Scenario Planning and Foresight 2018

Advancing Theory and Improving Practice

PROSPECTIVE SCENARIOS

Dynamic and Adaptive Technological Strategies for Enhancing Opportunities Generation in R&D under Uncertainty

MINISTÉRIO DA CIÊNCIA, TECNOLOGIA, INOVAÇÕES E COMUNICAÇÕES
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

EMBRAER

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MOTIVATION

- To leverage **RELEVANT OPPORTUNITIES** from uncertainties situations.

- To explore the alignment between

  TECHNOLOGICAL STRATEGY, PROSPECTIVE PROCESSES, AND BUSINESS VIEW,

  which is one of the greatest challenges for future competitiveness.

CONTRIBUTIONS

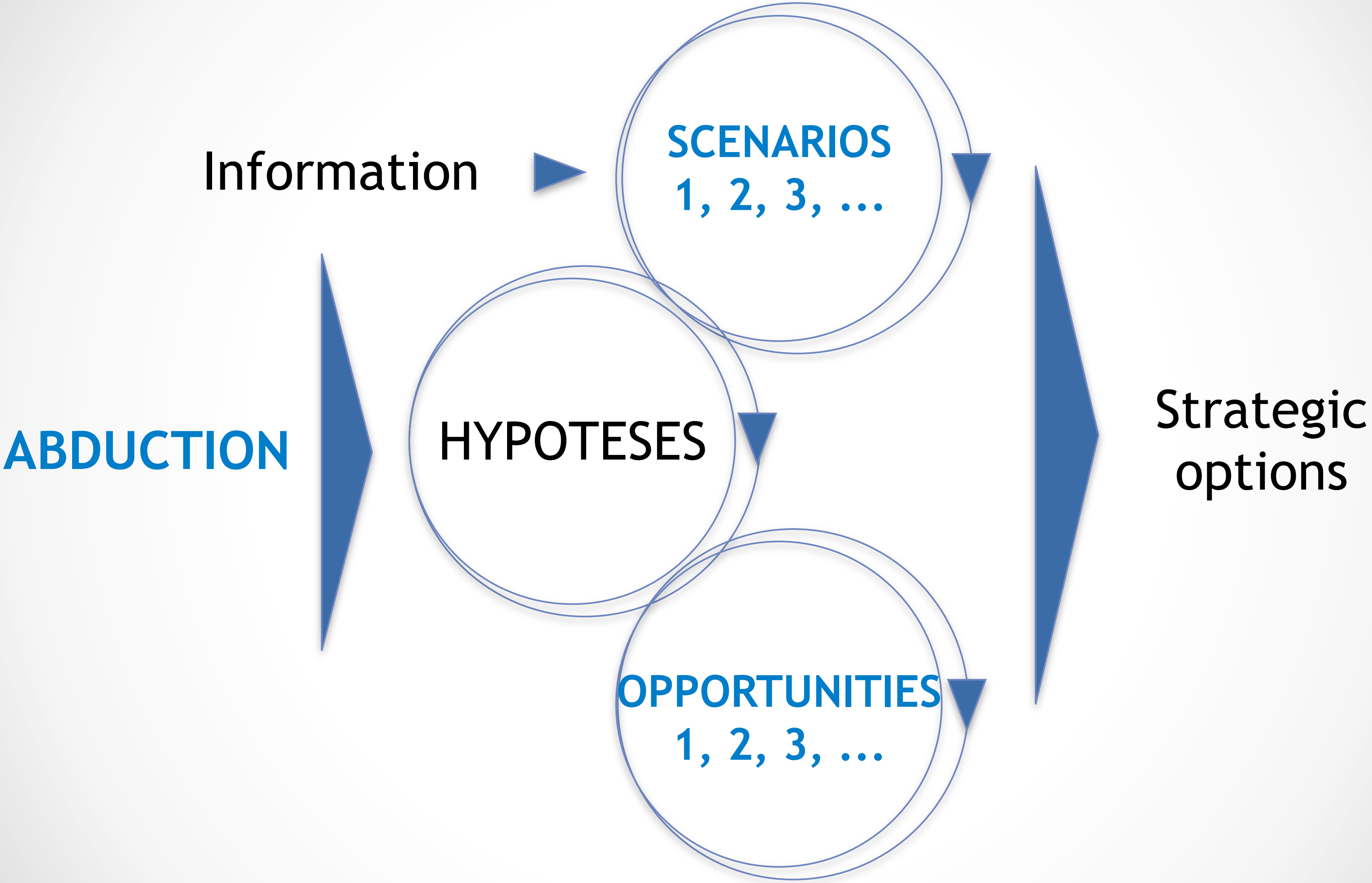
1. To propose an **ADAPTIVE DYNAMIC MODEL** that contributes to the technological development in the aerospace sector, and that allow to decision-makers to deal with uncertainty through **MORE FLEXIBLE STRATEGIES**.

2. To expand knowledge regarding the **TECHNOLOGICAL STRATEGY DEVELOPMENT** in a long-term horizon seeking to improve the **INVESTMENT PATTERNS** of organizations in different capacity development efforts.

3. To explore the characteristics of the **DECISION MAKING IN COMPLEX SYSTEMS**, through the expansion of the generative sensing concept to include seizing.

MAIN STRATEGIC CHALLENGES of an organization

- Dynamic Capabilities
- ability to cope with Deep Uncertainty

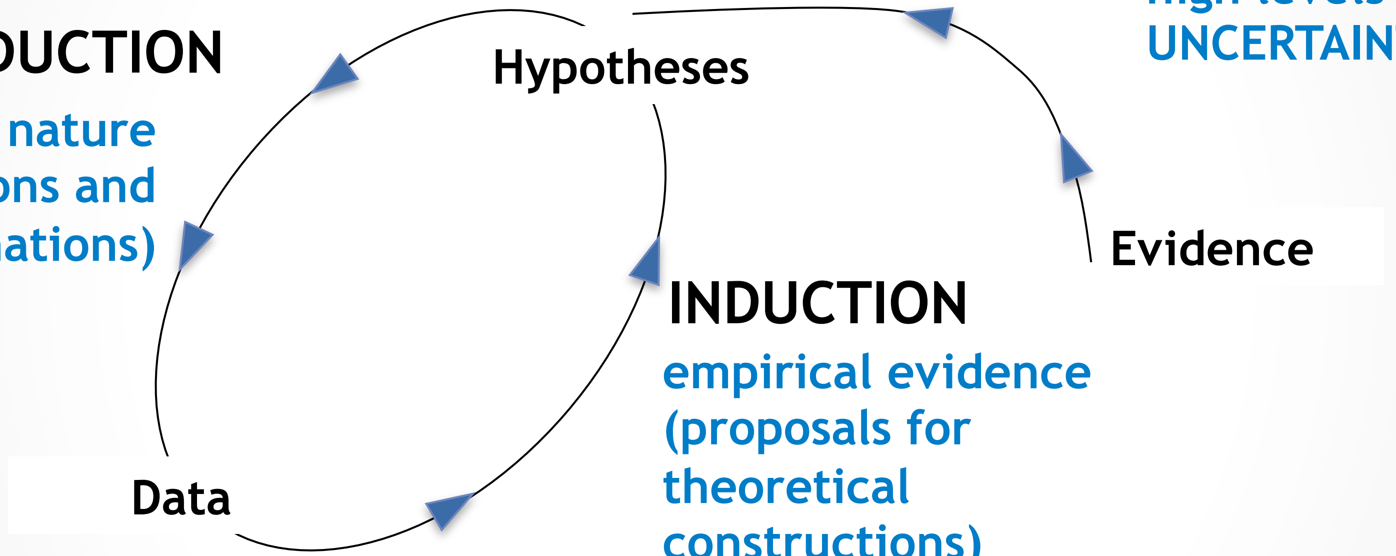

Information
SCENARIOS
1, 2, 3, ...
ABDUCTION
HYPOTESES
OPPORTUNITIES
1, 2, 3, ...
Strategic
options

ABDUCTION

INNOVATIVE proposals with high levels of UNCERTAINTY

DEDUCTION

laws of nature (predictions and explanations)

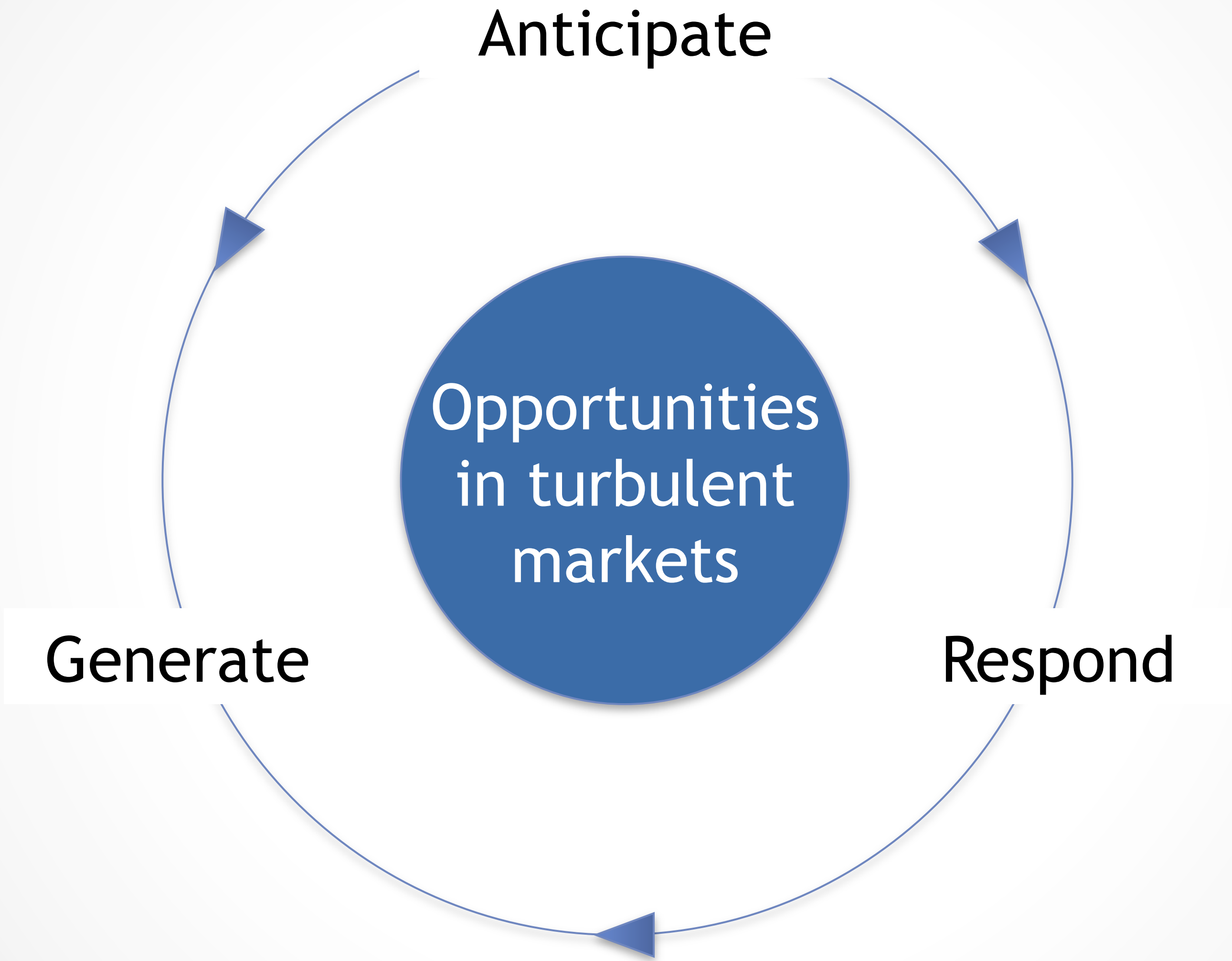


INDUCTION

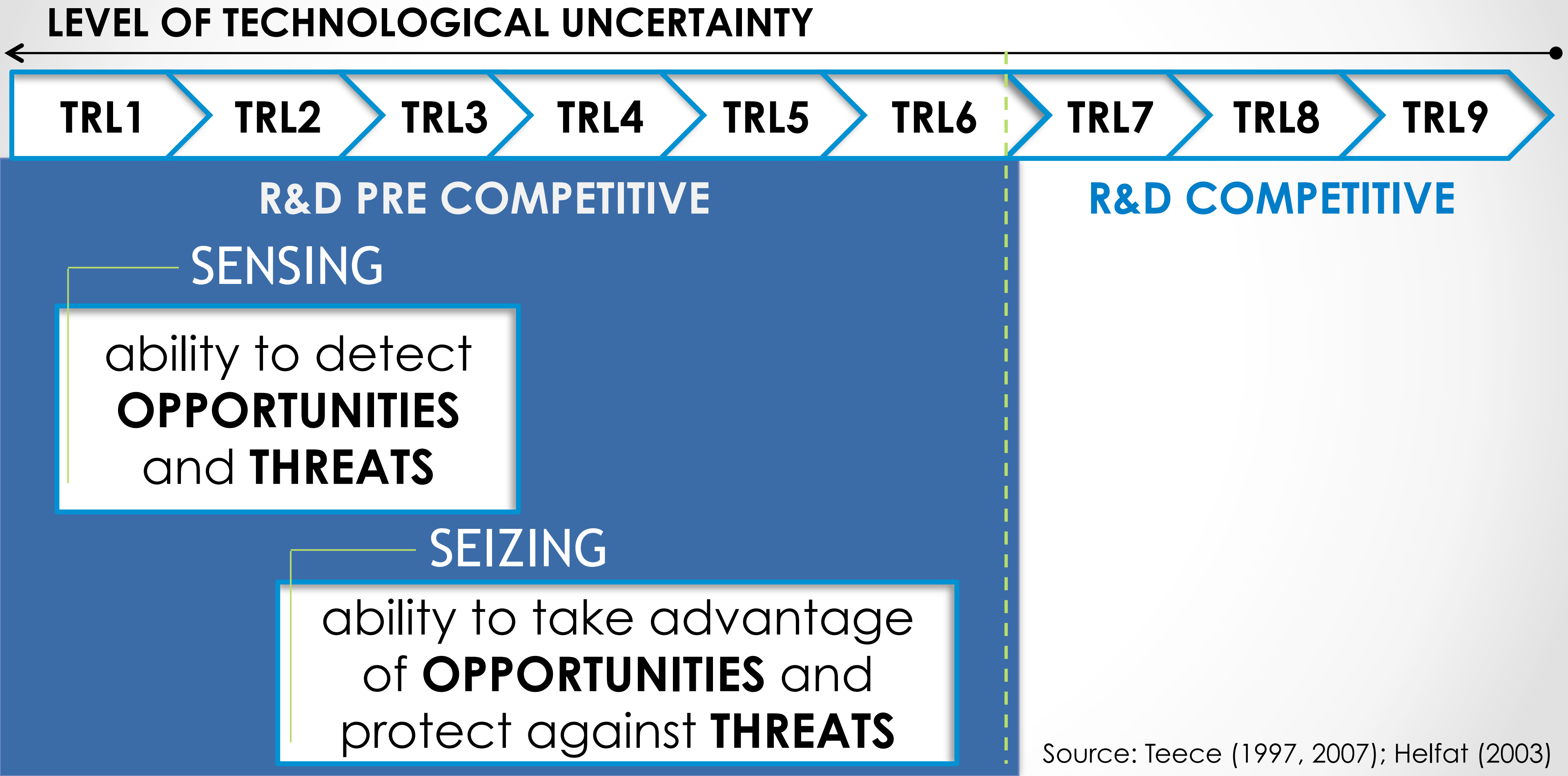
empirical evidence (proposals for theoretical constructions)

refers to past experiences	projected into the future
experimentation	exploration of new possibilities

Source: Peirce (1903)

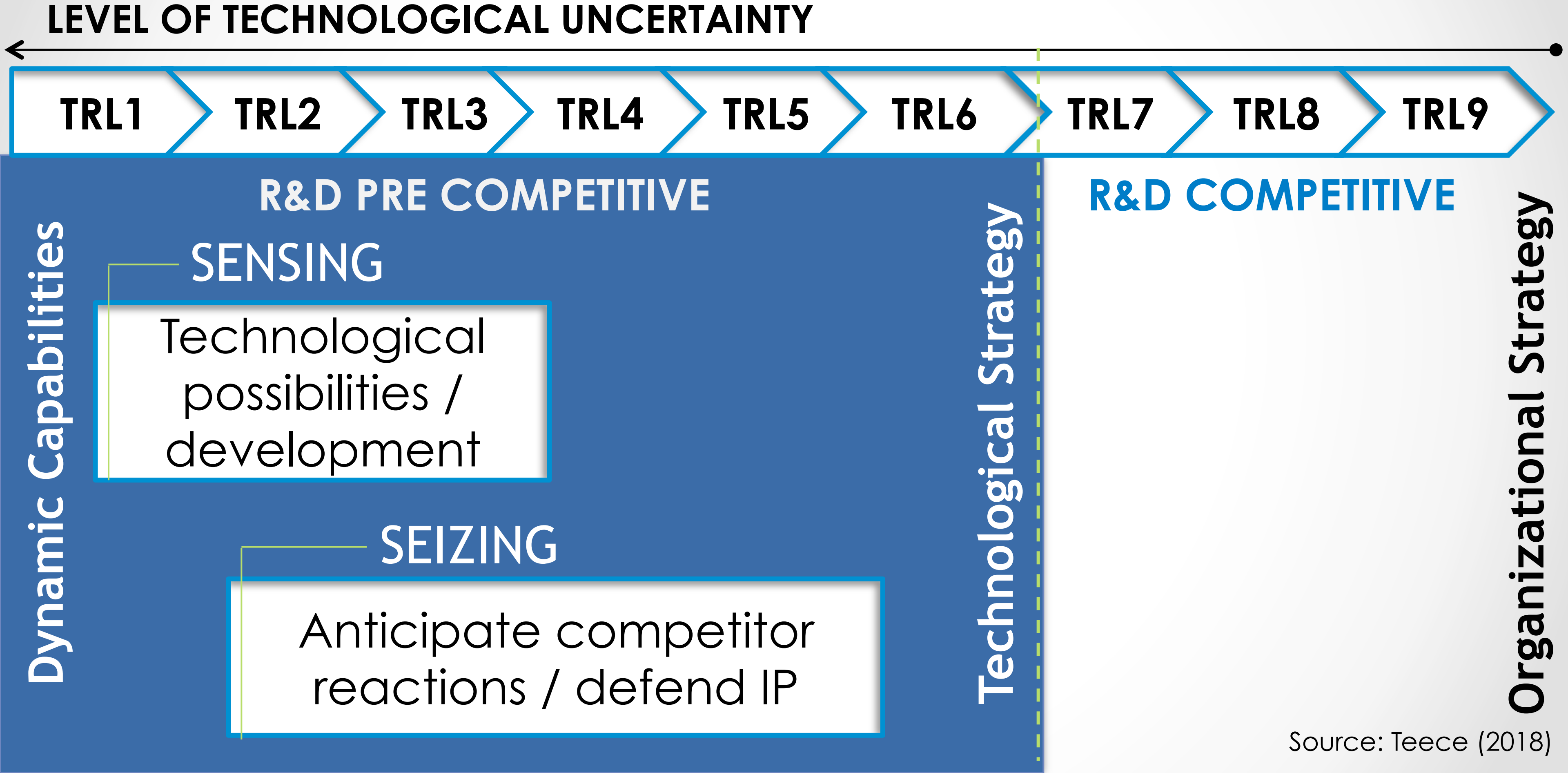

Anticipate
Opportunities in turbulent markets
Generate
Respond

TRL and DYNAMIC CAPABILITIES



Source: Teece (1997, 2007); Helfat (2003)

TRL and DYNAMIC CAPABILITIES

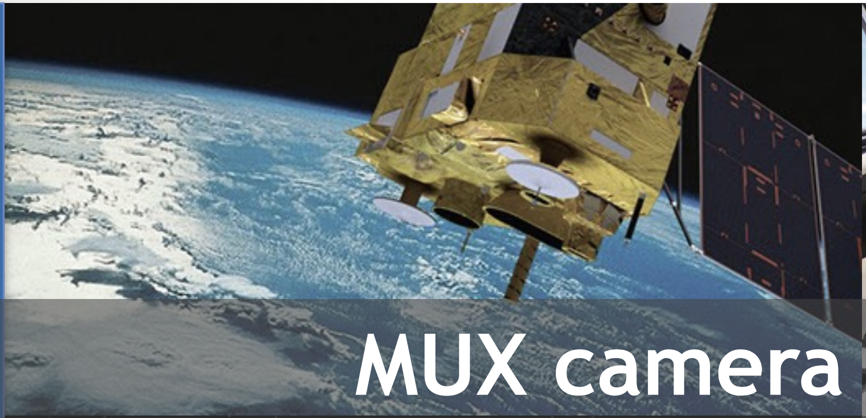


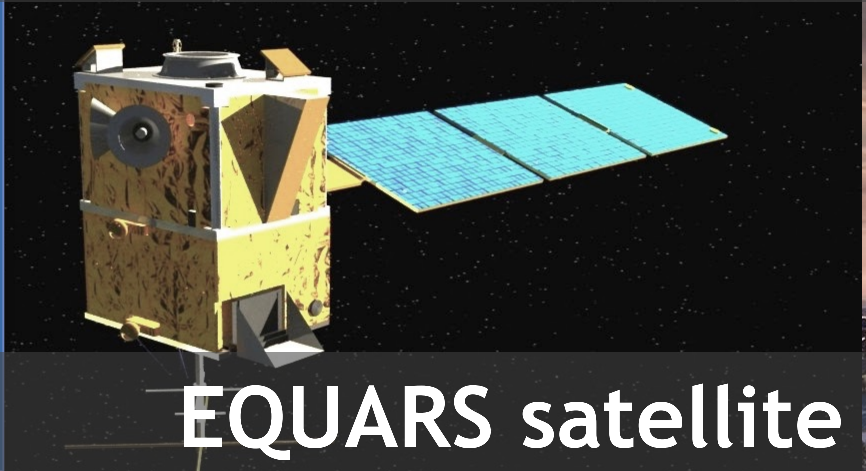
Source: Teece (2018)

RESEARCH METHODOLOGY

Multiple cases & Design science

INPE





EMBRAER

FLY BY WIRE

EMBRAER

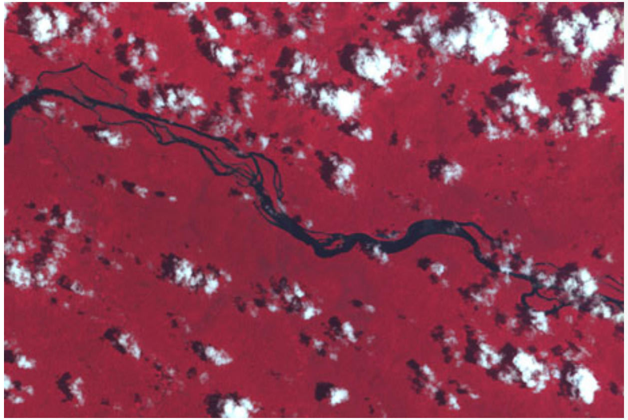
FLY BY WIRE is a system that controls flight command surfaces of airplanes through electronic signals transmitted to their actuators from embedded computers that read inputs of pilots (throttles, sticks, pedals and levers).

FLYING CARS

EMBRAER

FLYING CARS formally known as eVTOLs represent the milestones of the future of aviation.

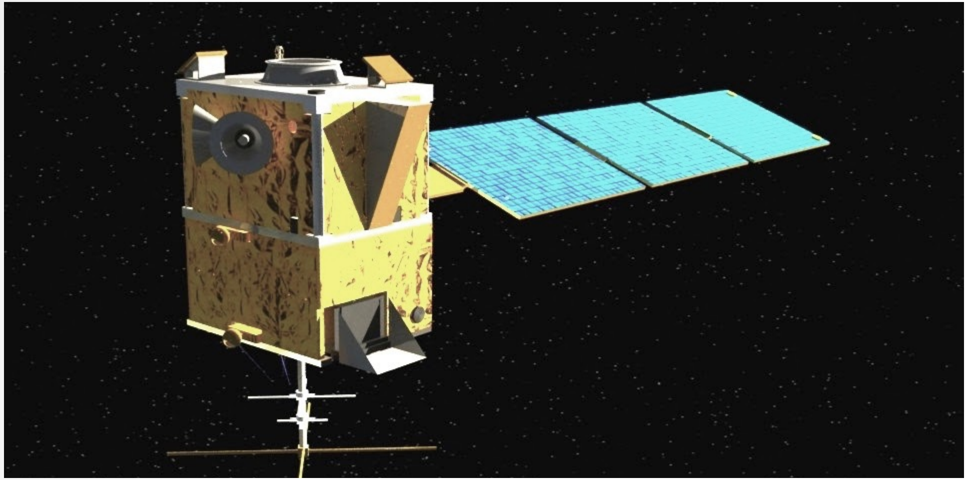
MUX CAMERA

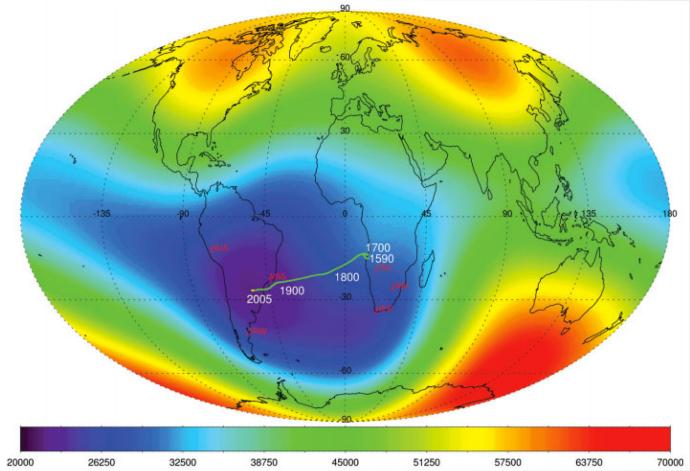


MUX CAMERA - INPE was responsible for developing a MUX (Multispectral) medium resolution camera after accumulating knowledge with the technological development of low resolution cameras for detection of fire and deforestation in the country.

EQUARS

INPE

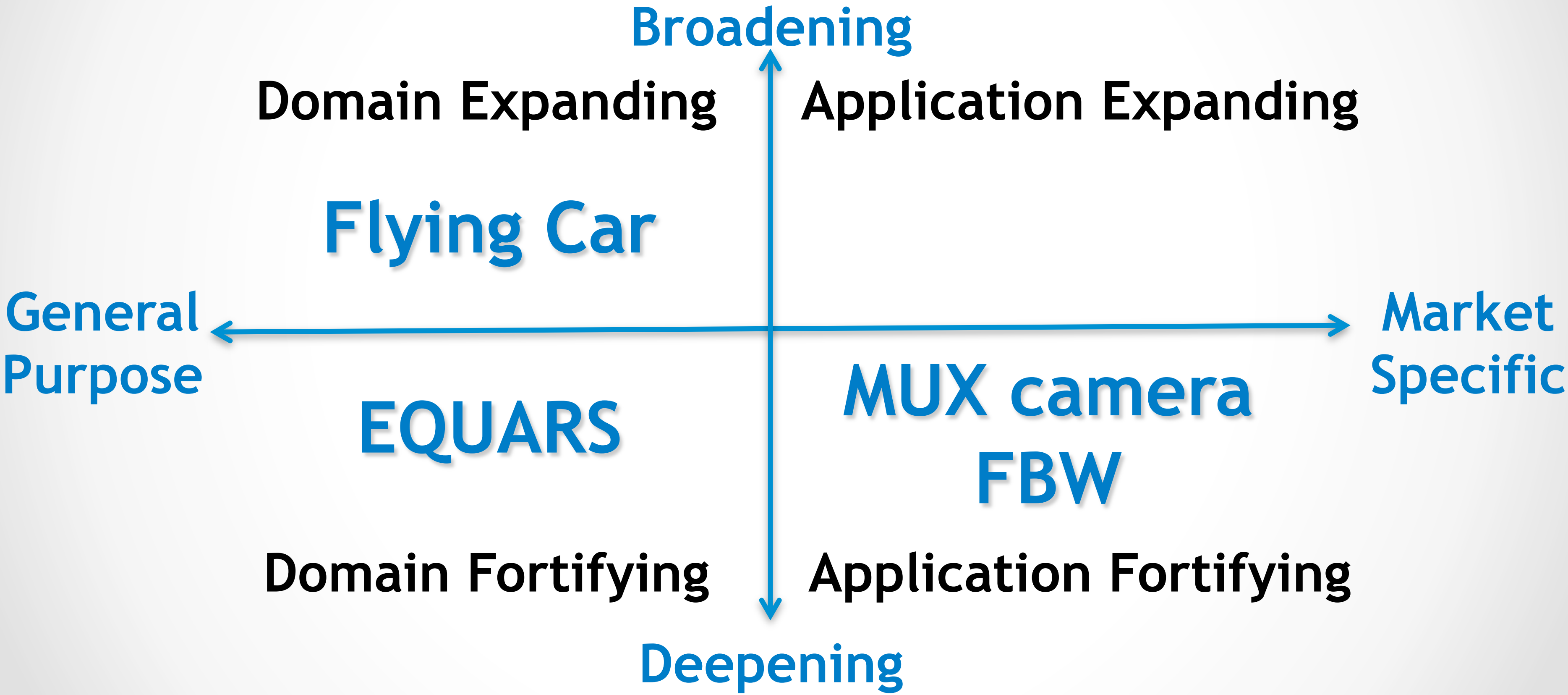




EQUARS is a scientific satellite that is being developed with the objective of creating new technologies to generate the best understanding regarding AMAS (South Atlantic Magnetic Anomaly).

CAPACITY DEVELOPMENT

critical choices map



Source: Pisano (2017)

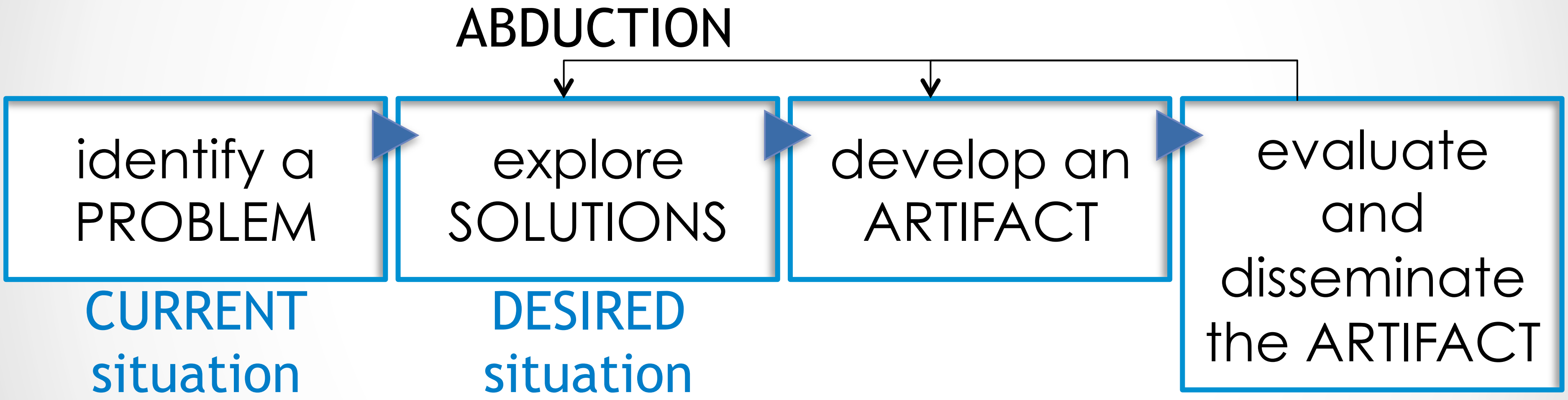
RESEARCH METHODOLOGY

MULTIPLE CASES & Design science

1. Influence of **uncertainty factors** in the decision-making process regarding the development of the technological basis of the organization;
2. **Decision criteria** considered in the evolution of the technological domains and the impacts of this decision for the competitiveness of the organization;
3. How the **emerging properties** of these technologies influenced organizational learning in the technology development processes.

RESEARCH METHODOLOGY

Multiple cases & DESIGN SCIENCE

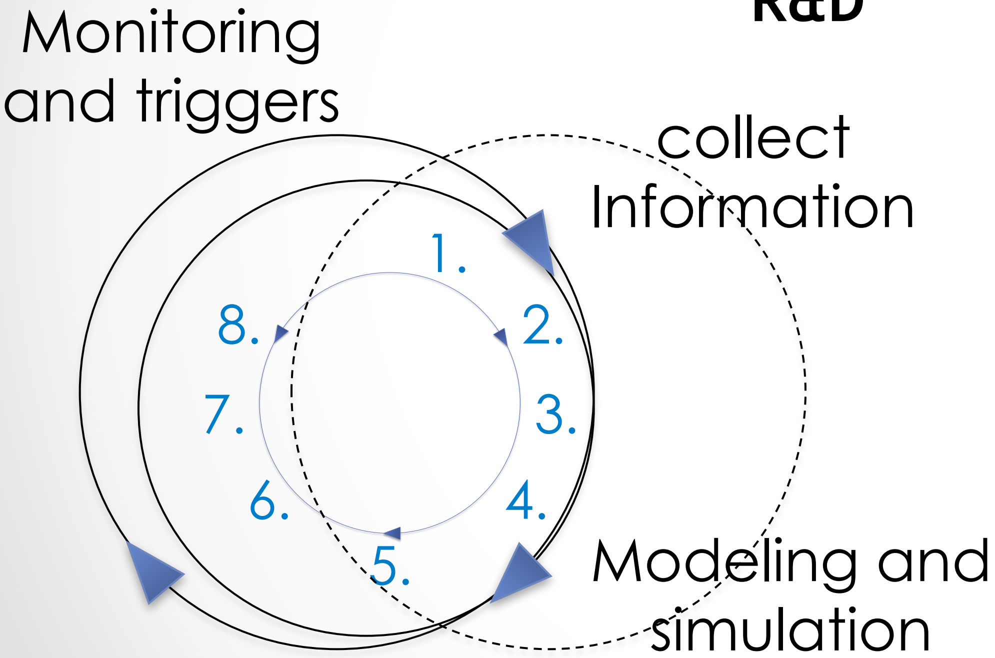


KNOWLEDGE
building

Source: Simon (1996)

DYNAMIC ADAPTIVE APPROACH

under deep uncertainty



It is important to **REPEAT THE PROCESS** along the evolution of TRL levels.

Source: adapted from Marchau, Walker, Van Wee (2010); Haasnot, Kwakkel, Walker, Maat (2013) ; Kwakkel, Pruyt (2013)

Technology Readiness Level (TRL)

degree of technological maturity, difficulty of development and importance of technology for the success of the program

	TRL3	TRL4	TRL5	TRL6
performance parameters	initials	improved	better	goals achieved
phases of R&D	initial	intermediary	system architecture definition	final decisions on system development
CONCEPTUAL UNCERTAINTY	**HIGH**		**AVERAGE**	**LOW**
	Individual Component Tests	High-fidelity system	Laboratory Demonstration	Field Demo

MODELING & SIMULATION

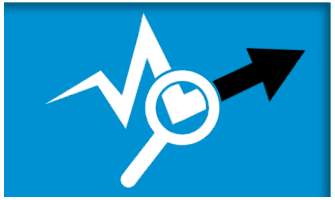
Source: adapted from Mankins (2009)

1. Current situation
2. Problem analysis
3. Hypothesis generation
4. Scenarios 1, 2, 3, 4, ... n
5. Contingency & Triggers
6. Technological strategy
7. Implementation
8. Monitoring

1. CURRENT SITUATION

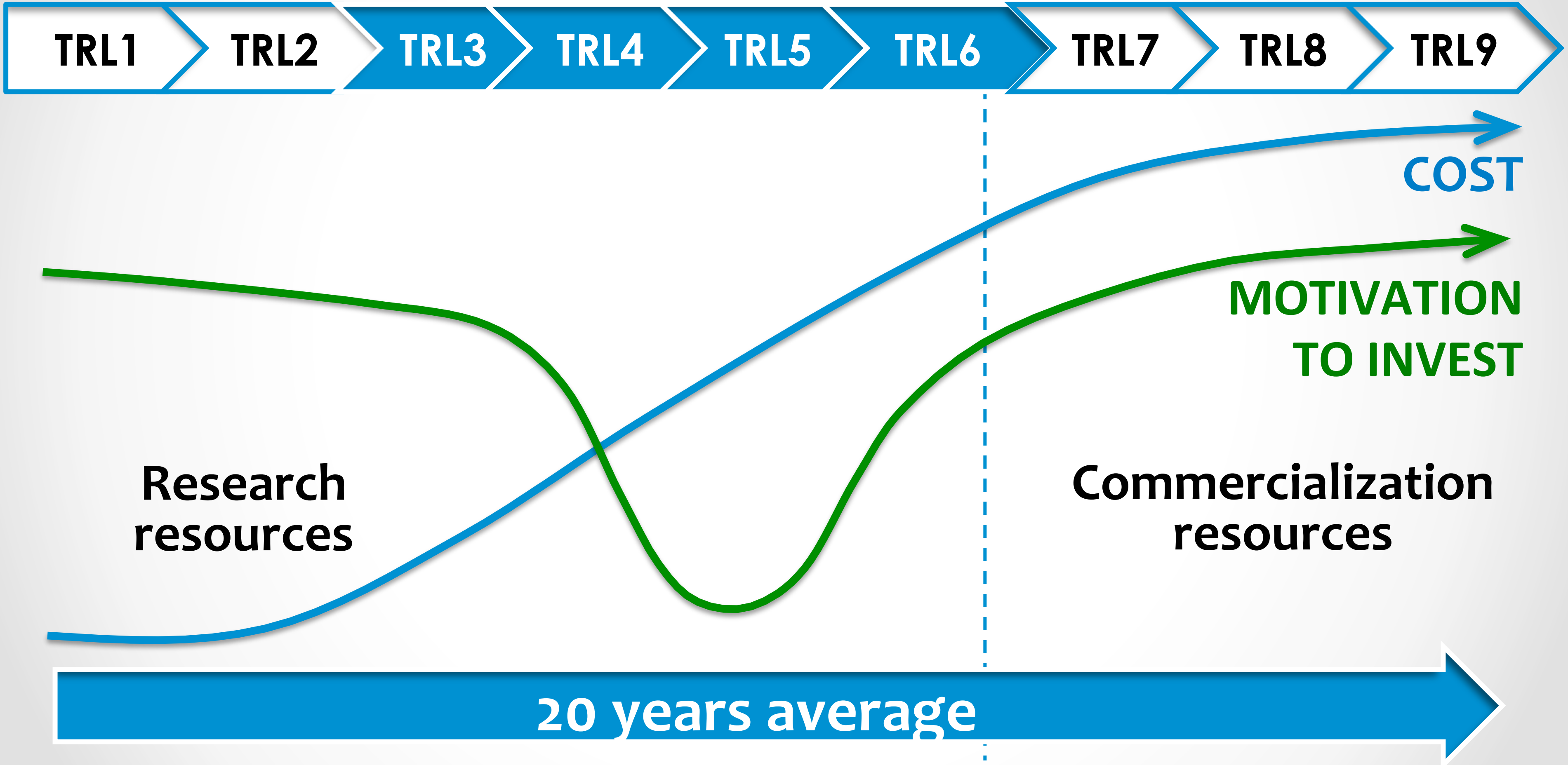
Analysis of the CURRENT SITUATION that includes the survey of the main expectations, trends and uncertainties.

2. PROBLEM ANALYSIS



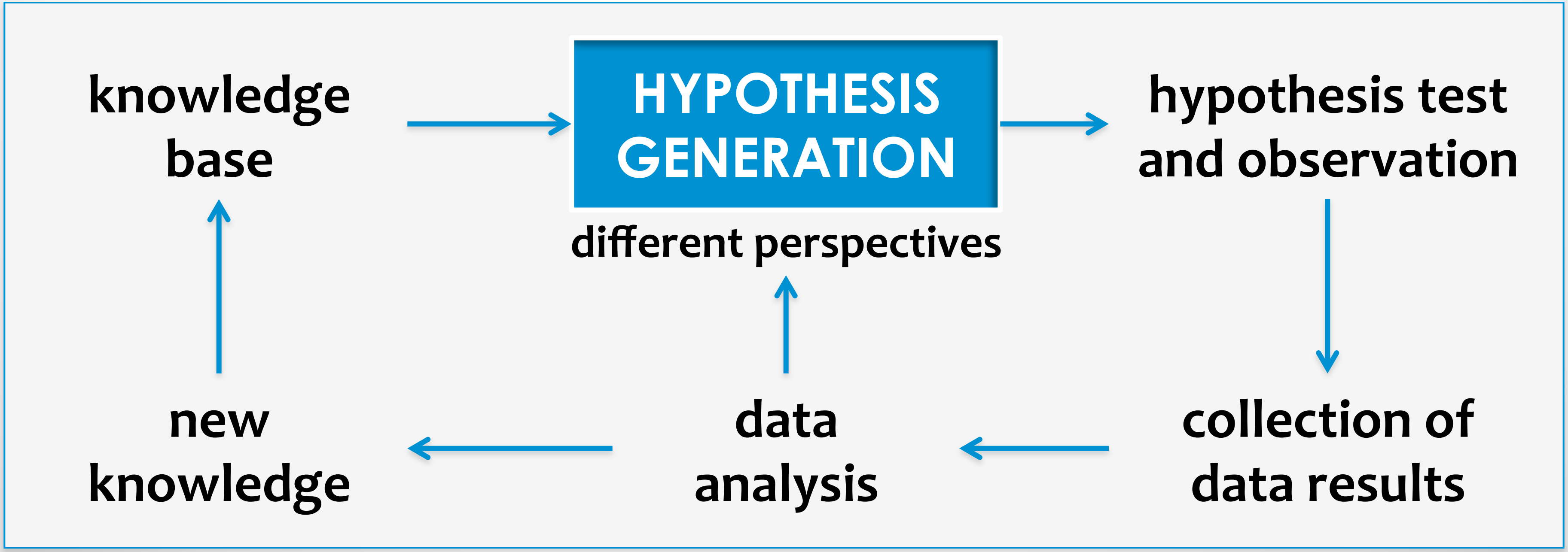
This step focus on PROBLEM ANALYSIS, vulnerabilities and opportunity for the organization, always trying to identify technological gaps.

2. PROBLEM ANALYSIS

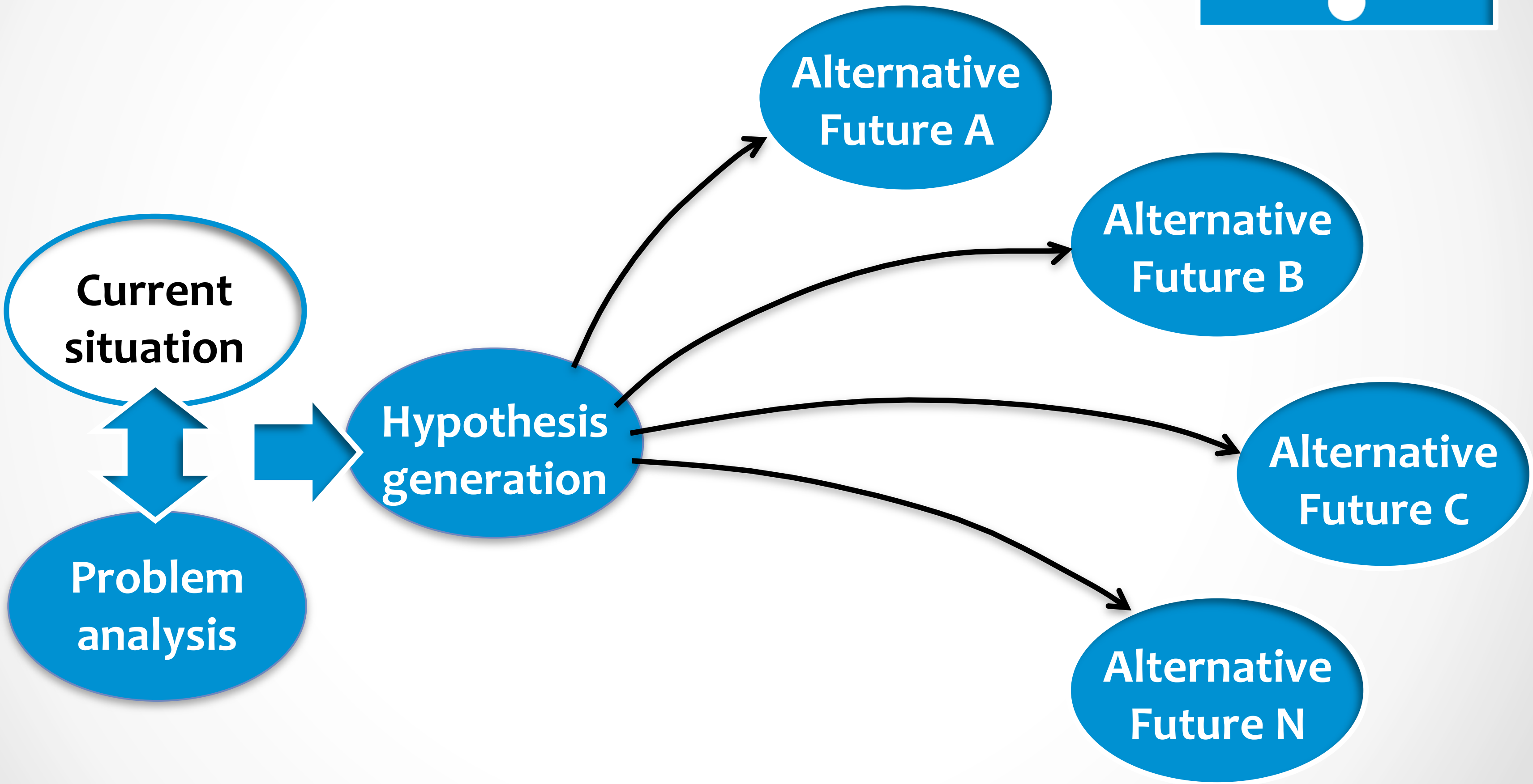


3. HYPOTHESIS GENERATION

The main objective of this step is TO GENERATE DIFFERENT PERSPECTIVES.



4. SCENARIOS


Current situation
Problem analysis
Hypothesis generation
Alternative Future A
Alternative Future B
Alternative Future C
Alternative Future N

5. CONTINGENCY AND TRIGGERS

Any corrective action should seek the STRATEGIC ADAPTATION if the future becomes different than expected.

In this step, the INFORMATION TO BE MONITORED must be DEFINED for a good definition of the TRIGGERS.

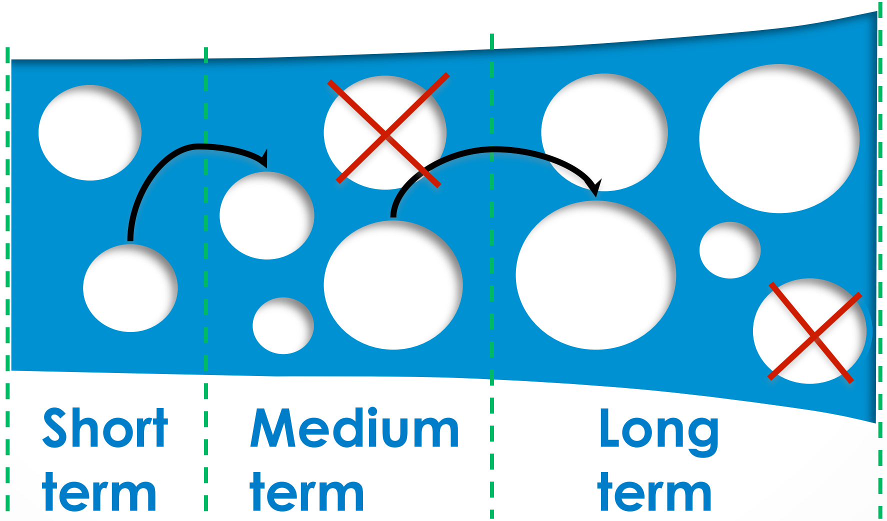
6. TECHNOLOGICAL STRATEGY

The strategic actions should answer some questions: (1) considering a set of scenarios and uncertainties, what strategic actions should be taken NOW and which can be POSTPONED?

The CHALLENGE is to develop a technology strategy to KEEP THE OPTIONS OPEN during most of the time.

7. IMPLEMENTATION

At this stage, strategic actions are IMPLEMENTED and PRIORITIZED in short, medium and long-term horizons.



8. MONITORING

This dynamism related to monitoring system and triggers gives FLEXIBILITY to the system.

CONCLUSIONS

- The study shows that it is essential to consider **HOW INDIVIDUAL COGNITIVE CAPACITIES MIGRATE TO A COLLECTIVE DECISION-MAKING PROCESS** that will verify the dynamics of capacity creation.

- The paper addresses the dynamics of innovation through the exploration of cases in the Brazilian aerospace industry, and **SEEKS TO IMPROVE OUR UNDERSTANDING ON THE INFLUENCE OF COMMERCIAL, TECHNOLOGICAL, SYSTEMIC AND EPISTEMIC UNCERTAINTIES** on the organizational decision-making process.

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