Technology and Knowledge Transfer: the path of applied research

Lecturers:

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The 3 Missions of the University

1st : Teaching (inside)

2nd : Research (inside)

3rd : All the rest (outwards)Tech. Transfer is part of the 3rd mission

A bit of history

1088: Alma Mater Studiorum first University in Bologna

1810: first «modern» University in Berlin, funded by Wilhelm von Humboldt, to combine research and education in the name of the Nation's progress, with the explicit mandate of training the elite

‘80-’90: the entrepreneurial university model, born in UK under the will of Margaret Thatcher

The entrepreneurial university model has positive elements, such as evaluation and innovation that, however, have also been transformed into negative elements, such as indicators, student-clients, productivity, ranking.
This model finds its most extreme expression in the English and American university system.

In Italy we are still far from a real entrepreneurial university (good or bad?).

The third mission has been officially recognized by the Government in 2010.

What is Third Mission?

The term Third Mission refers to the set of scientific, technological and cultural transfer activities and the productive transformation of knowledge, through processes of direct interaction of the University with civil society and the entrepreneurial fabric, with the aim of promoting growth economic and social development of the territory, so that knowledge becomes instrumental in obtaining benefits of a social, cultural and economic nature.

What is Technology Transfer ?

The technology transfer process helps a manufacturing company more effectively use its human, physical, and capital resources by providing knowledge, information, or assistance, which leads to improvements in its facility, equipment, manufacturing methods, management methods, or marketing methods.

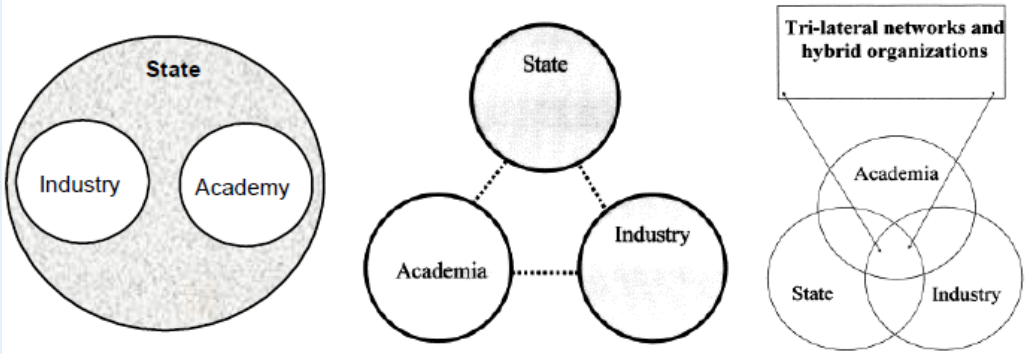
Technology & Knowledge Transfer !

Triple Helix…and more

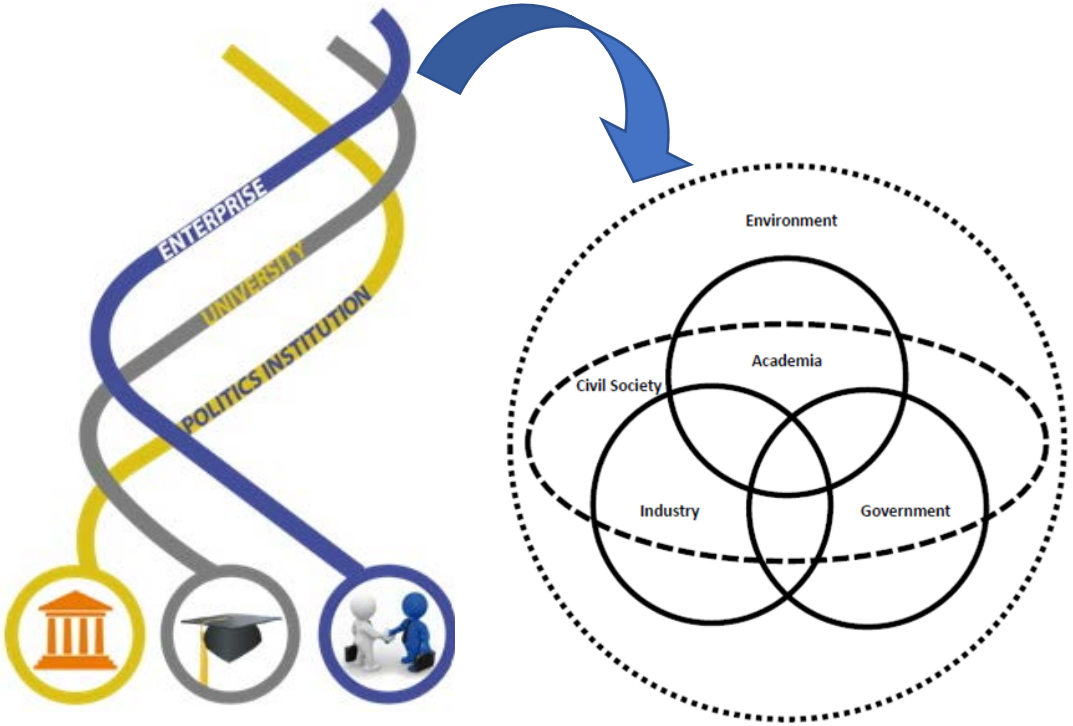
Henry Etzkowitz

The **triple helix model of innovation** refers to a set of interactions between academia (the university), industry and government, to foster economic and social development

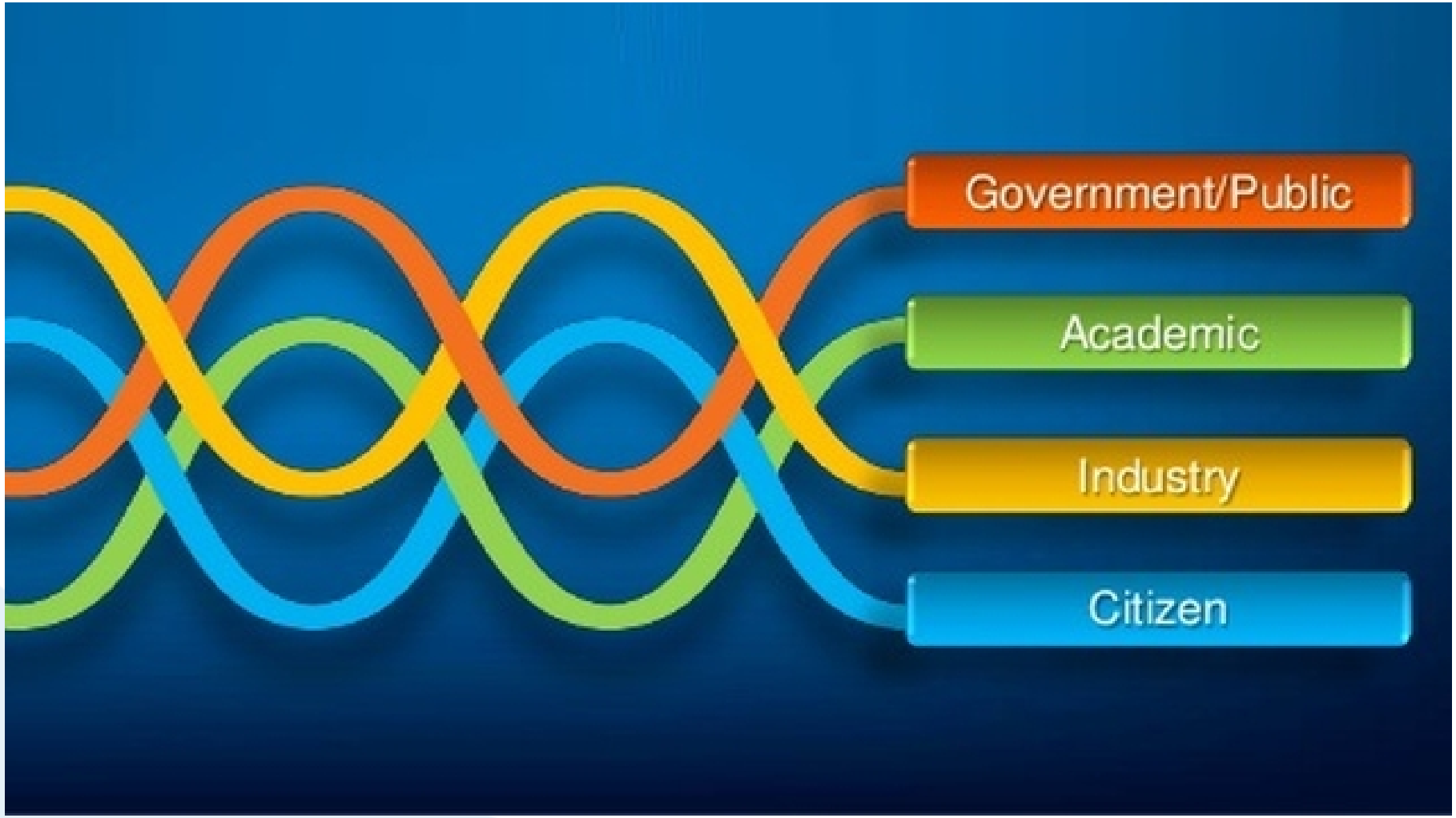
Figure 1: From the Statesman and Laissez-faire the Triple Helix



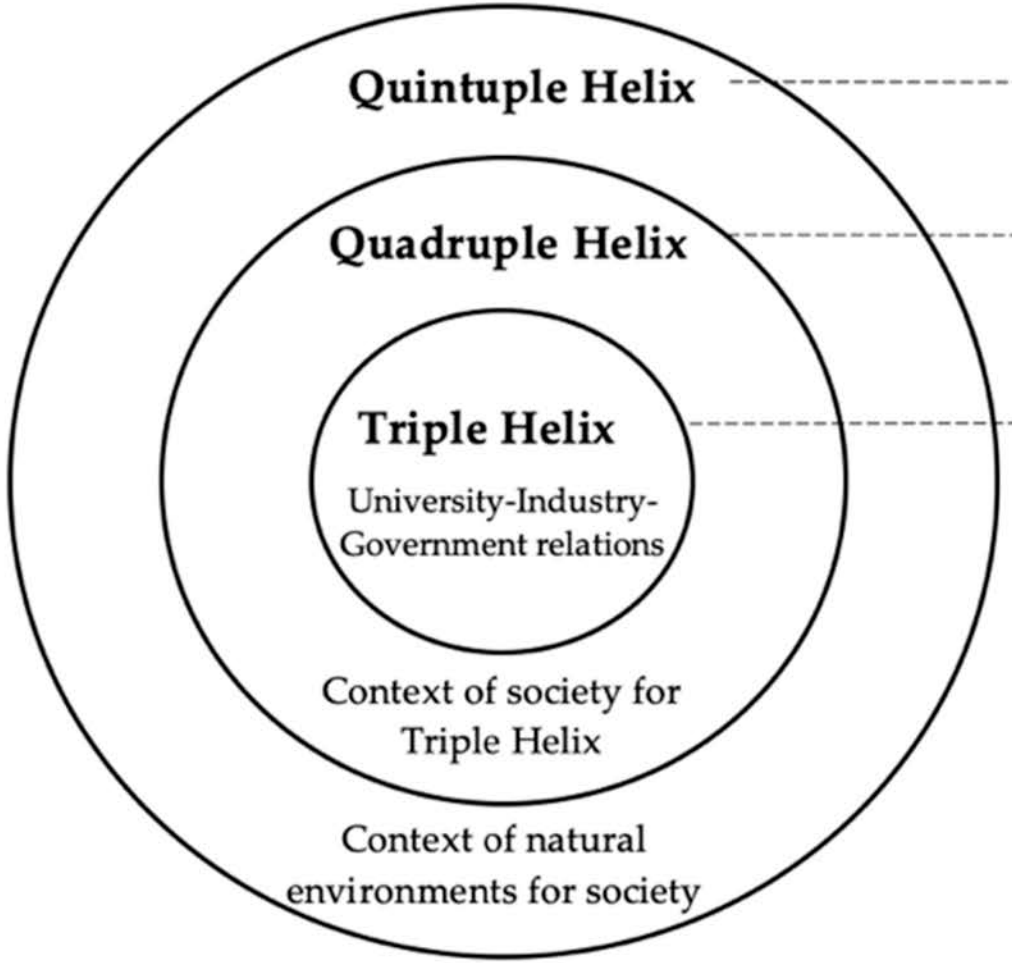
Source: Adapted of Etzkowitz & Leydesdorff (2000, p. 4).



Quaduple Helix



Quintuple Helix



Natural environment, it provides the natural capital to society.

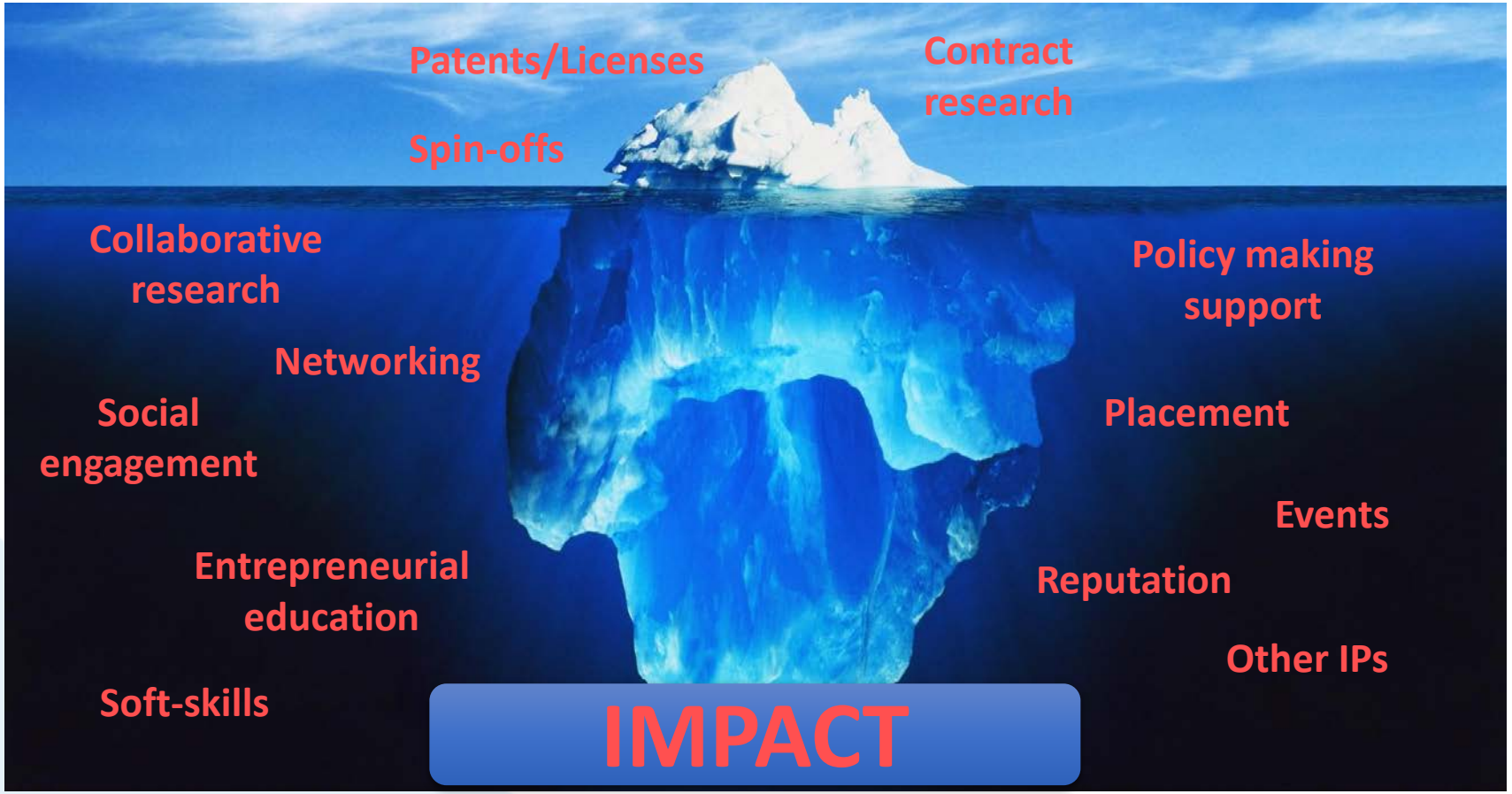
Media and *culture*, combines two forms of capital, the information and social capital, respectively.

Education system, which incorporates human capital and is shaped by the dissemination of research and knowledge.

Economic systems, it includes industries, firms, services and banks, focusing on economic capital.

Political system, the "will" of a nation-state.

The Knowledge Transfer Iceberg



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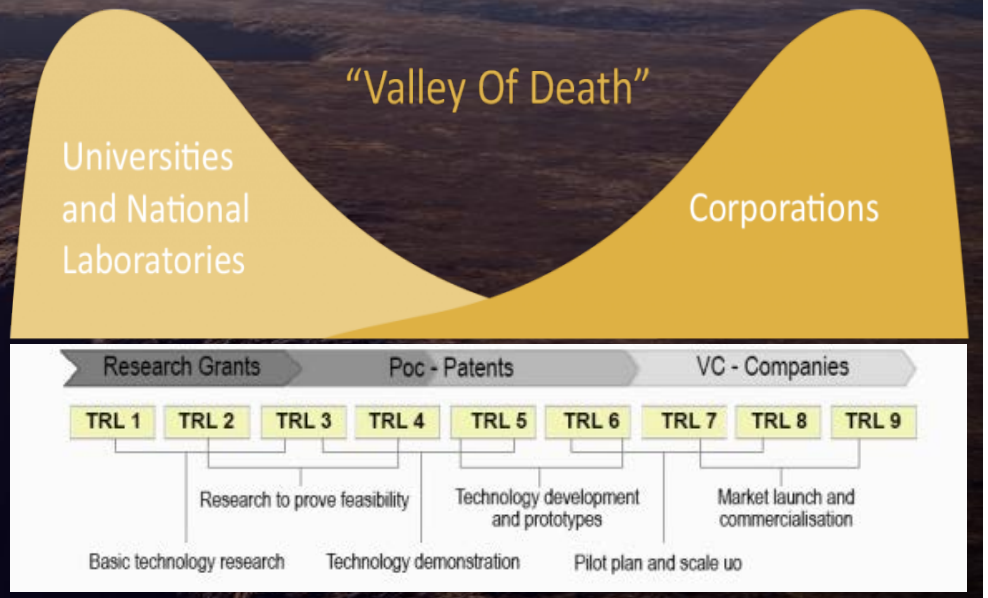
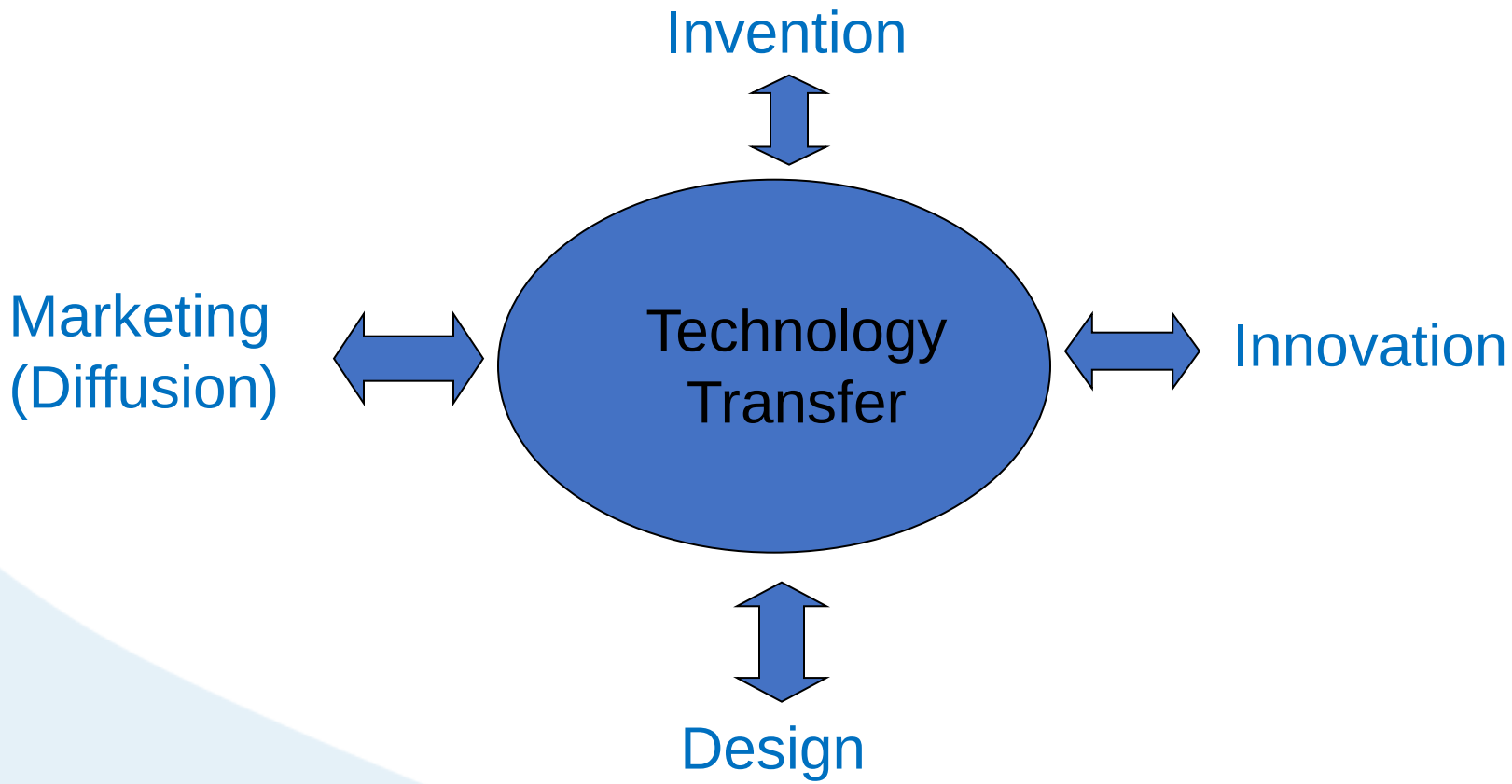
TECHNOLOGY READINESS LEVEL (TRL)

…because it’s hard to cross the «Death valley»

And we can accomplish it only in collaboration with the industrial world



Technology Transfer

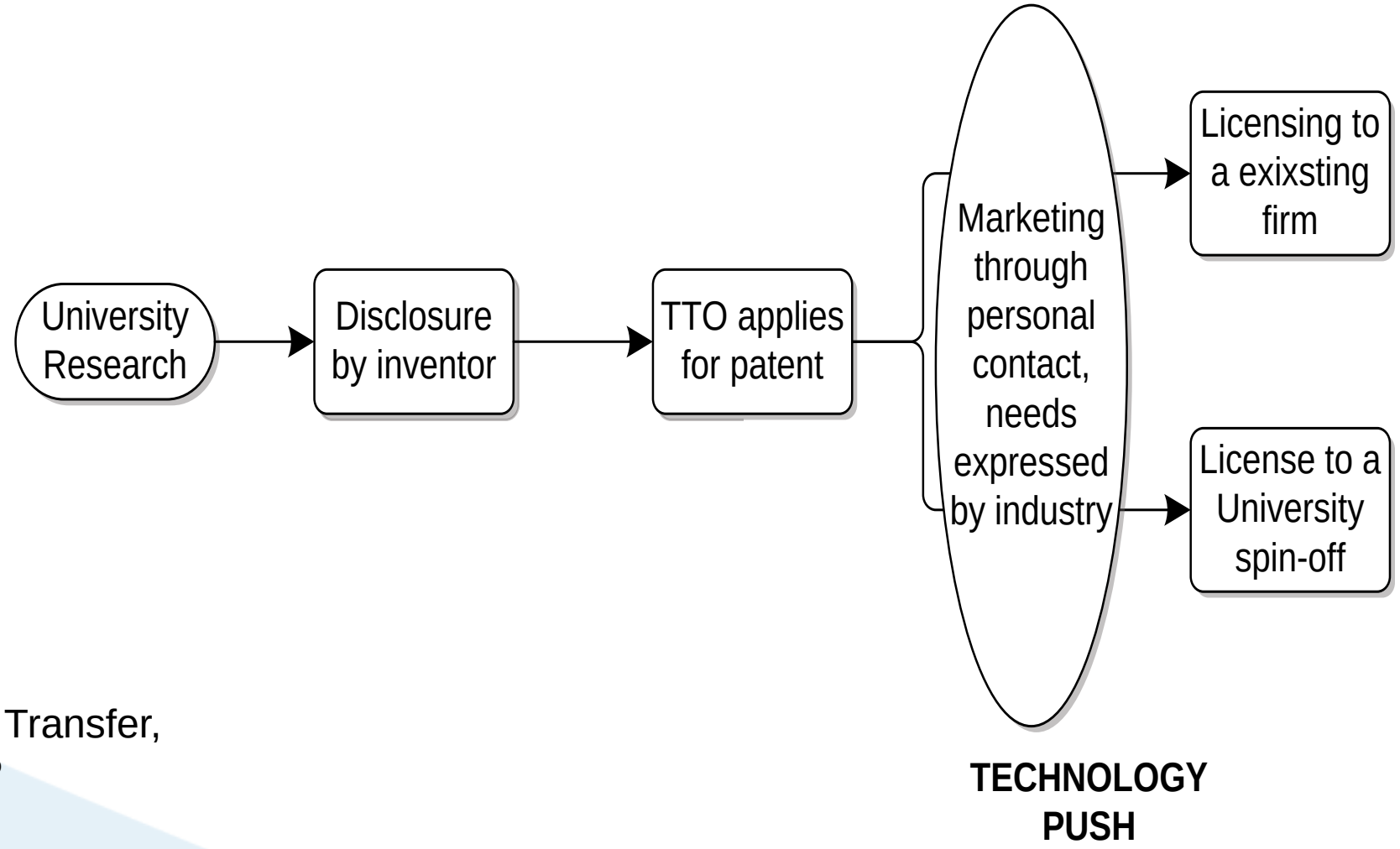


A simple example: the wheel

- Incredible that people a million years ago invented the wheel that would be useful for so long. They saw the need for such a device that would make certain tasks easier – invention.
- Someone needed to device a way to utilize the wheel – innovation
- Turn idea into reality and implement other ideas to use the wheel – design
- Further developments need promotion and device/idea needs to be disseminated - diffusion

Technology Transfer evolution: 1° Stage

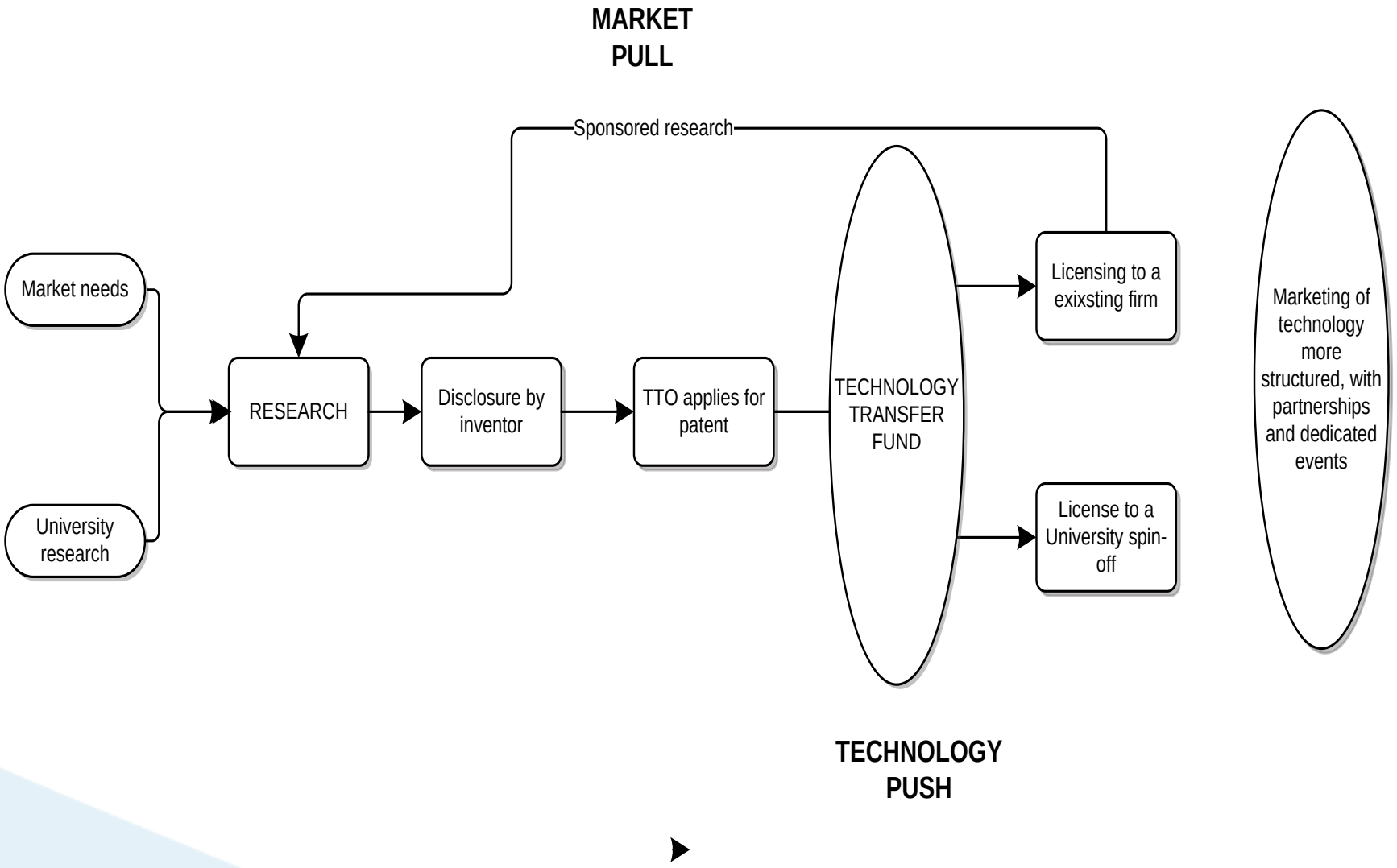
Technology Transfer at its first was thought as a linear model, based on Technology push of Universities inventions, mainly driven by the Bayh Dole act. Introduction.



The Evolution of Technology Transfer, Arundeep S. Pradhan, RTTP

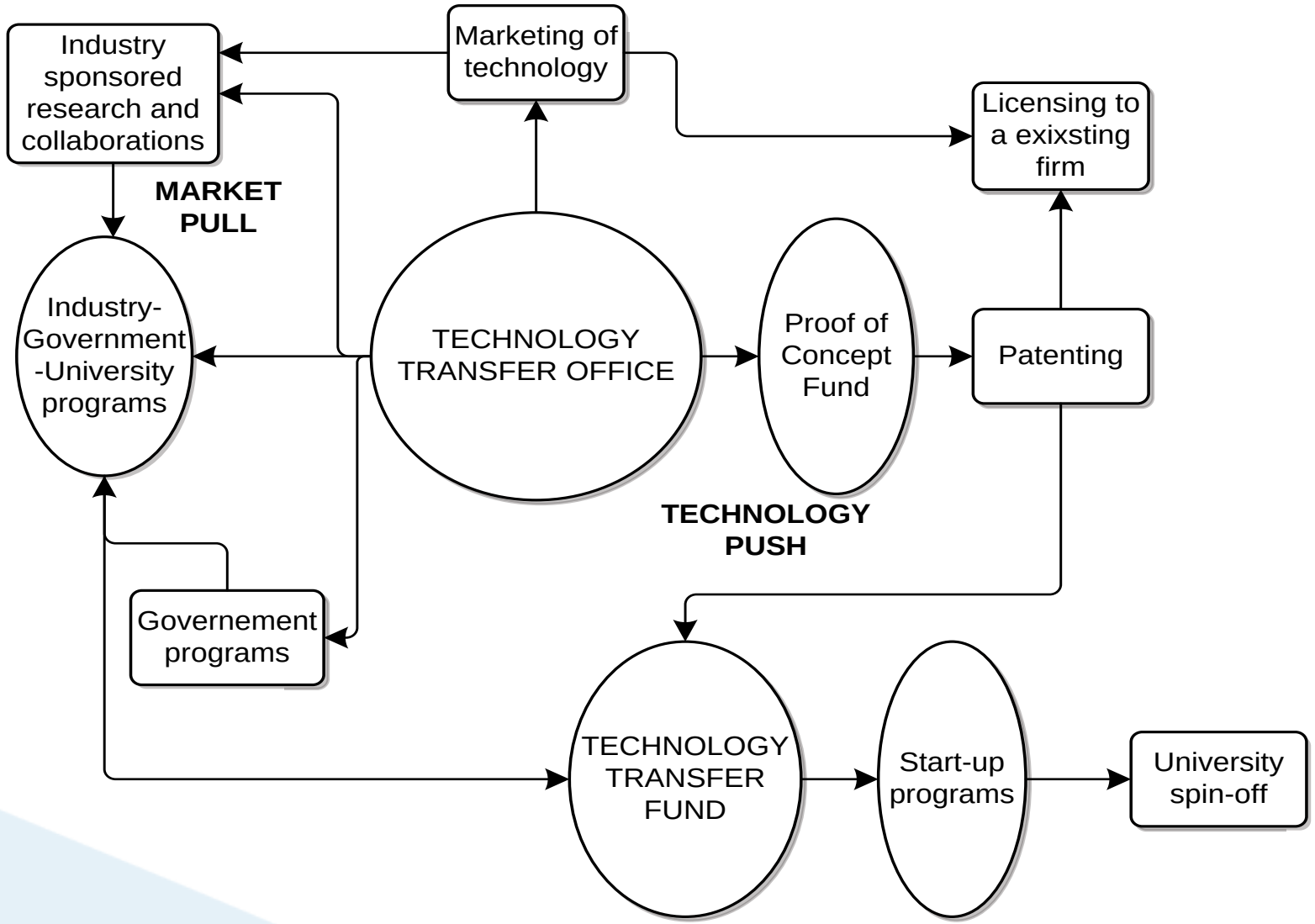
Technology Transfer evolution: 2° Stage

First stage of evolution encompassed increasingly entrepreneurial faculty, the need to foster relationships with industry, advancing technologies for a greater commercial value, protecting non-patentable materials, and developing targeted communications to stakeholders.
Gap funding instruments were first created.



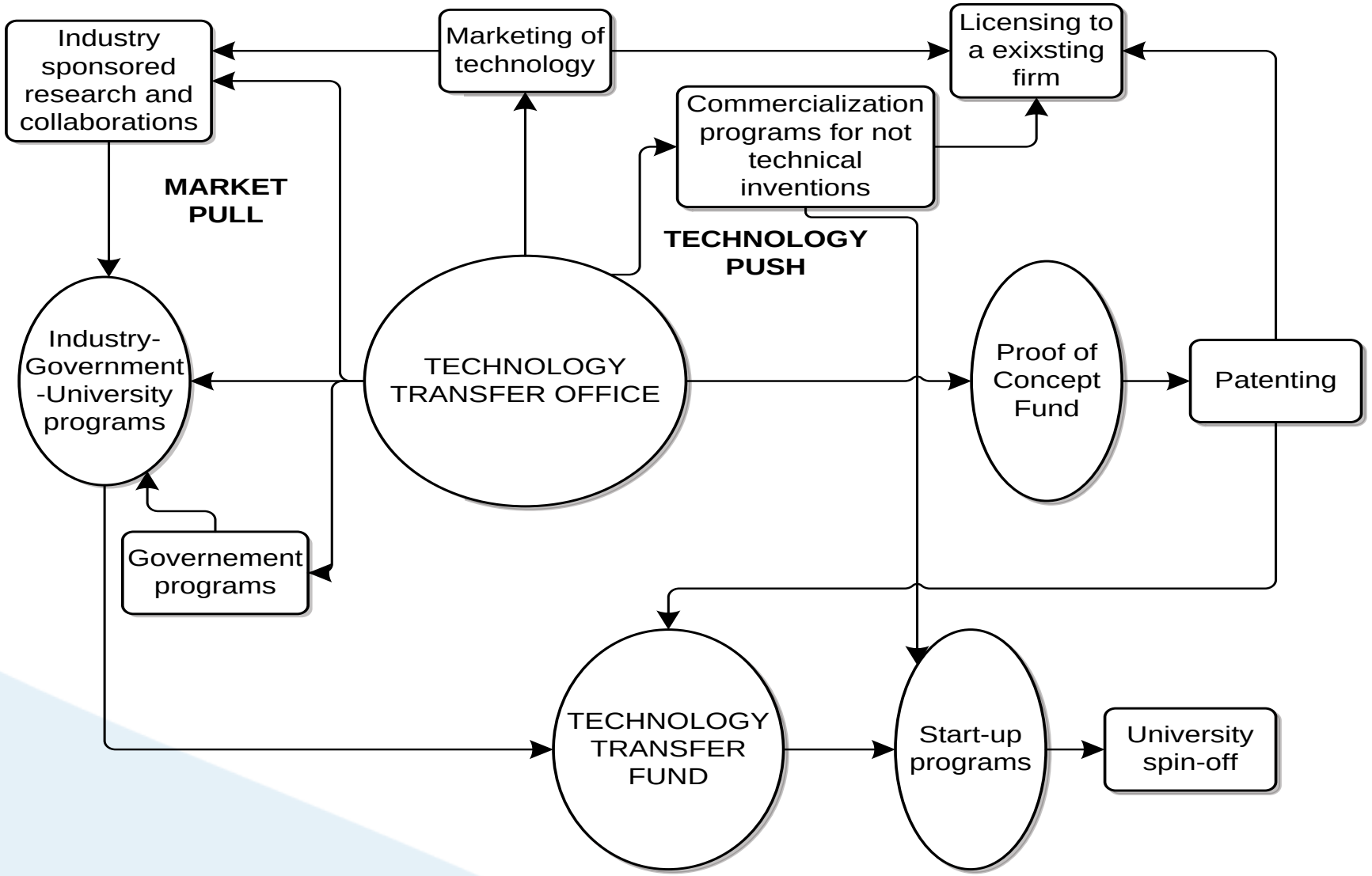
Technology Transfer evolution: 3° Stage

Widening the scope of TT, introducing of legal staff within the TTO, entrepreneurship courses for faculty and students, starting to address the «second valley of the death».
More structured and targeted marketing messages to relevant stake holders.



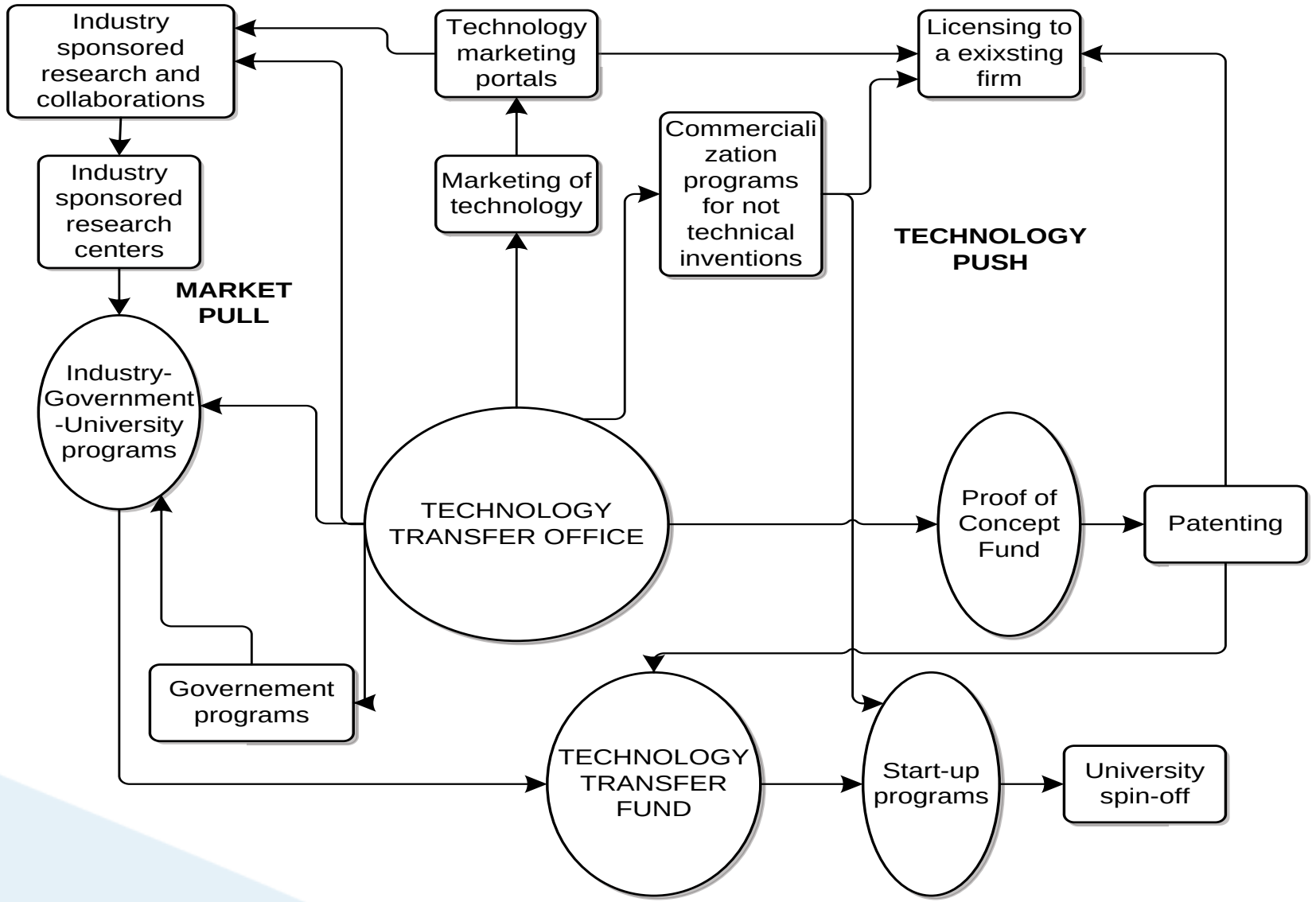
Technology Transfer evolution: 4° Stage

Focus on clinical translational research, liberal arts, social sciences, and clinical trial programs



Technology Transfer evolution: 5° Stage

Automatized patent application process, more focusing on pharmaceutical research, more professionalized and broad roles of TT officers.
New tools for more efficient and automatized commercialization of non-STEM innovations.
Continuously growing focus on entrepreneurial education



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Terza Missione

Critical Materials are not new: learning from the history

- "The stone age did not end because we ran out of stones" – Steven Chu.

- The copper age replaced the stone age because copper was better for some things.

- The bronze age replaced the copper age because bronze was better than copper.

- But the bronze age was not replaced by the iron age because iron was better than bronze. It ended because copper became unavailable.

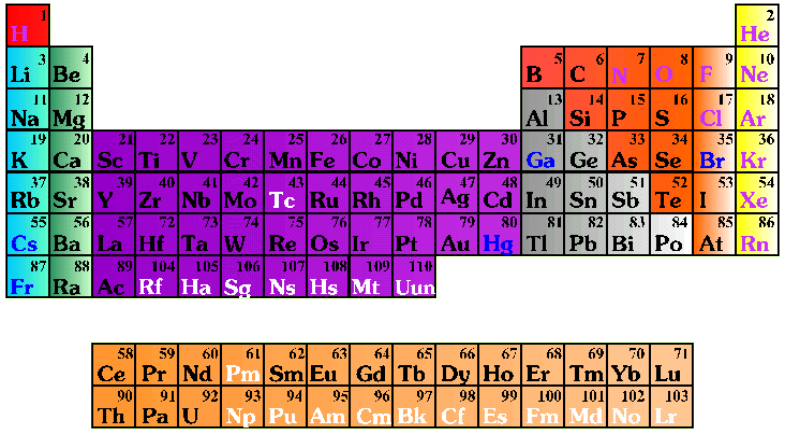
Iron vs. Bronze, 1200 BC

- Processing
  - Bronze requires lower temperatures
- Hardness
  - Bronze is better, because no effective hardening mechanisms are yet available for iron.
- Corrosion
  - Bronze is better
- Cost
  - Iron was nine times more expensive than gold

The Bronze Age Collapse

~1200 BC

- Bronze becomes unavailable
  - Possibly because Cyprus is overtaken by war, making copper inaccessible.
- Results
  - Collapse of trade; collapse of civilization
  - Relative strengthening of Egypt, which found alternative sources in Africa
  - Eventual emergence of the iron age
- Responses include
  - Recycling
  - Source Diversification
  - Materials Substitution



Inventions

Some are nothing more than scientific curiosity for years before being transformed into a working device, prototype, or product

Aluminum
(H. Saite-Claire Deville, 1854)

100 Years

Utensils, mast for sailboats window frames – late 1950's

Total Internal Reflection
(William Wheeler, 1881

90 Years

Fiber Optics
1971

Theory of Lasing
(A. Einstein, 1917)

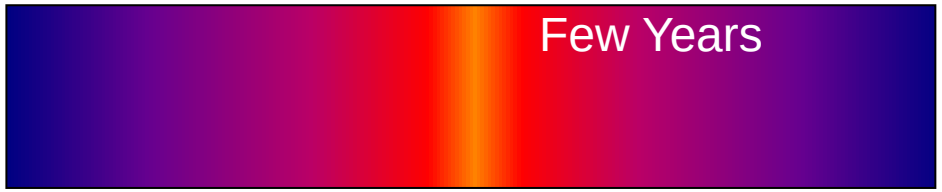
43 Years

First I Prototype Gas discharge laser 1950

Inventions

Some inventions have immediate appeal

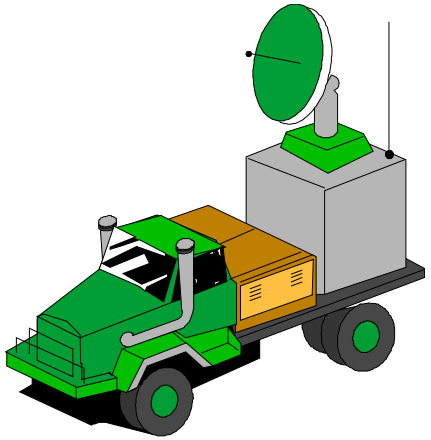
X-Rays
(1895 – William Rontgen)



1900’s
Used in Medical Profession

Inventions

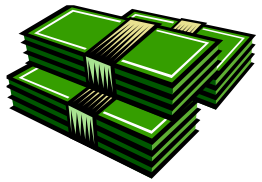
Some Inventions are forced

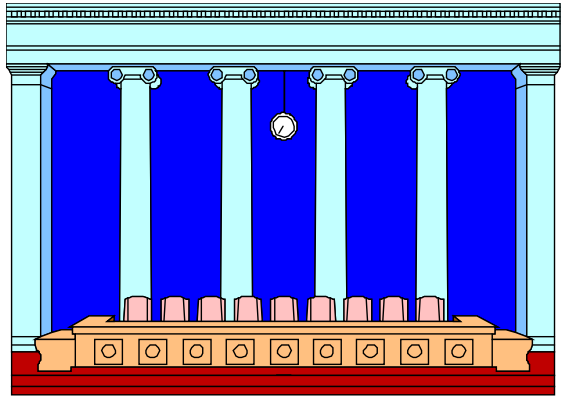


Radar
(Patent, 1914)
unworkable

35 years

Nothing happened





1940's need
WWII

Some important steps forward for photovoltaics

1839 : PHYSICIST ANTOINE-CÉSAR BECKEREL DISCOVERS PHOTOGALVANIC EFFECT IN LIQUID ELECTROLYTES
→ BIRTH OF PHOTOVOLTAIC EFFECT

1921 : ALBERT EINSTEIN OBTAINS THE NOBEL PRICE FOR THE EXPLANATION OF THE PHOTOELECTRIC EFFECT

1954: FIRST SILICON PV CELL AT BELL LAB WITH EFFICIENCY OF 6%

1963: SHARP PRODUCES FIRST COMMERCIAL SI MODULES

1973: WORLDWIDE OIL CRISIS SPURS MANY NATIONS TO CONSIDER RENEWABLE ENERGY INCLUDING PHOTOVOLTAIC

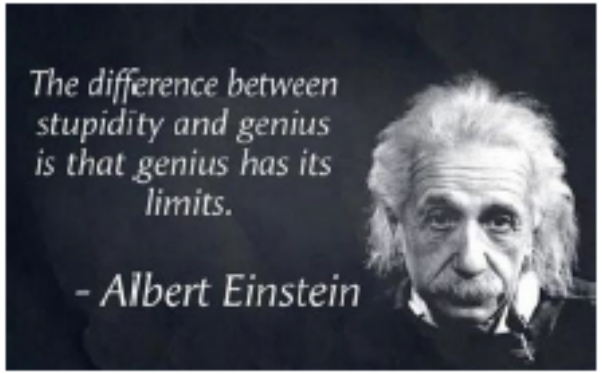
1978 : WORLD PRODUCTION OF 1MW$_p$

1985: SI SOLAR CELL > 20% UNDER STANDARD SUNLIGHT (UNSW)

2014: WORLD PRODUCTION OF 100 GWP

2014: 25% ON LARGE AREA SOLAR CELL (SUNPOWER)

L.L. Kazmerski / Journal of Electron Spectroscopy and Related Phenomena 150 (2006) 105–135



3. The first silicon p-n junction solar cell was made in 1954 by Darryl Chapin, Calvin Fuller and Gerald Pearson at Bell Laboratories. The device was around 6% efficient.

Inventions

The need proceeded the product – another example

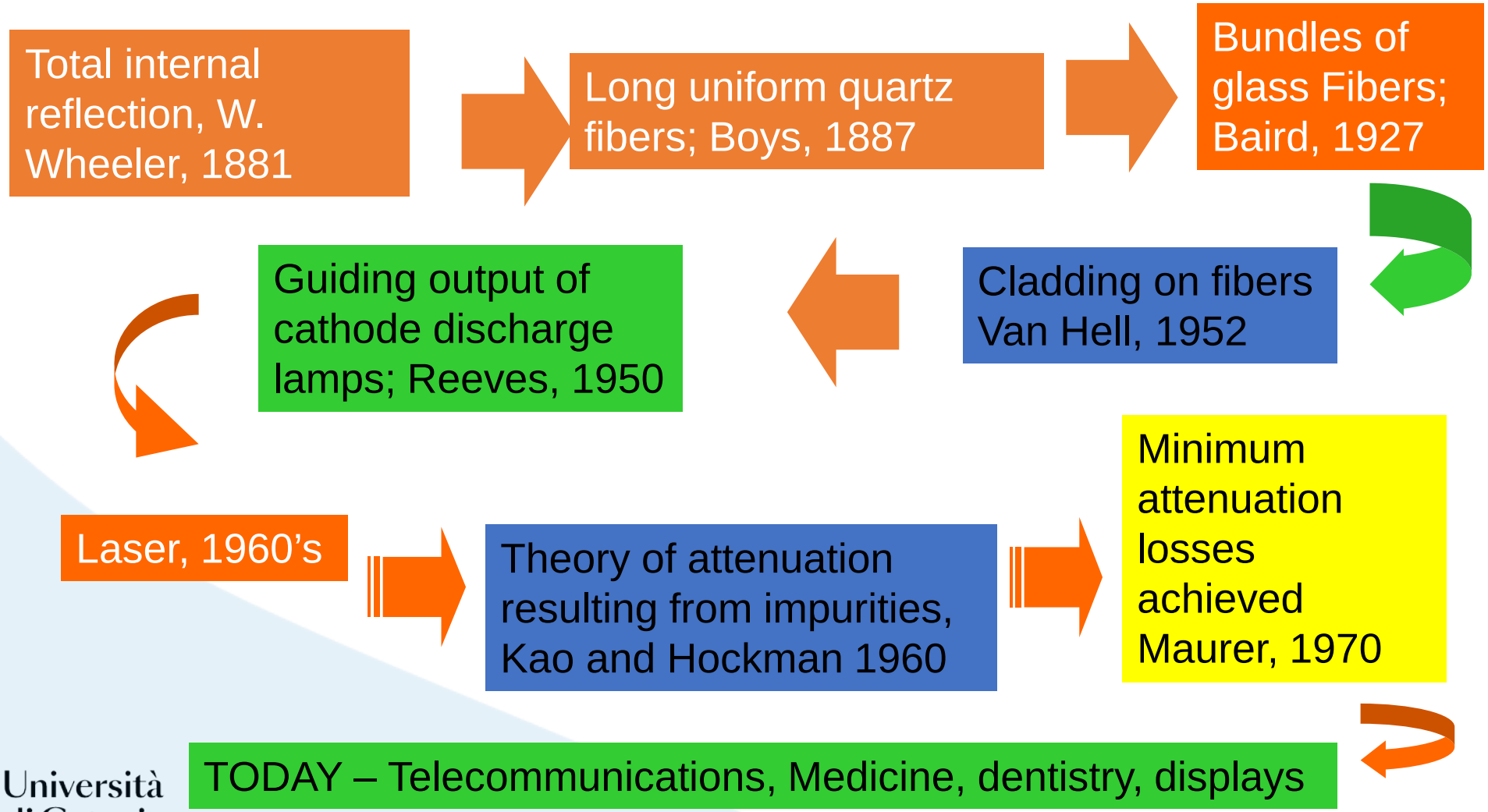
The vacuum tube was bulky, fragile, power hungry, and had lifetime issues – it was inherently unreliable

The need for a transistor existed long before its invention

Bell laboratories poured money into it resulting in the first patent of the resistor (1940)

In 1951, the first point – contact transistor was manufactured

The complicated path of Invention

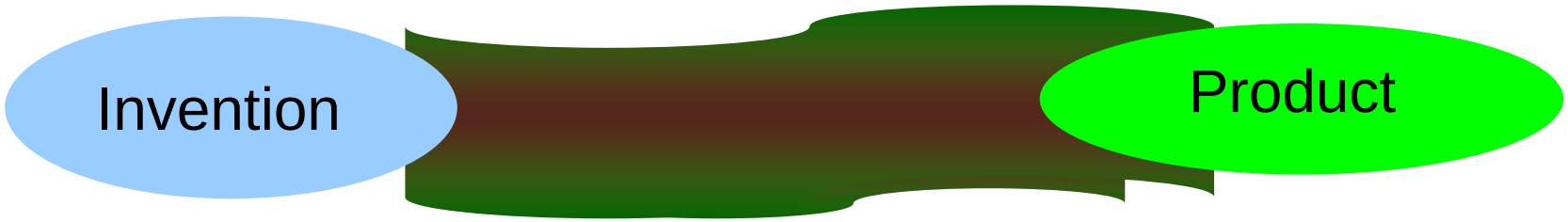


A Fundamental Question of Technology Transfer

- Why do inventions, in some cases, take so long to reach the market place?
- What factors govern the time lag between invention and application?

In today's marketplace, speed to market dictates success or failure

Innovation



This period of development is characterized by INNOVATION!

Innovation vs. Invention

- Invention = Original Concept
- Innovation = the development, refinement, and change of an existing idea / product
- E.g. Easier to manufacture, Cheaper to Fabricate, Better Performance, More reliable

Then and Now

- The wheel has been improved over thousands of years – improvements evolved slowly

- Consumer Electronics Industry, time to market:

  1980 = 1.5 years 1990 < 1 year

- Today, there is a lot more effort on conscious design and modeling

Design

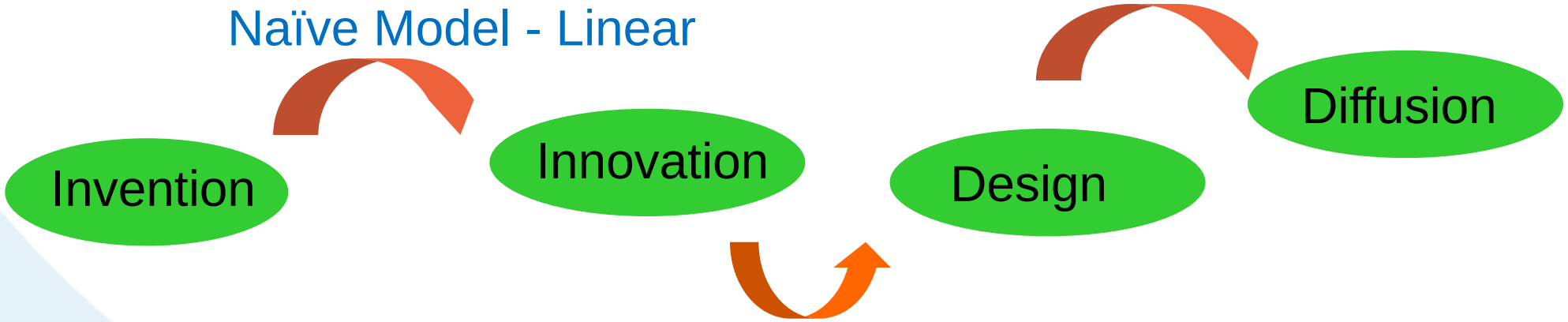
- Design is part of the innovation process, sophisticated modeling and software shaves years off the development process

- Many issues can be identified during the modeling stage, before prototyping – saves time and money

Diffusion

- Sometimes referred to as marketing,
  - everything that is involved in the promotion and sale of the product
- Also important is promotion by use of publication
- Users and customers have important input on how to improve or refine the product
- Can conflict with IP

Relationship
Invention, Innovation, Design, and Diffusion



What's Wrong with this Model?

- Feedback from each stage
- No real beginning and end, invention is often continuous

Realistic Model

Innovation – Embrace the entire Process

Technology Transfer – Means to achieve innovation

Innovation

Embraces the entire process

Some Working Definitions

- Technology Transfer The transactions between changing technology and invention, innovation, production, and diffusion

- Innovation – The exploitation of new ideas

Reasons to Innovate

- Competition – Keep ahead of Competitors
- Science & Technology – Technological change can be the result of science push and changes in the science and technology base lead to product innovation
- Market – Customer feedback influences innovation leading to product improvements
- Legislation – Government can force innovation (e.g. safety, environment, economic Policy)
- Human Nature – Curiosity “what happens if I do this…?”; Laziness “There must be an easier way to do this”

Innovation as a Policy

- Innovation does not guarantee success, but a lack of it will ultimately lead to failure
- Innovation and invention are integral and key to many companies (e.g., Philips, 3M)
- Each year Nissan holds a competition for its employees to come up with a novel form of transport
- Innovation is policy, change is inevitable and in part is driven from within the company. The company is not simply waiting to respond to one another of the external proximal cases, but is itself a vehicle for change.

Information

- Inventors and Innovators need information available to them
- Knowledge – Base information – often academic and abstract, contained in journals, scientific magazine, patents, and at conferences.

Ex.: Transmission of light through a glass fiber is limited by impurities in the glass rather than inherent properties of glass. This was published in an archival journal, but did lead glass manufacturers to improve the quality of glass by reducing impurities – this paved the way for fiber optics

Information

Equipment based knowledge – Knowledge conveyed via products/devices. Knowing what machine tools are available and what they do, what merchandise is available in the marketplace and what features it has.

Also conveyed in trade journals, magazines, and conventions.

Another information channel is through sales reps, advertising, other companies, etc.

Technology Transfer Process

IBM grants a license to the government of Taiwan – the computer corporation undertakes a transfer of knowledge.

French cheese maker passes on recipes to Japanese firms – transfer of knowledge

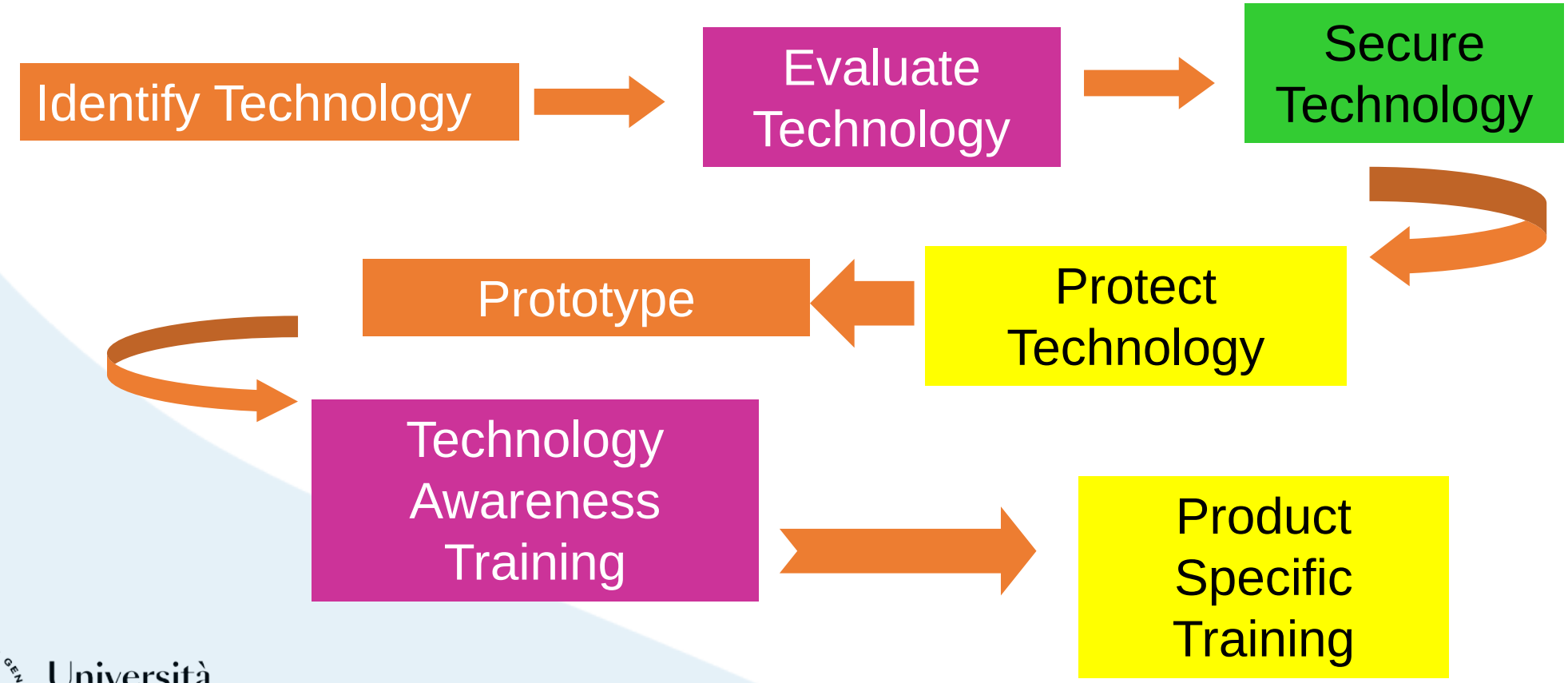
Brown University organizes a short-course – transfer of educational and technology information

Flow of information

The flow of information and knowledge are various and wide ranging.

Innovation Process Checklist

Technology Transfer is a subject of Innovation



Barriers to Innovation

- Management Attitude: Upper level management does not embrace change easily
- R&D effectiveness: Needs to be continuous, not discretely when a new product is needed
- Short Term Pressures: Companies take a short term perspective by not investing in higher risk, long term payoffs
- Resistance to Change: Same-old, same-old; comfortable with current position
- Poor Information Flow: Need to maximize flow of information around the company… poor information flow hinders technology transfer
- Weak Links: Good idea's products can be destroyed by poor marketing or not listening to customers

Using Higher Education Research and Development

Universities can often help small and big companies with R&D. The University often offers much cheaper rates than a private research company.

- Access to new technology (A lot of pie in the sky stuff)
- Keep abreast of new developments
- Access consultancy skills
- Professors are possible technical board members
- Develop joint new technology, benefits both.

Linking Organizations to Educational Establishments

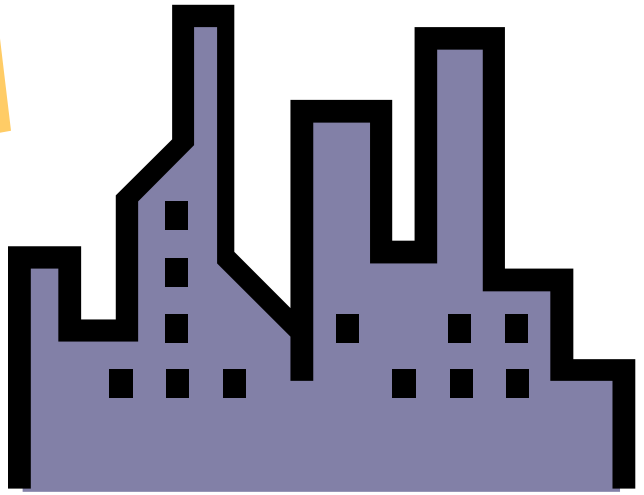
Forming Links

1. Graduate Employment – companies hire graduates and create a natural link back to their alma mater
2. Sabbaticals – Companies hire university professors to work on-site for a year or semester to bolster in-house expertise (pretty cheap)
3. Industry/University Research Units – Organized research units where focused groups at the university partner with companies. Companies gain access to professors, students, and earn results
4. University/Industry Liaison Units – Universities are creating internal organizations that are in charge of protecting and developing valuable new technologies to be transferred to industry.

University – Industry Partnership

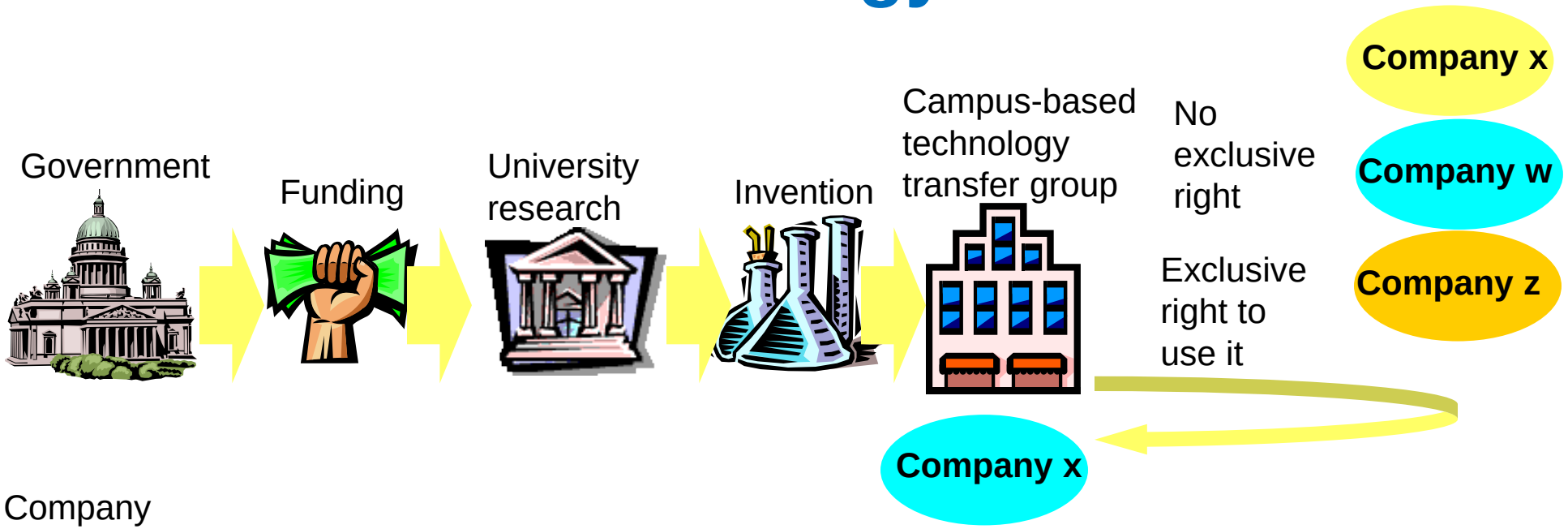
Information

Product ideas, real world perspective, focused problems, prototyping facilities, market experience



New results, interesting devices, research with seemingly no applications, professors, and students

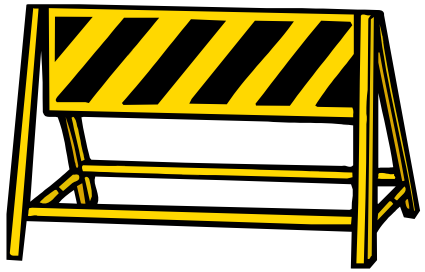
Paths of Technology Transfer



Why Collaborate?

If you are faced with a problem that you cannot solve yourself – technical, financial, or commercial problem:

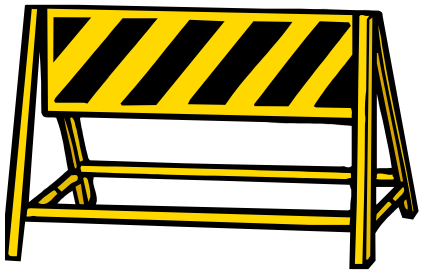
- To share risks
- To share costs
- To gain technological know how
- To speed up product development
- To develop industry standards
- To gain additional markets
- Reduce time-to-market



Barriers to Transfer

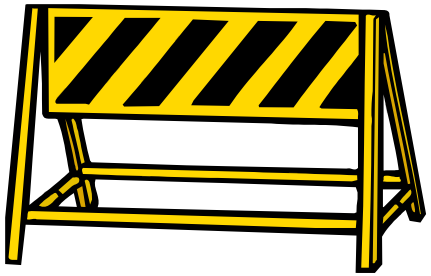
What hinders technology transfer and what cause joint projects to fail?

- Lack of awareness – what technologies are available to them
- Lack of knowledge – If staff of company is lacking technical knowledge, it may not be able to capitalize on the technology being offered in the transfer
- Lack of funds – company may not be able to afford the development costs of the technology being transferred
- Lack of common interests – Individuals putting the interests of their own company ahead of the alliance
- Conflict of interest – Even in collaborations on the technical level or strong, it has been found that collaborations between competing companies doesn't work.



Barriers to Transfer (cont.)

- Lack of Trust – If little trust exists between companies, it is doomed to fail
- Poor communications – Fail to keep each abreast on everything relevant to the collaboration, activities, thoughts, processes, goals, direction of venture
- Lack of infrastructure – company may lack equipment and facility in infrastructure to take on the transfer
- Over-committed – The company may be over-committed on current projects and simply lacks the time needed for success.



Barriers – With Regard to Collaboration

- Technical Problems – which are generally overcome, but which add time and money and frustration
- Resource Limitation – Poor budget control
- Change in Project's Structure – Loss of key members or loss of partner
- Organizational Problems – due to a partner losing or changing interest in the technological side.

Evaluating the Technology

Large companies solicit proposal on new and innovative ideas. There will be well defined criteria for the assessment of new proposals

- Is proposal consistent with company strategy
- Any synergy with existing efforts on projects
- Have the risks, advantages, potential payoffs, and implications been considered in detail

Proposals may be evaluated by internal or external reviewers

For small companies, startups, they are contained in business plans.

Protecting Technology

IP plays a vital role in technology transfer. Those interested in the technology will want to hear that there is a strong IP position. If others have IP that is close to yours, this may muddy the waters!

- Patents
- Trade-Secrets
- Trademarks
- Copyrights
- Confidential Information

The Importance of IP cannot be over-emphasized

To Prototype or Not To Prototype, That is the Question

	Advantages	Disadvantages
Prototype	**Identify issues and potential problems**	**Expensive and time consuming**
No Prototype	**Save money & Time to market**	**Could miss design flaw, for example**

By prototyping you can minimize risk and uncertainty at the expense of cost and time

Prototyping

Assists in the following areas

- Planning of implementation
- Feasibility
- Clarification of necessary requirements
- Explore Options
- Improve product
- Improve understanding
- Verify Design
- Explore maintenance issues

Prototyping Risks

- Increased time-to-market (increased development)
- Prototyping too early
- Insufficient testing of materials (components)
- Lack of knowledge in new technical environment

Prototypes

A well designed prototype can help you to market your idea to potential partners.

Summary – Technology Transfer

- Innovation and Technology transfer is exciting, but it is a complex process

- Innovation and Technology transfer are a judicious mix of management and science, creativity with technology.

Trasferimento Tecnologico a UniCT

- **Fase 1** – Esame preliminare;
- **Fase 2** – Valutazione della Commissione Brevetti;
- **Fase 3** – Adempimenti interni;
- **Fase 4** – Affidamento del servizio consulenziale;
- **Fase 5** – Promozione e commercializzazione del brevetto.

Iter della procedura di cessione d’invenzione ad UniCT

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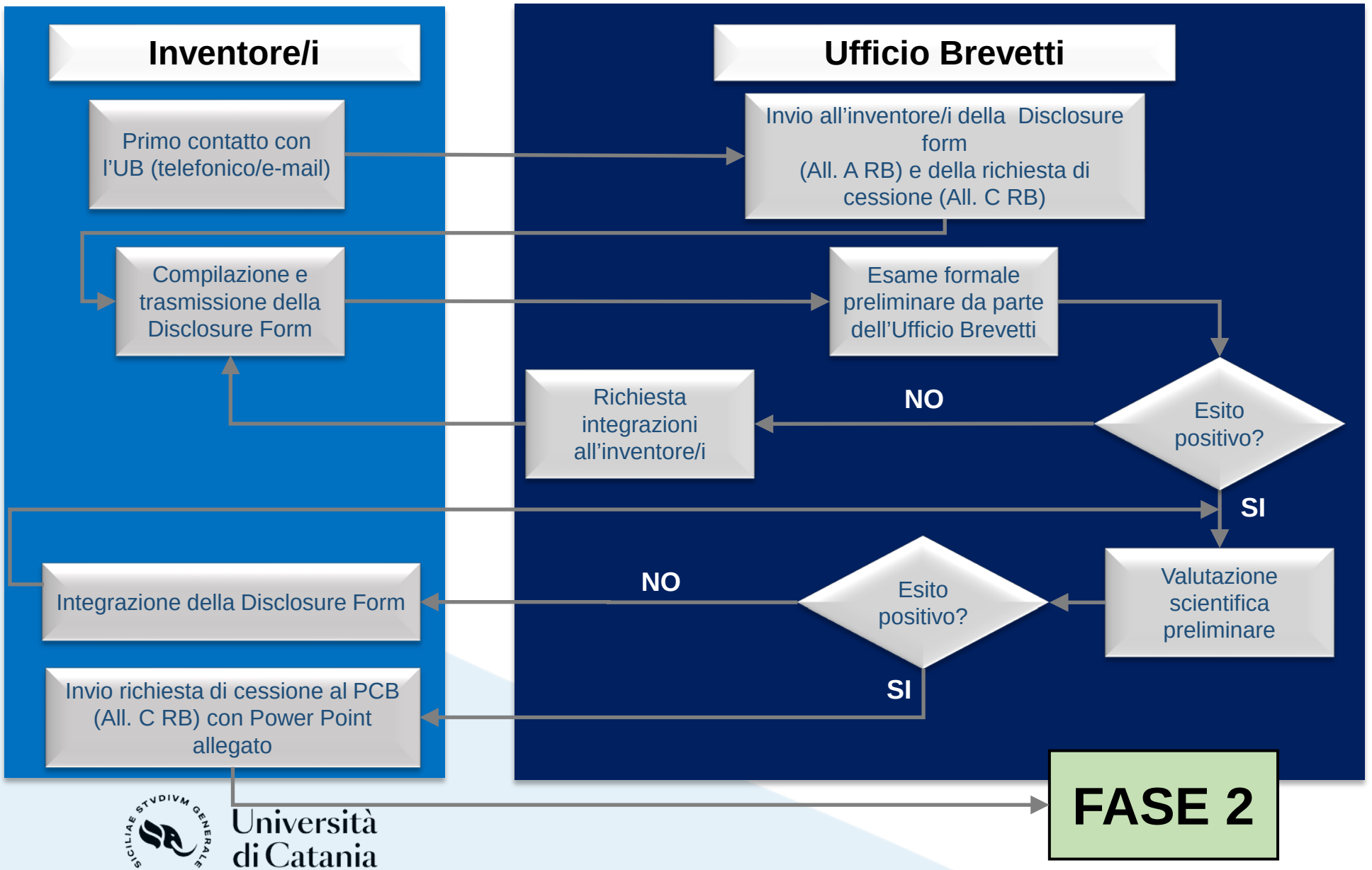
Fase 1 – Esame Preliminare



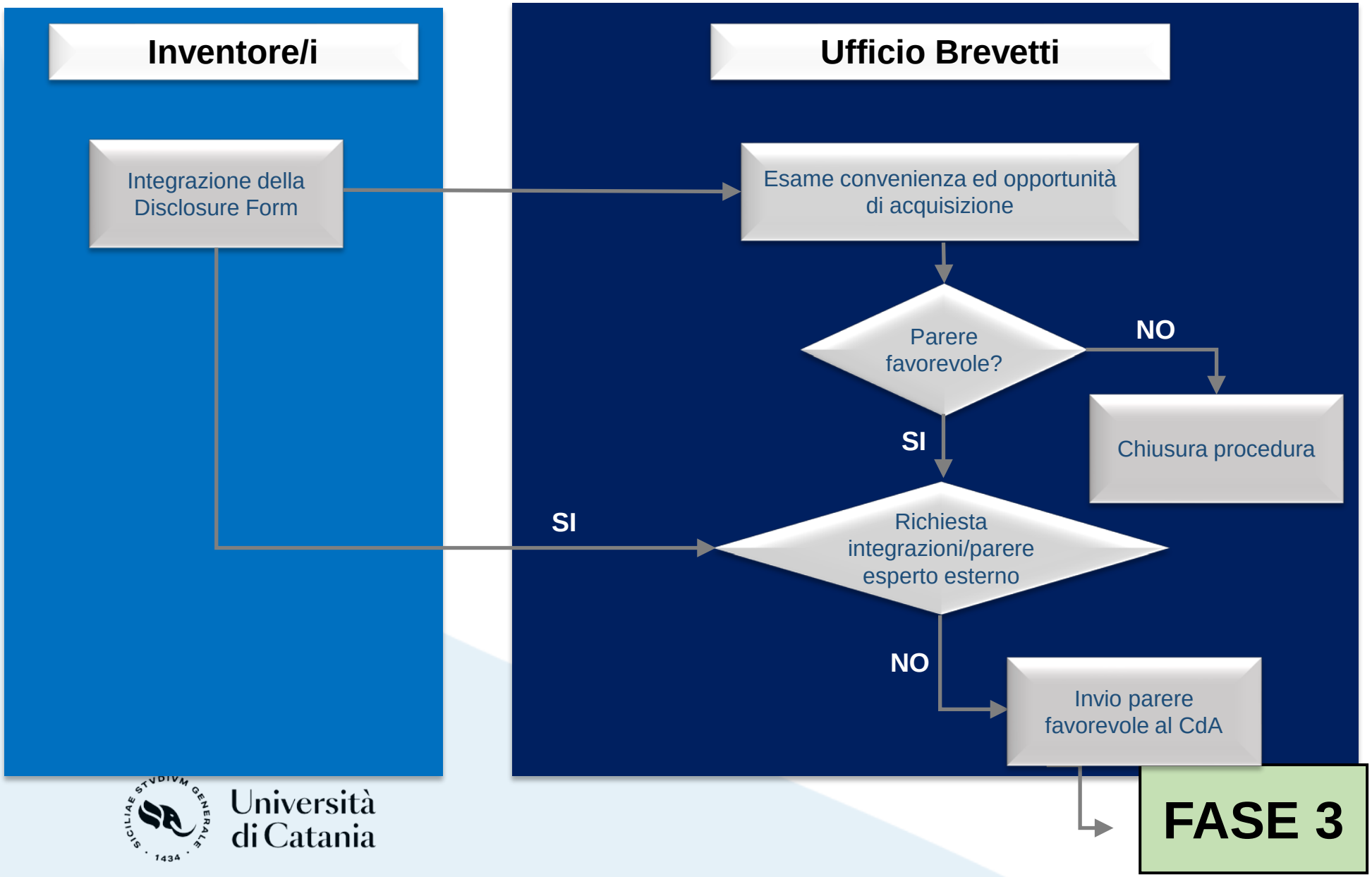
UB: Ufficio brevetti

RB: Regolamento Brevetti

CB: Commissione Brevetti

PCB: Presidente Commissione Brevetti

Fase 2 – Valutazione della Commissione Brevetti



CdA: Consiglio di Amministrazione

N.B.

SFRUTTAMENTO ECONOMICO

CASO 1: cessione a UniCT

50% agli Inventori

10% ai loro Dip.

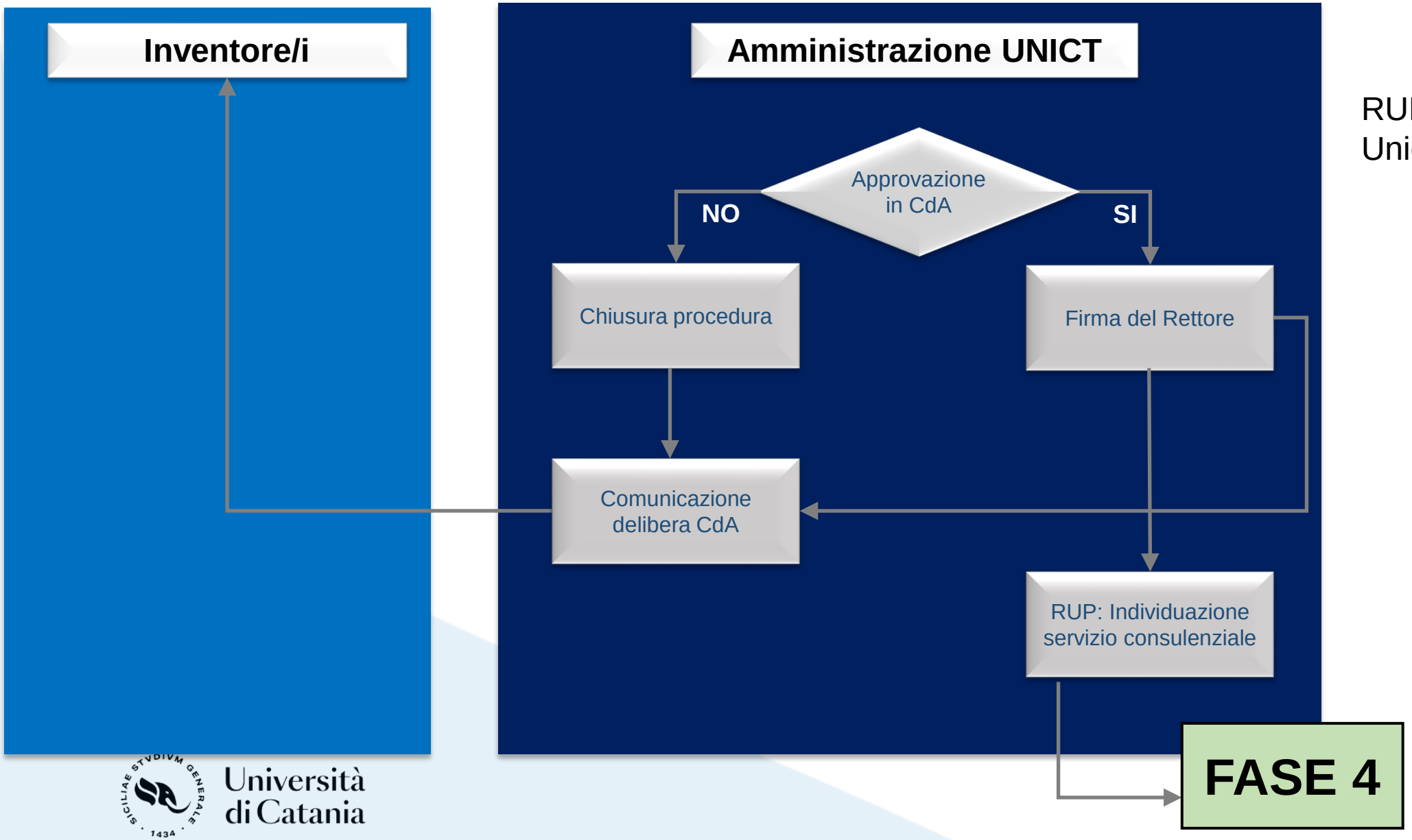
40% all'Ateneo;

CASO 2: NON cessione

50% agli Inventori

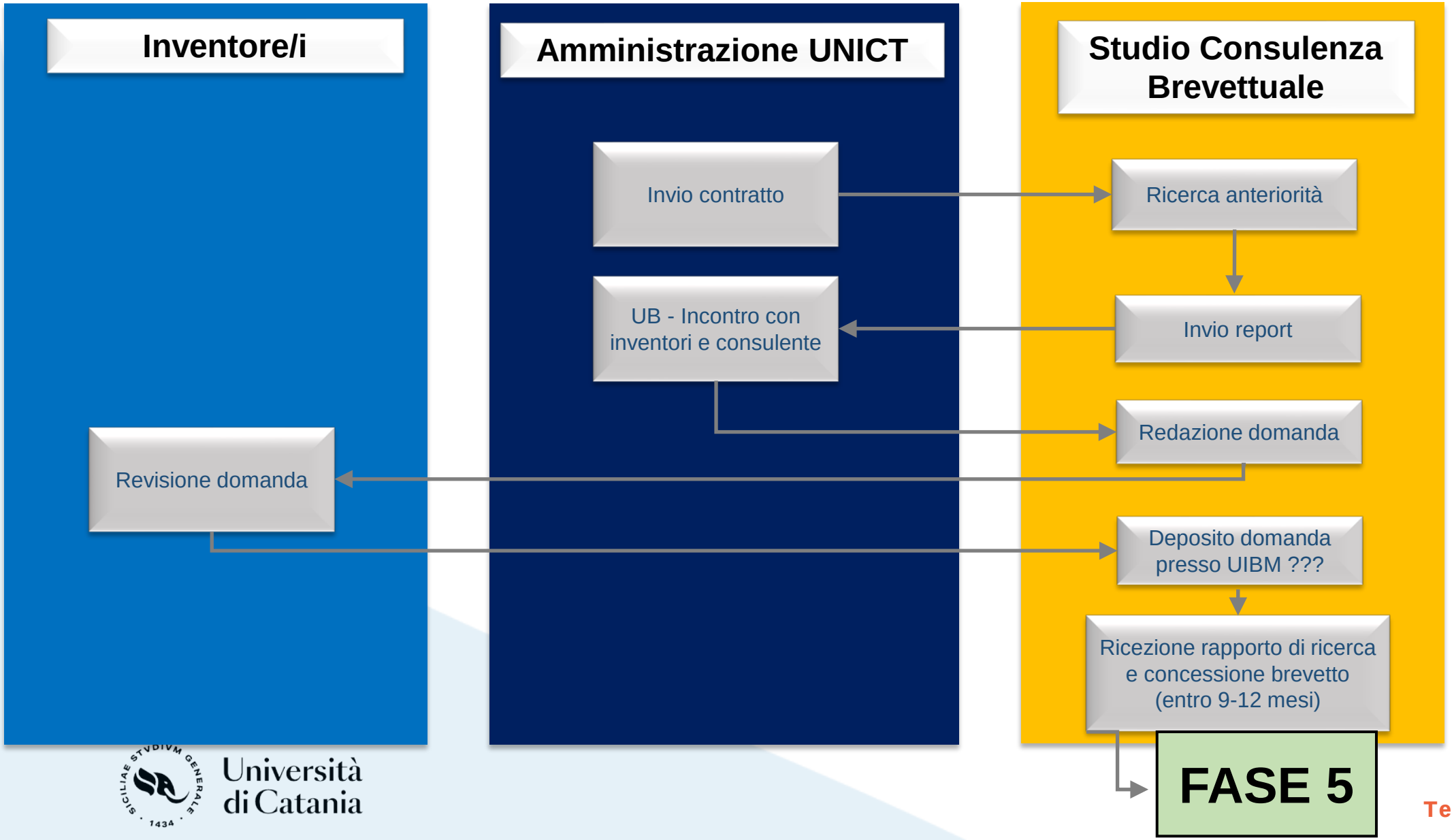
50% all'Ateneo;

Fase 3 – Adempimenti Interni

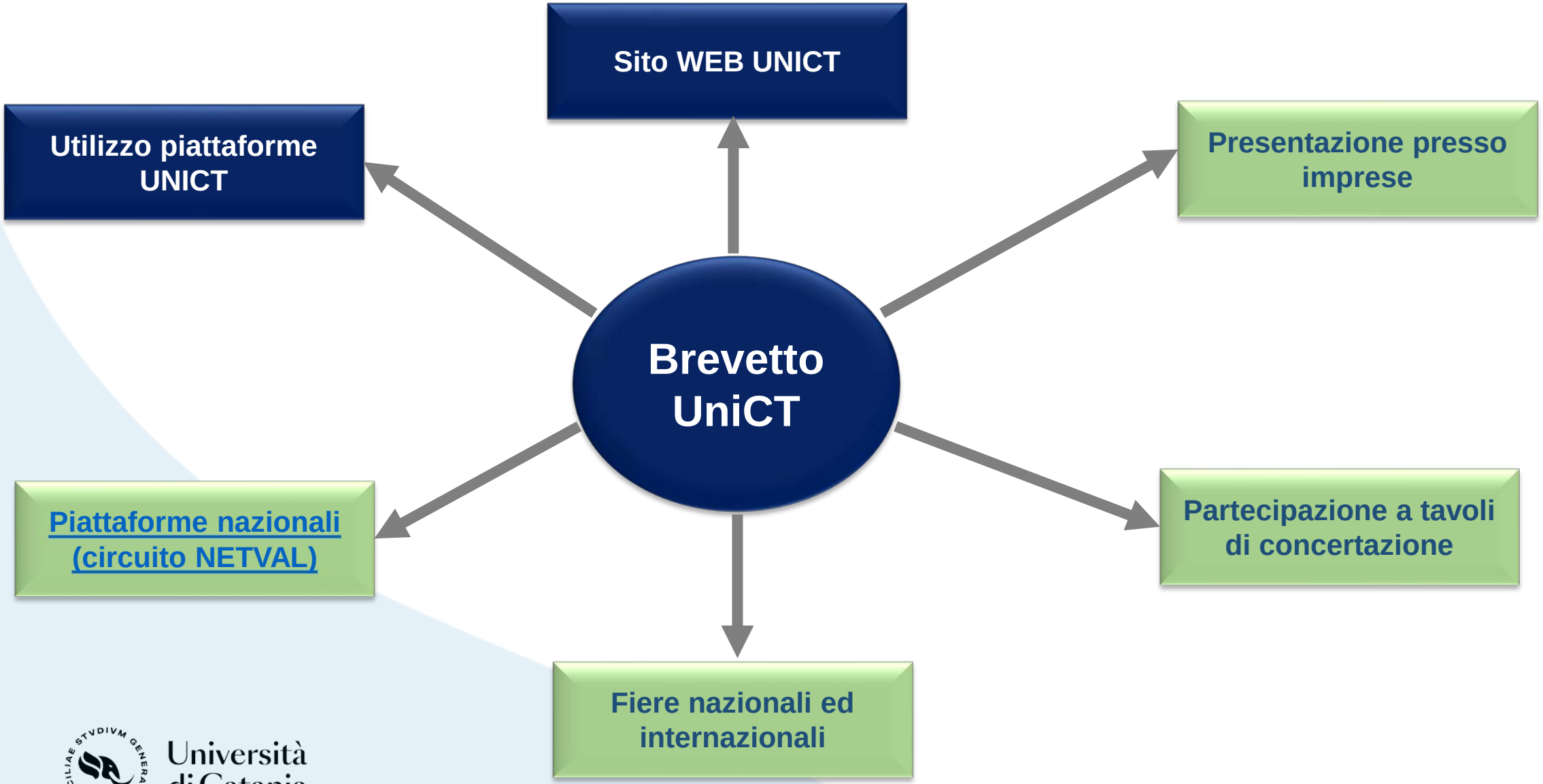


RUP: Responsabile Unico del Procedimento

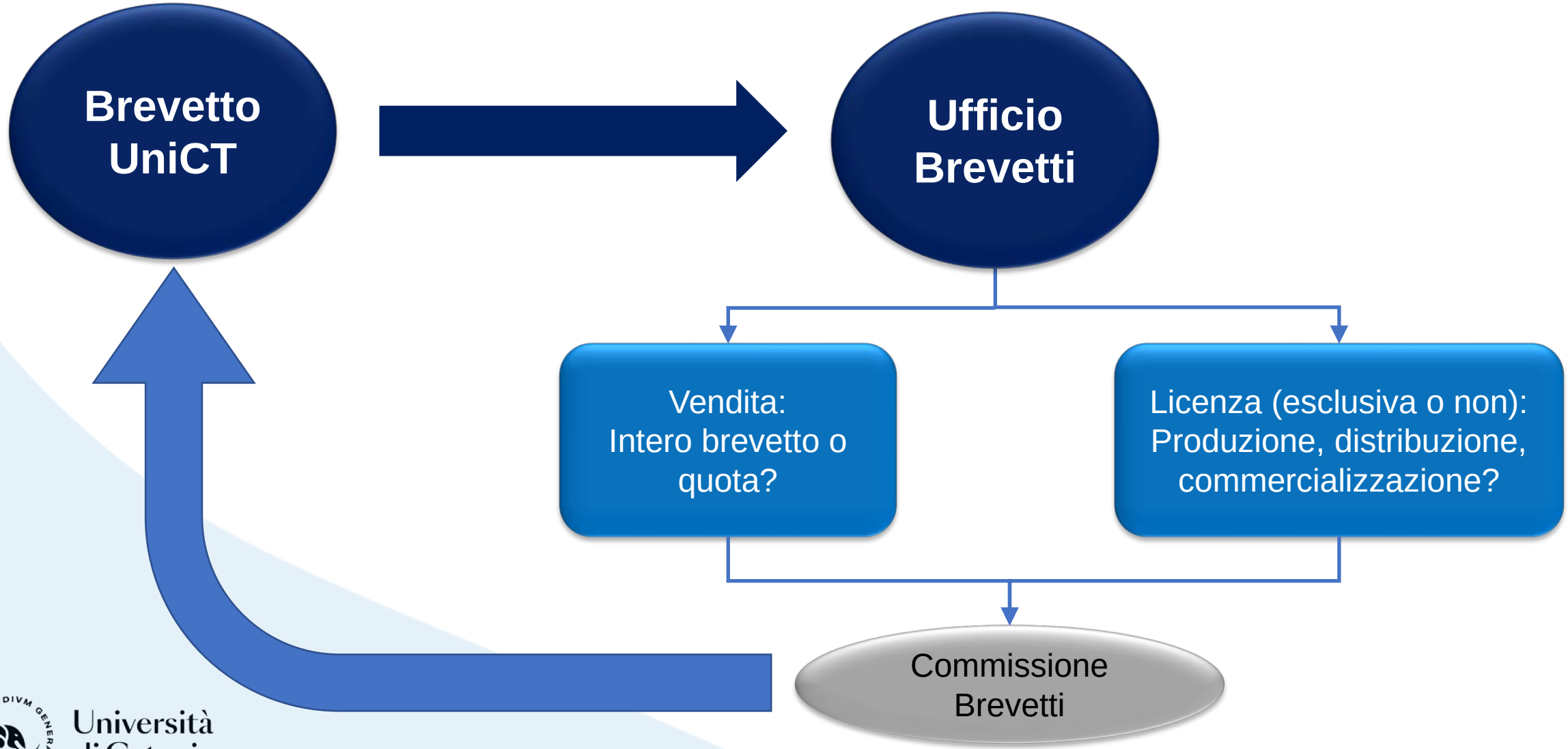
Fase 4 – Affidamento del Servizio Consulenziale



Fase 5 – Promozione del Brevetto UNICT



Fase 5 – Commercializzazione del Brevetto UNICT



… a voi il prossimo passo!

Università di Catania