html

Tavola rotonda
«Prospettive e nuove sfide tecnologiche e scientifiche nel settore dell'Automatica»

Automatica.it
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Control engineering: non-scientific/technical challenges

Some considerations

1. Marketing of control engineering and control engineers/scientists

   The hidden engineers for the hidden technology?

2. Quality of research

   How many citations to convince the management?

Focus on:

- technology transfer and visibility in industry
- balance between control theory and applications

Responsibility lies mainly in the hands of the academic community

How large technological firms manage R&D

An example - ABB

- One of the largest engineering companies worldwide
- Approx. 132,000 employees in about 100 countries
- $33 billion in revenue, 12% EBITA, $2 billion net income (2016)
- #1 or #2 in Electrification, Robotics, Motion, Automation, Transmission and Distribution businesses

How large technological firms manage R&D

Structure

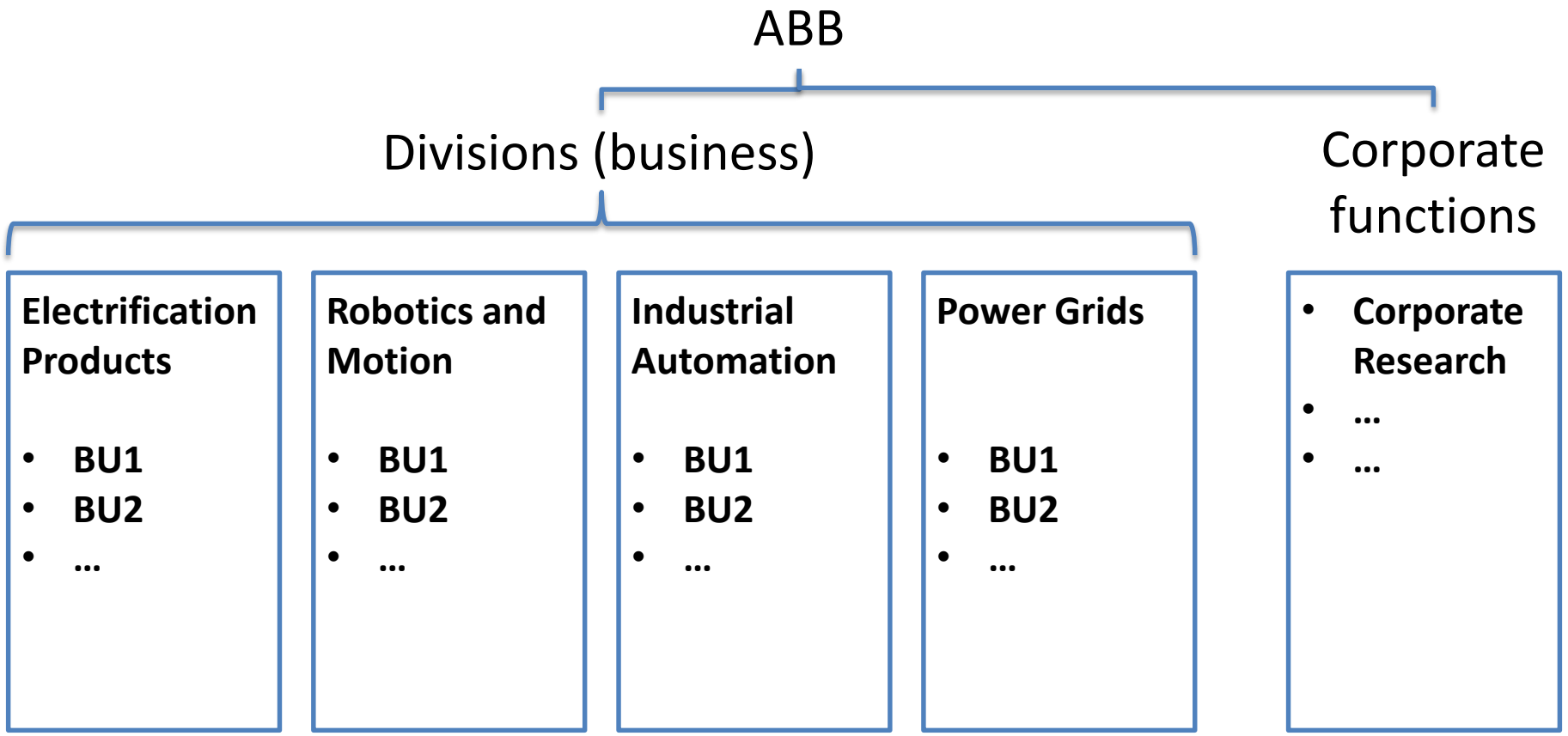


ABB is essentially a control company

How large technological firms manage R&D

R&D capacity

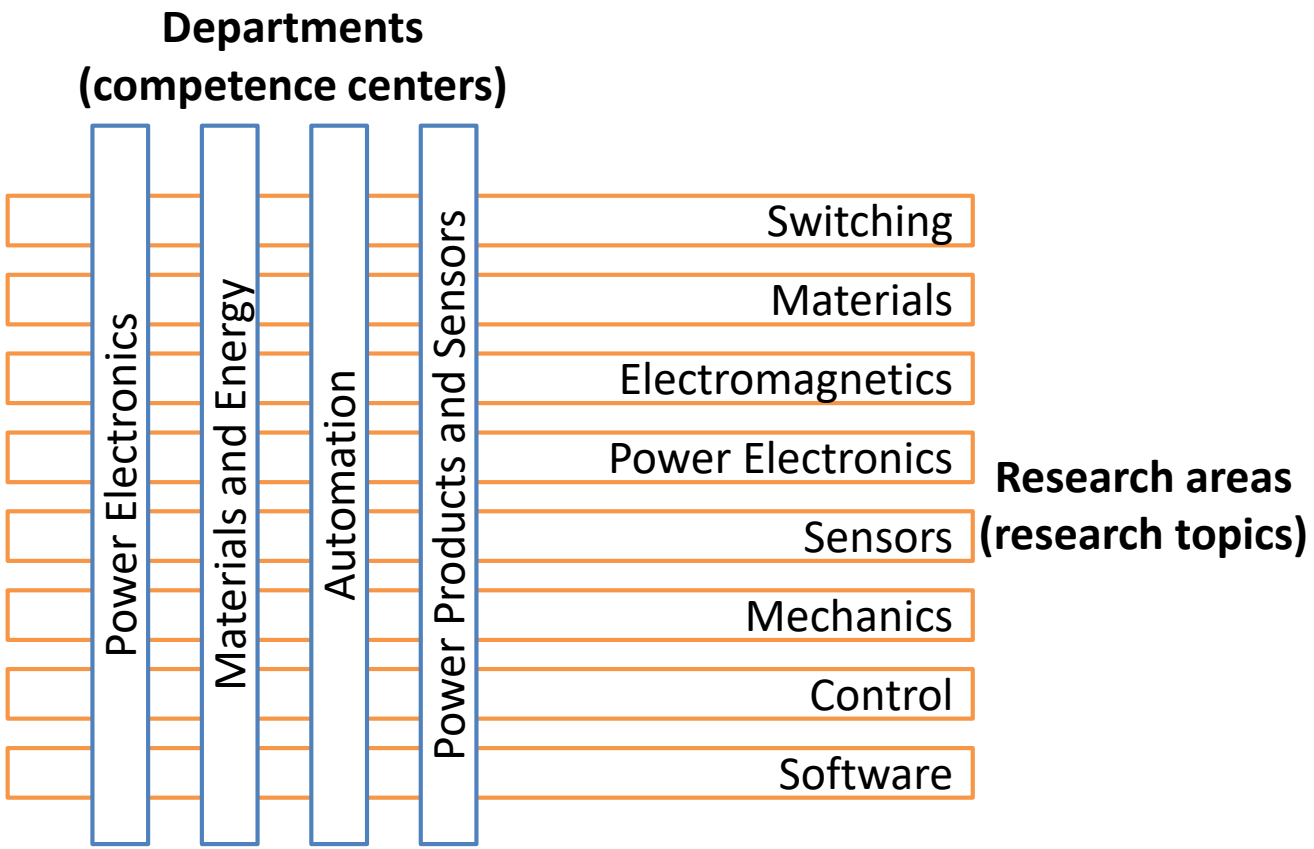
About $1.5 billion invested yearly for R&D

8,500 technologists across the divisions and corporate research centers

Corporate research: 7 centers globally, total about 800 researchers

How large technological firms manage R&D

Corporate Research R&D management structure



Strong similarity with public (EU) R&D investment strategies

How large technological firms manage R&D

Example: ABB Corp. Research Switzerland (est. 1967)

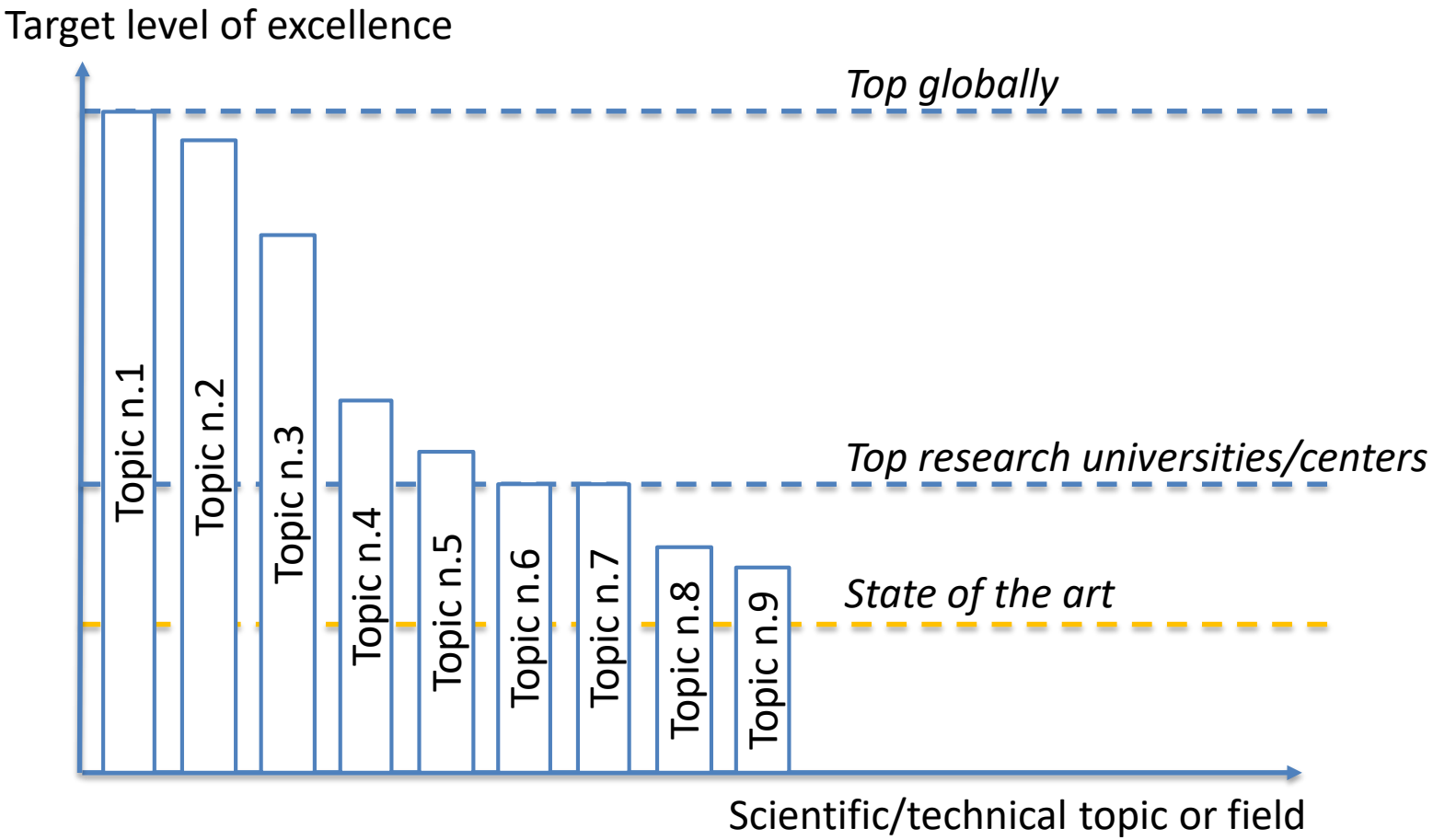
- 4 Departments:
  - Power electronics
  - Power products and sensors
  - Materials and energy
  - Automation

- About 200 researchers, **all with PhD and typically several years of academic experience** (post-doc, faculty)

- Typical tasks: medium-long term technology development, fundamental research, technology scouting and assessment, discretionary projects, university collaborations

How large technological firms manage R&D

Research priorities and positioning



How large technological firms manage R&D

Let's break some misconceptions

1) Industry is not equipped to implement the latest advancements developed in academia (or interested in doing so)

Kollsnes gas compression plant

Processes about 40% of Norway's total gas export

16 billion $ revenue in 2013

6 inverters, > 40MW each

Variable speed drive controlling 50MW compressor with fast nonlinear MPC*

2) Industry is not interested in reading/writing scientific articles

Paper writing and conference participation is a KPI

3) Industry is not interested in hiring PhD graduates

100% new scientist-level hirings in several Corp. Res. Centers must have PhD

T. Besselmann et al., "Model Predictive Control in the Multi-Megawatt Range", IEEE TIE 2016

The challenges

- Firms like this (and many others) are **fully equippend to receive/transfer results** developed by academia
- "Response" and R&D times can be very fast

BUT

- Not all scientific/technical advancements are transferred and/or deliver the expected impact

What are the ingredients that make technology transfer successful, and a scientific/technical field well-known and respected?

1. **People**
2. **Quality of research**

Ingredient n.1: People

Most important ingredient for research impact.

- People are behind any decision in any company, no matter how complex
- **We should make sure that engineers and researchers trained in control are well visible and appreciated. We should transfer people to industry.**
- A manager with background in (or exposed to) control engineering will appreciate its added value
- A manager with no knowledge of control engineering will not even consider its existence when e.g. hiring or taking strategic decisions
- In «traditional» fields control engineering is well known. To achieve the same in emerging/changing/future fields **is a challenge for both education and research.**

Ingredient n.1: People

The challenge: marketing of control engineers and scientists

Marketing mix (4P):

- **Product**: system perspective; capability to see problems from different angles, problem abstraction, culture of modelling (dynamical systems) and data analysis, use of optimization... are qualities with strong potential also in non-traditional fields
- **Price**
- **Place**: need to reach non-traditional fields/applications (with quality research)
- **Promotion**: people trained in controls should be aware of their specific qualities and give them value

Is «Automation» the most appropriate term to describe our competences?

A challenge for both our education and research approaches.

Ingredient n.2: Quality of research

Impact and multidisciplinarity

- Academia: impact = highly cited
- Industry: impact = useful

Not always one implies the other...

- Paper citations mean virtually nothing when it comes to implement and adopt the proposed methods.

- It is responsibility of who carries out the research to demonstrate that it's useful (**results exploitation** in addition to **dissemination**)

- Crucial (and connected) points are
  1) link between theory and applications
  2) collaboration and outreach to other disciplines

Ingredient n.2: Quality of research

Theory AND Applications or Theory VS. Applications?

- Need to balance the two (as a whole community). «*You were made from applications, and to applications you will return».*
- **Strong risk:** oversell theoretical results/algorithms. Result is bad publicity (several first-hand experiences about this).
- Serious research in applications (=meaningful experiments) usually is very expensive in terms of time and money. **Need to build deep knowledge of the specific application domain**.
- Collaboration with experts from other disciplines is key.
- Very often a «controls perspective» and well-established methods have huge impact.

Ingredient n.2: Quality of research

The challenge: how to promote quality of research (notwithstanding the current trends)?

- Current trend is to promote n. of citations, n. of papers, ranking and pertinence of the journal
    - Advantage (?): easy to compute automatically
    - Drawbacks:
        - Penalizes (expensive and time consuming) experimental research and collaborations with other fields
        - Papers and citations might become the goal and not the consequence of research
        - Penalizes reaching out to other communities
        - **In summary: might penalize quality of research**

- How to recognize the value of implementation, experiments, transfer and dissemination to other communities? **A challenge for how we conduct and evaluate research**

Final thoughts

- Most of the considerations above hold also for public research funding schemes (see e.g. H2020 pillars)

- How do these general considerations apply to Italy? Is the responsibility stronger or weaker?