



# Risk Reduction and Opportunity Exploitation through TRIZ-based Technology Forecast

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Politecnico di Milano

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- Established in 1863
- Organized in 12 departments (devoted to research) and a network of Schools of Engineering, Architecture and Industrial Design spread over 7 campuses over the Lombardy region
- Ranked as one of the most outstanding European technical universities
  - ❖ 48<sup>th</sup> World Engineering & Technology 2012
  - ❖ 14<sup>th</sup> Europe Engineering & Technology 2012
  - ❖ 1<sup>st</sup> Italy Engineering & Technology 2012





## Architecture

Professors & Researchers

293

Students

9,153

## Design

Professors & Researchers

118

Students

3,749

## Engineering

Professors & Researchers

935

Students

24,998

17% of Italian architects graduated from Politecnico di Milano

56% of Italian designers graduated from Politecnico di Milano

16% of Italian engineers graduated from Politecnico di Milano

- 1999 : PhD in Machine Design – First acquaintance with TRIZ
- 1999 – 2008 : Assistant Professor at University of Florence
- 2008 – now : Associate Professor at Politecnico di Milano
  
- Past:
  - ❖ 2003-2005 : Founder and first President of Apeiron, the Italian TRIZ Association
  - ❖ 2005-2009 : Founder and Vice-Chair of the IFIP 5.4 Working Group (Computer-Aided Innovation)
  - ❖ 2006-2009 : President of the European TRIZ Association
  
- Currently:
  - ❖ Coordinator of the Marie Curie Project IAPP (PIAP-GA-2011-286305):  
**FORMAT (FOrecast and Roadmapping for MAnufacturing Technologies)**
  - ❖ Member of the Editorial Board of the **Journal of Integrated Design & Process Science**
  - ❖ Member of the Editorial Advisory Board of the **International Journal of Design Creativity and Innovation**
  - ❖ Member of the **ETRIA** Executive Board
  - ❖ Chair of the **Computer-Aided Innovation** workgroup and Publications and Events Officer of the TC-5 Committee (Computer Applications in Technology) of IFIP (International Federation for Information Processing)
  - ❖ Author of **120+ papers** presented at International Conferences and published in authoritative Journals
  - ❖ Author of **13 patents** (assignees University of Florence, Whirlpool Europe, Bracco Imaging, Logli, SCAM, Meccaniche Fiorentine, Otlav, Politecnico di Milano, Saes Getters, Rold)



# Outline

## ■ Introduction

- ❖ Innovation, opportunities and threats
- ❖ Innovation, Market and the Society

## ■ Anticipating future innovations

- ❖ Technology Forecasting, scope and approaches
- ❖ TRIZ-based Technology Forecasting

## ■ FORMAT project

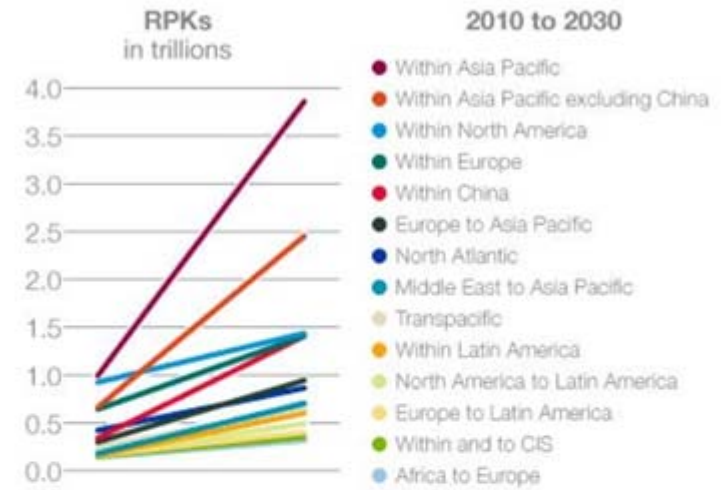
- ❖ Aims and partners
- ❖ Reference models and partial achievements
- ❖ Case Study: Chilean Mining Industry

## ■ Conclusions



## Technology Forecasting:

### Forecast summary Passenger traffic development



### Current Market Outlook 2011-2030



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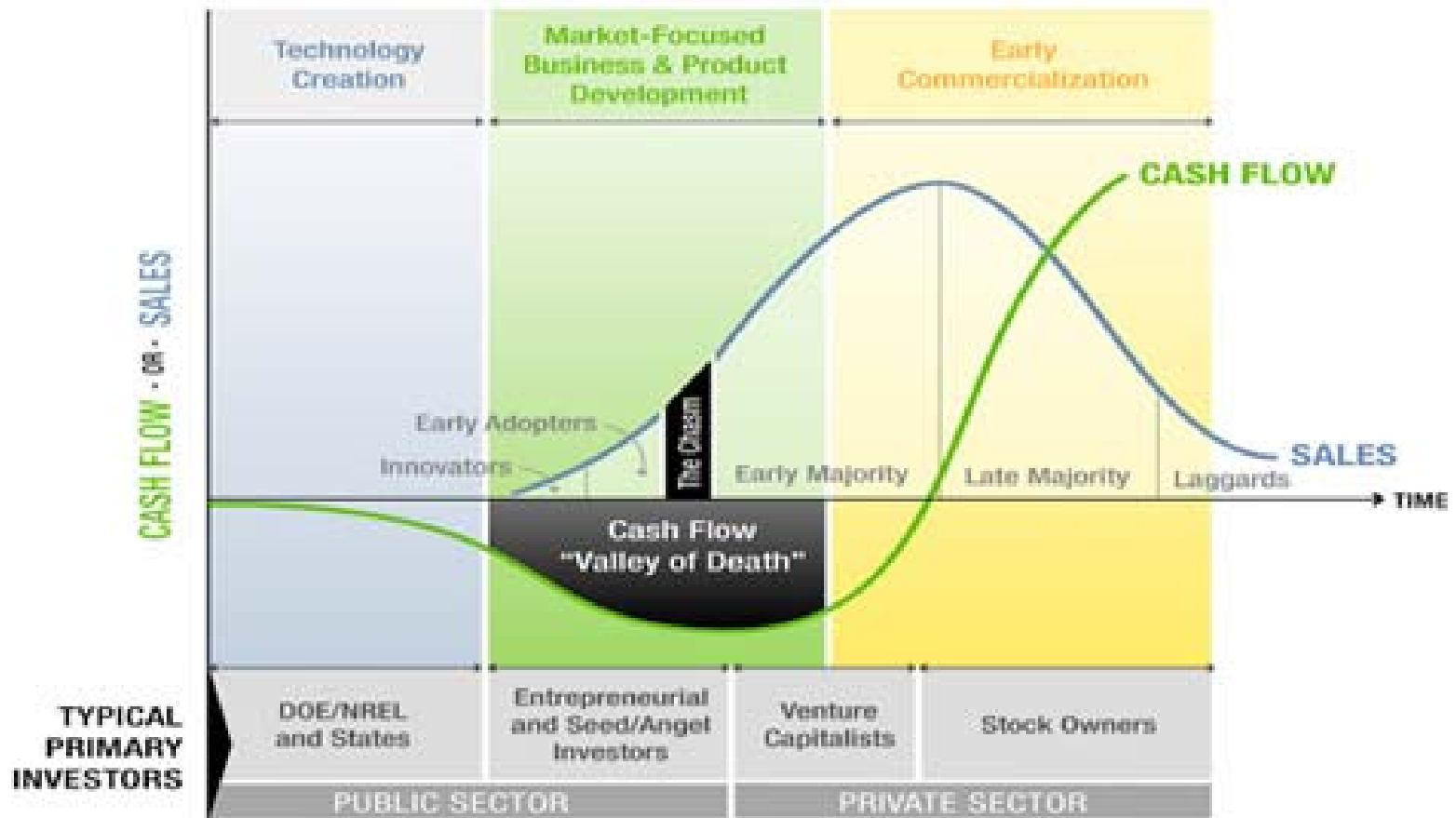
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### 2011-2030 Current Market Outlook



## ■ Innovation, Opportunities and Threats

❖ From basic research, to market exploitation

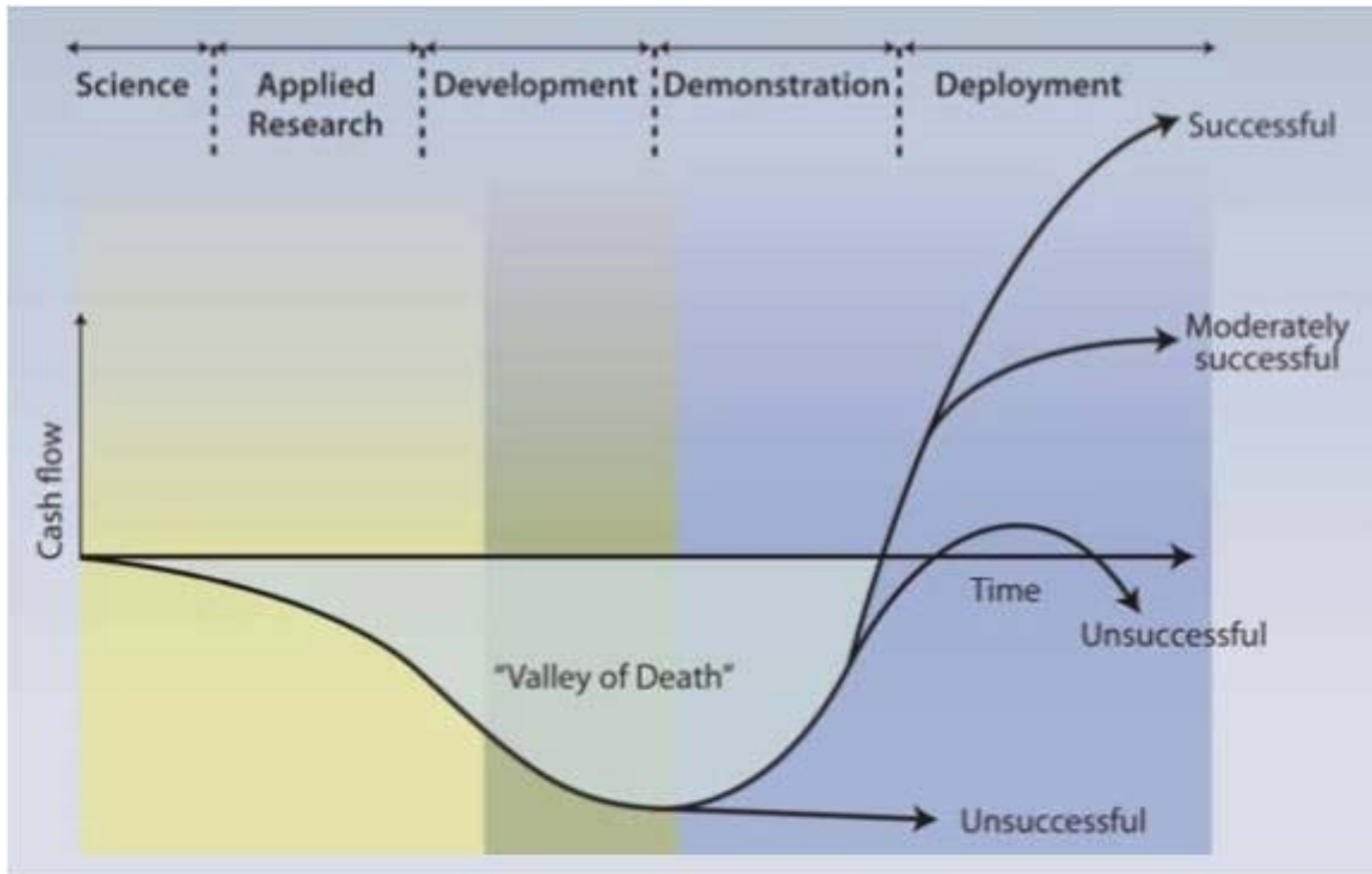


source: US Dept. of Energy

# Introduction

## ■ Innovation, Opportunities and Threats

❖ From basic research, to market exploitation



source: ca.gov



# Introduction

## ■ Innovation, Market and the Society

### ❖ Role in the Society and time perspective



Businessman

next  
1 ÷ 4  
quarters



Politician

next  
1 ÷ 4  
years



Scientist

next  
1 ÷ 4  
decades

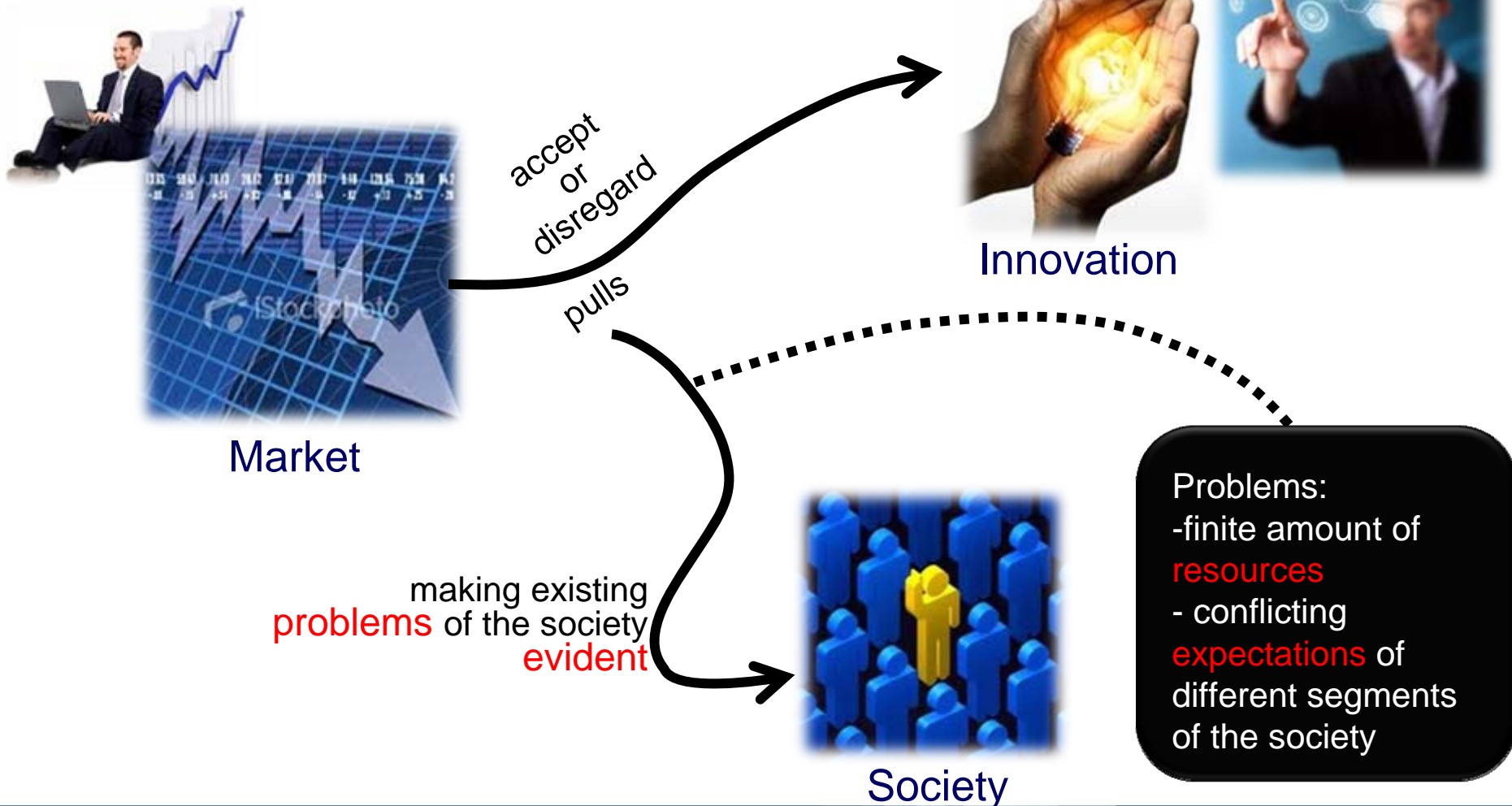


R&D  
Innovation  
Manager

# Introduction

## ■ Innovation, Market and the Society

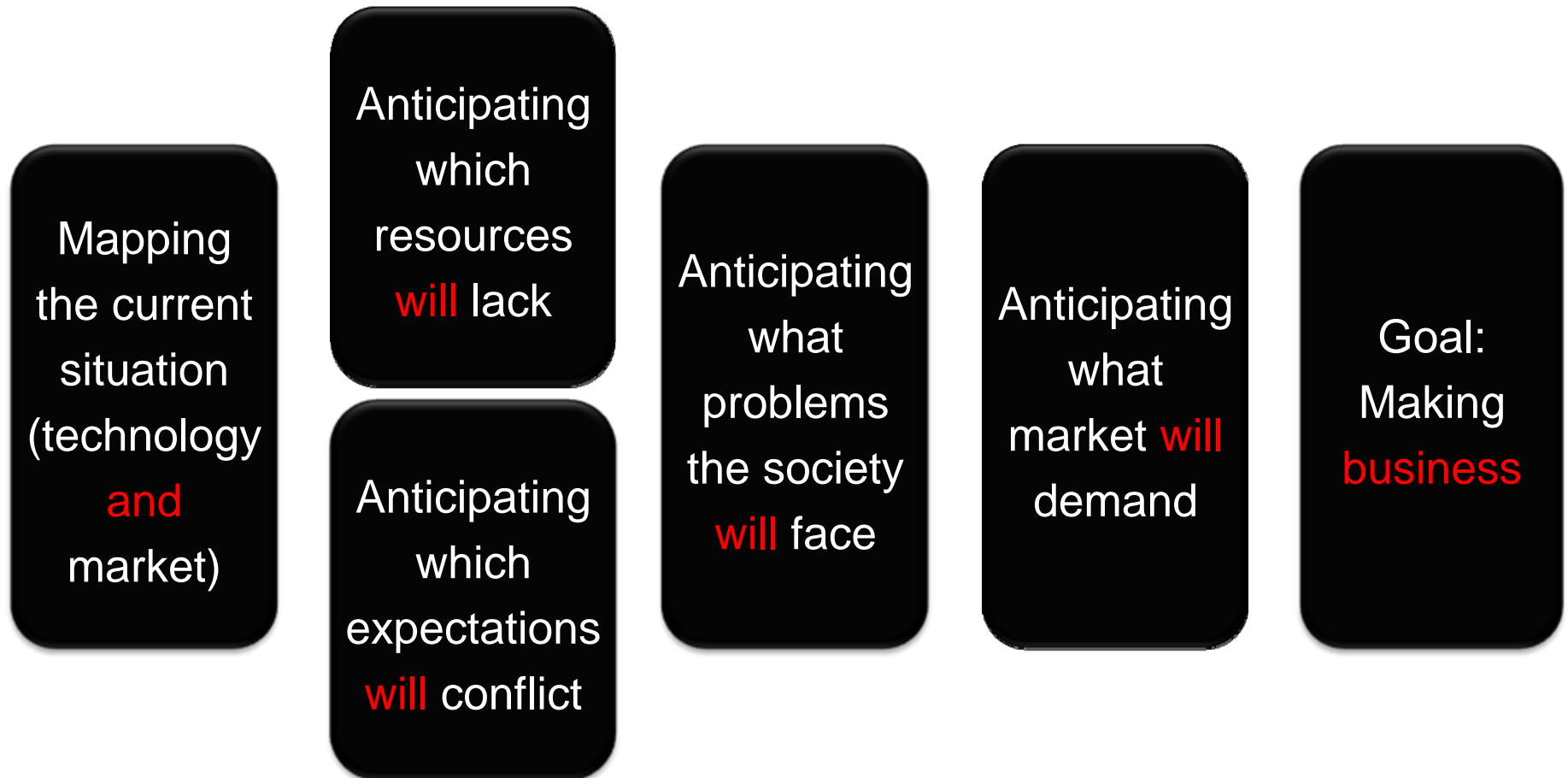
### ❖ Role in the Society and time perspective



# Introduction

## ■ Innovation, Market and the Society

### ❖ Reflections (4 causal steps)



# Introduction

## ■ An example Best Practice from IBM

Since 1982, IBM Research has marshaled the unique capabilities of its worldwide community of top scientists to create the **Global Technology Outlook (GTO)**.

The GTO is a comprehensive analysis that looks **three to ten years into the future** seeking to identify significant, disruptive technologies that will change IBM and the world.

The completed GTO is used within IBM to **define areas of focus and investment** and is shared broadly with a range of IT influencers, including clients, academics, and partners, through education programs and client briefings.

IBM Research

Global  
Technology  
Outlook  
2012



GTO is not **perfect**:  
predicting is difficult

GTO is not  
**speculative**: driven by  
business

GTO is not **ignored**:  
100M\$+ investments  
based on GTO

# Anticipating future innovations

## ■ Technology Forecasting, scope and approaches

### ❖ Technological forecast:

- a comprehensible description of emergence, performance, features, and impacts of a technology in a particular place of a particular point of time in the future
- (What? When? Where? Why?)

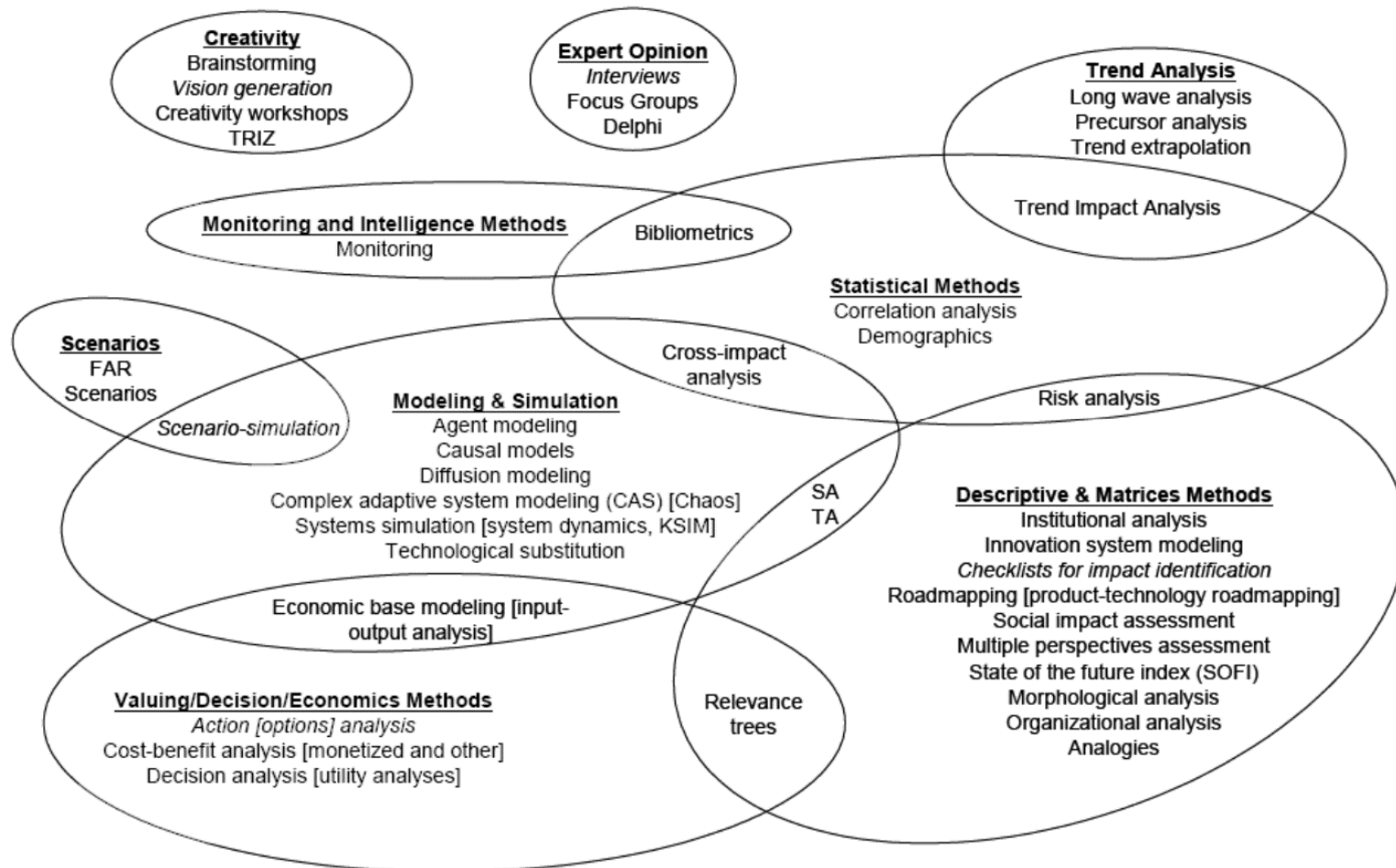
### ❖ Prediction:

- a statement made about the future, anticipatory vision or perception. This statement is mostly qualitative
- (What? Why?)

# Anticipating future innovations

## ■ Technology Forecasting, scope and approaches

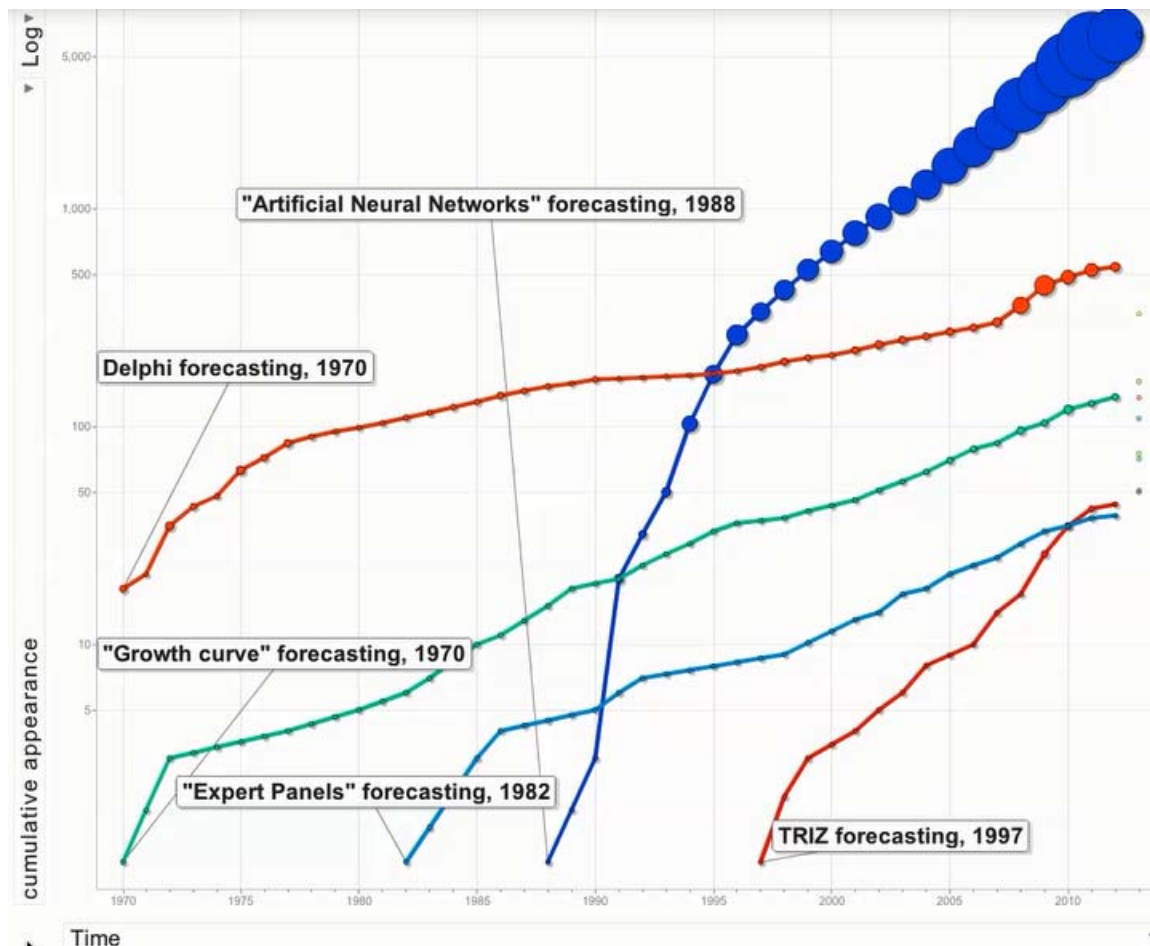
### ❖ Types of forecast:



Source: Phillips, Heidrick, Potter

# Anticipating future innovations

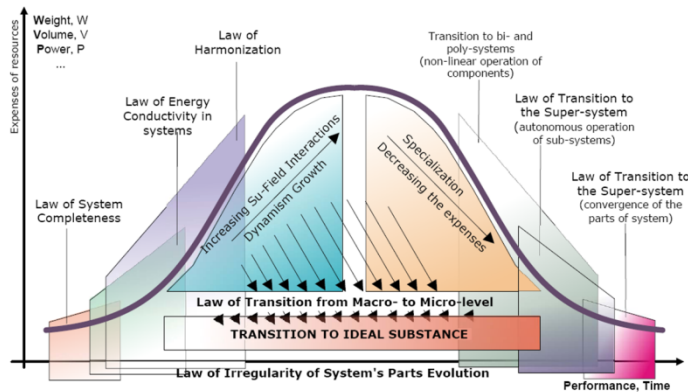
- Technology Forecasting, scope and approaches
  - ❖ Types of forecast: cumulative appearance of articles



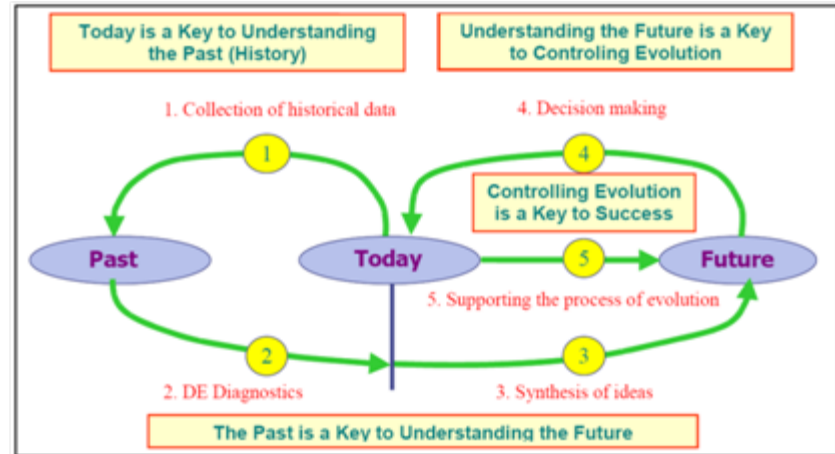
# Anticipating future innovations

## ■ TRIZ-based Technology Forecasting

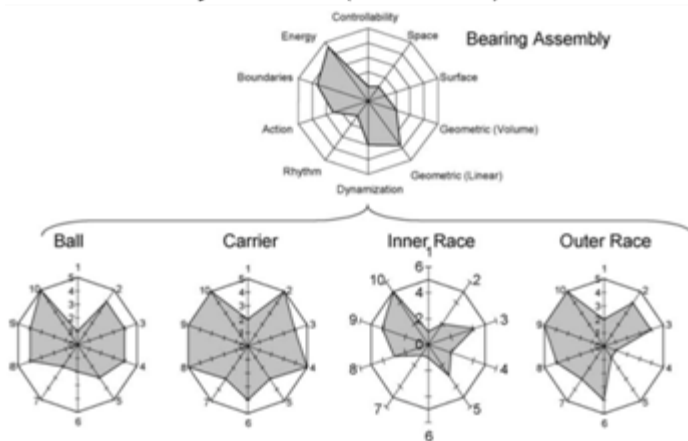
Salamatov Y.P (1984-1991)\*:  
wave model (bell-shaped running curve)



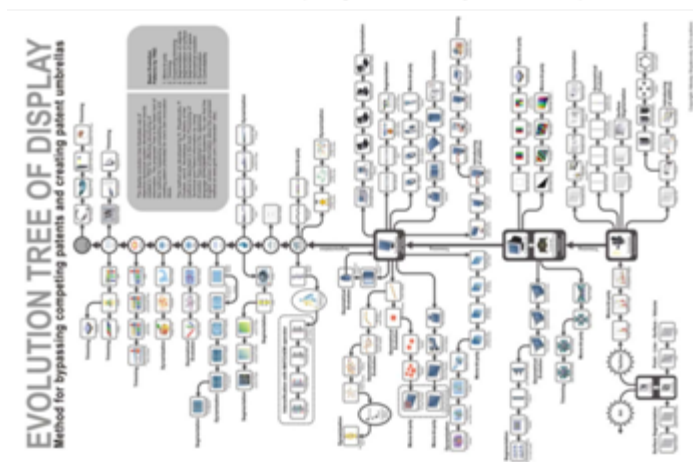
Directed Evolution (Zlotin, Zusman, 2001)



Evolutionary Potential (Mann 2003)



Evolution Trees (Shpakovsky, 2006)





## ■ General Info

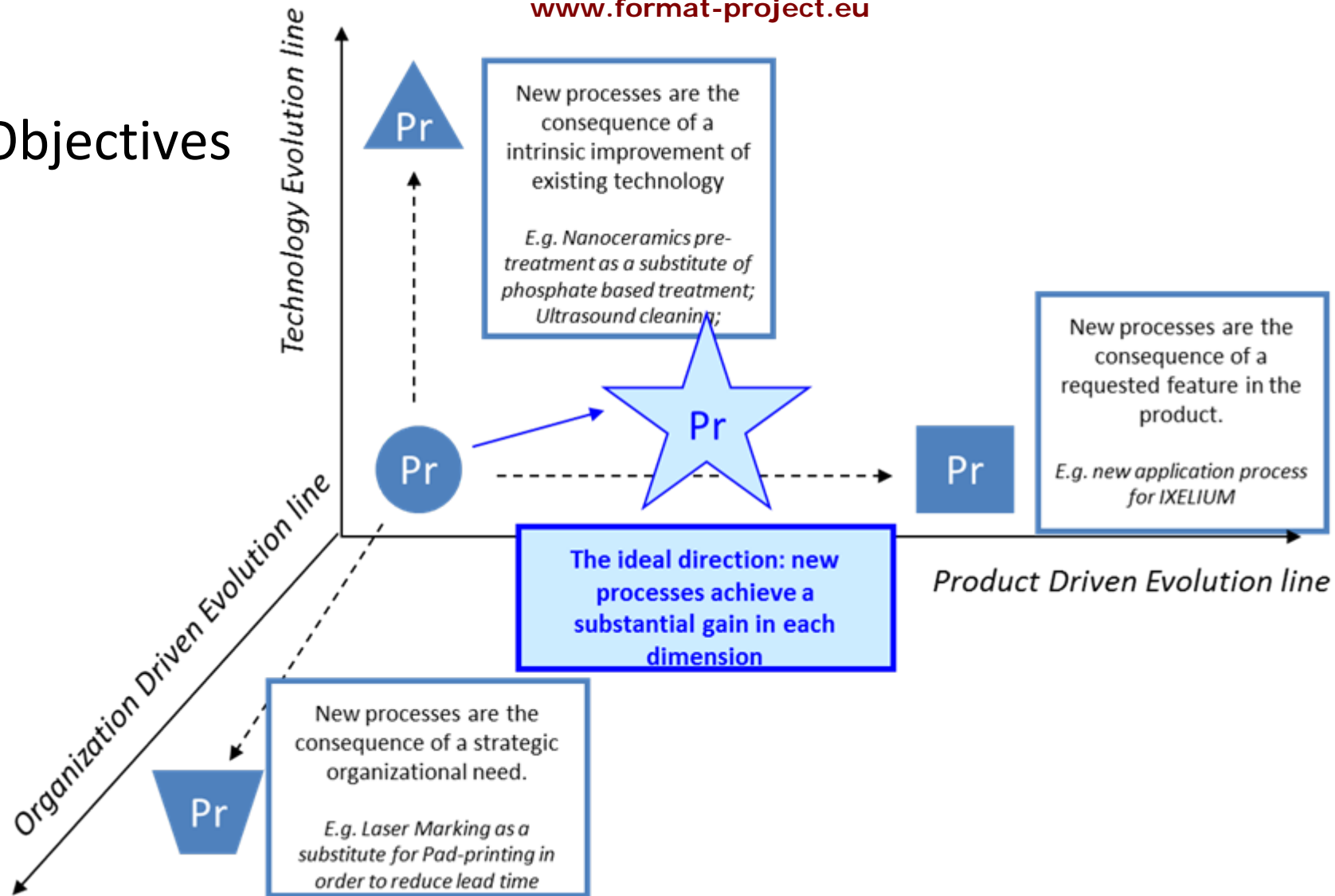
- ❖ Project Duration: 48 months (Jan 2012-Dec 2015)
- ❖ Contract Number: FP7-PEOPLE-2011-IAPP- 286305
- ❖ Total EU contribution: 1,690,454.00€
- ❖ Partners:



## ■ Objectives

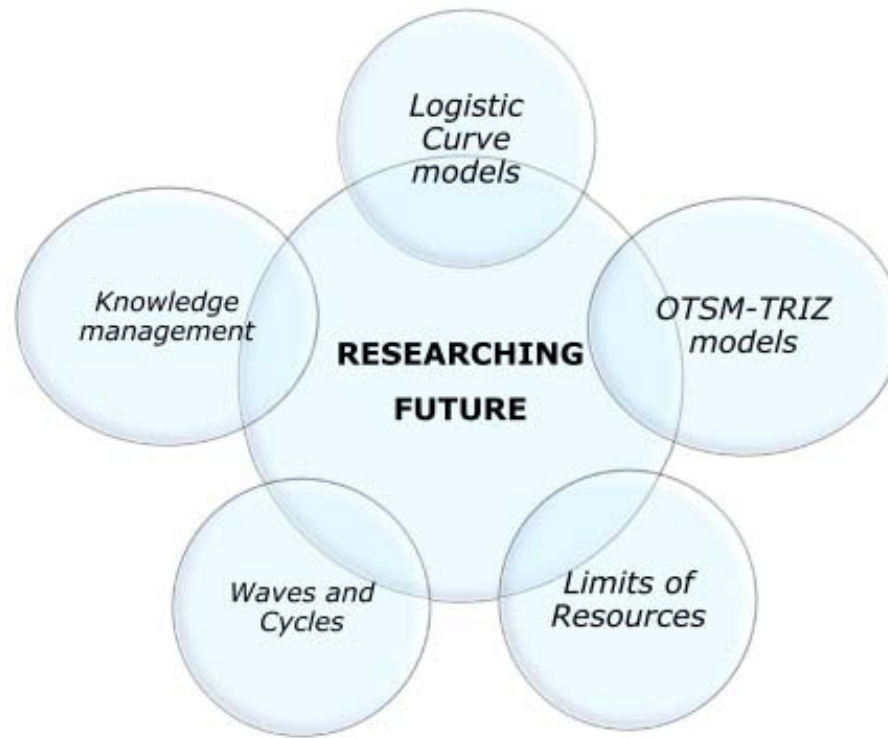
- ❖ The FORMAT project aims at developing an innovative forecasting methodology supporting decision making in Manufacturing Industries, facing and answering the 3 perspectives:
  - 1. Product Evolution: the design of new products can require new process technologies for the product itself to be manufactured;
  - 2. Technological Evolution: technological pressure leads to changes and improvements in the manufacturing processes for quality improvement and reduction of resources consumption;
  - 3. Organizational Evolution: new regulations and industrial strategies can imply changes in the manufacturing processes, e.g. in terms of productivity, personnel employment, integration etc.

## ■ Objectives



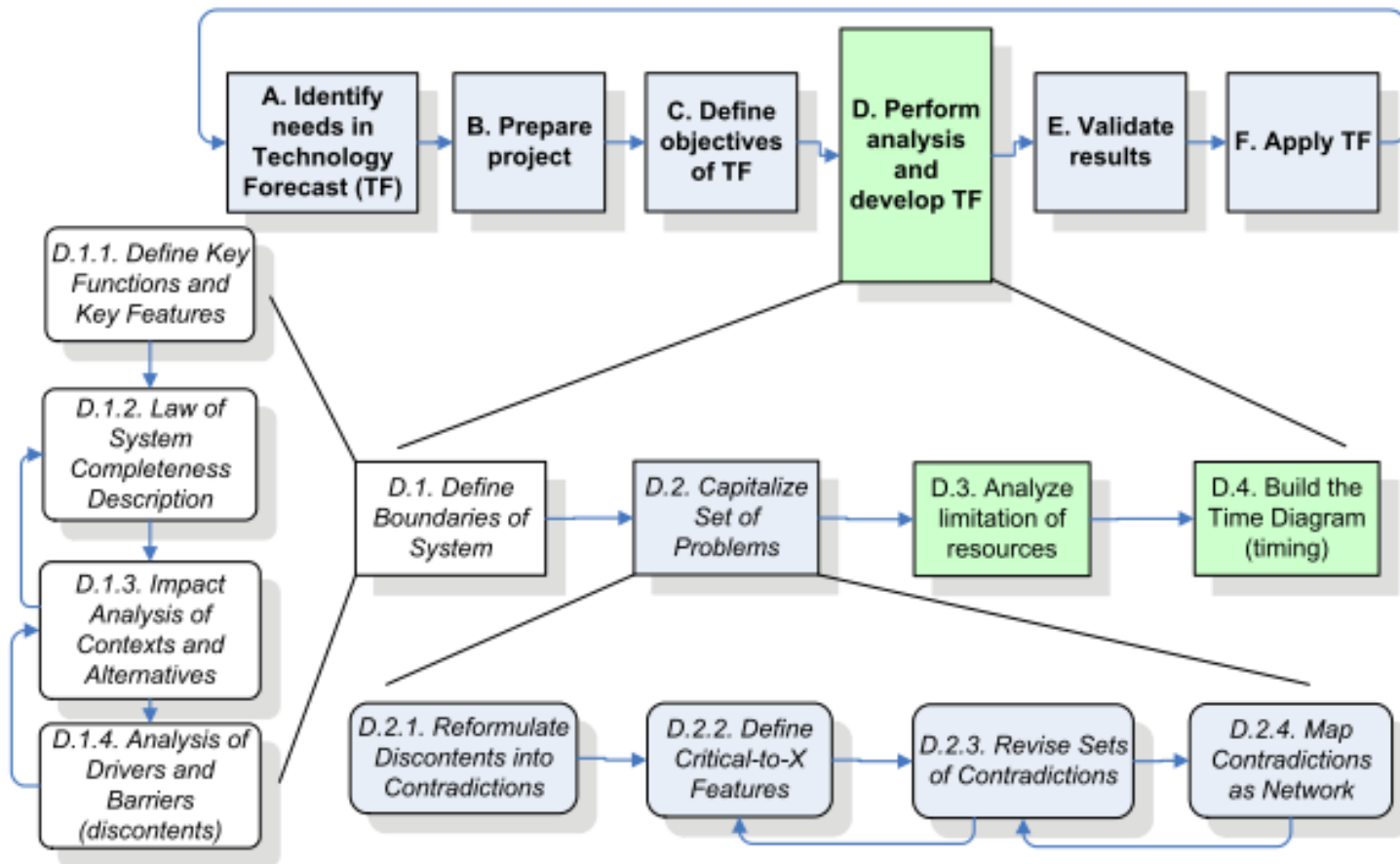
■ Reference models and partial achievements

❖ Researching Future Methodology (D. Kucharavy, 2008)



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### ❖ Researching Future Methodology (D. Kucharavy, 2008)



## Reference models and partial achievements

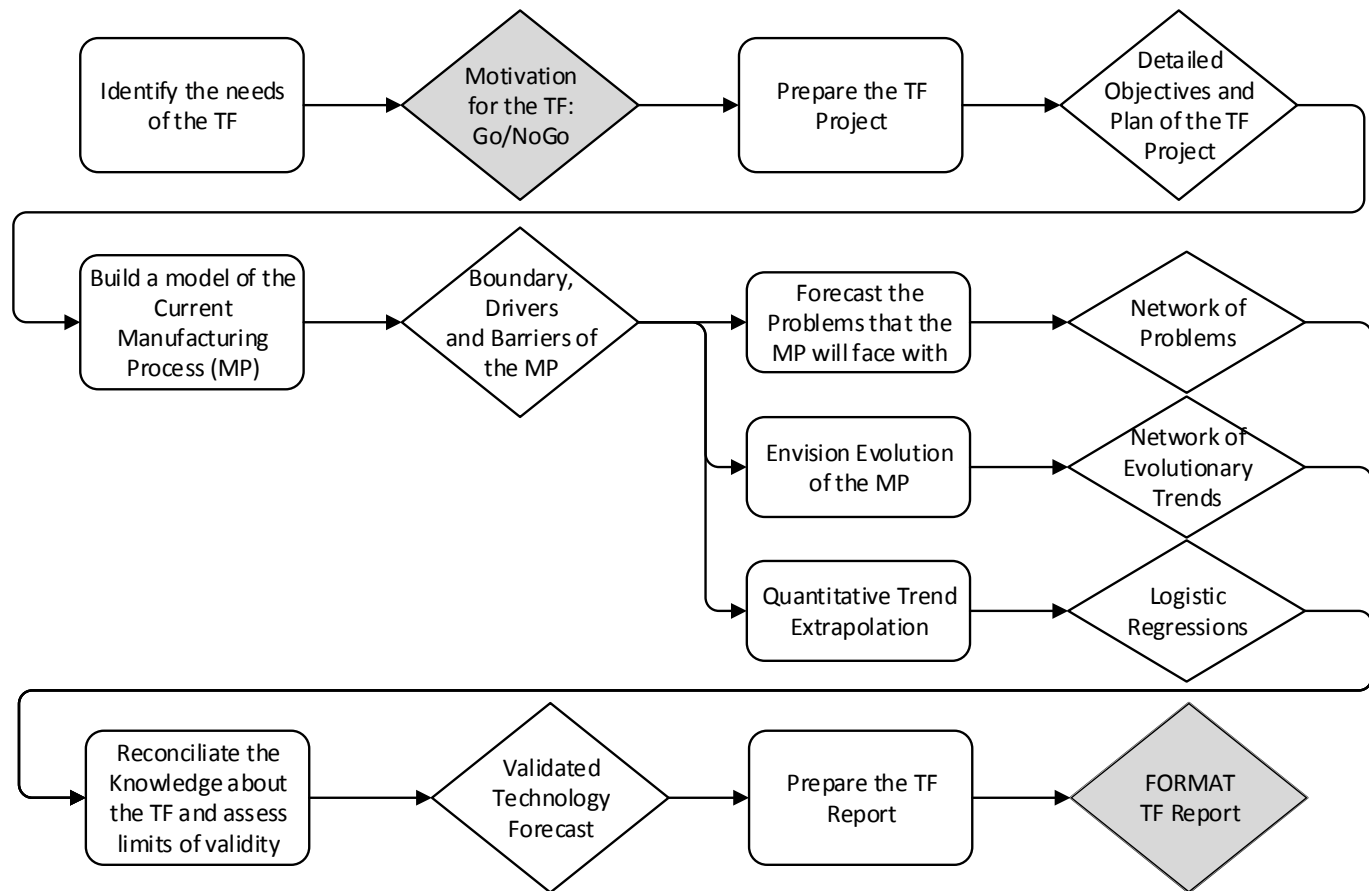
### Stage-Gate Process Model for Technology Forecasting

#### Legend

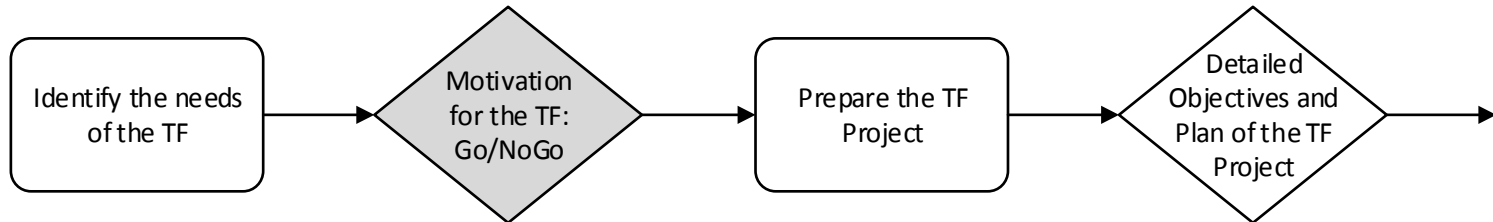
Activities  
(Methods and Tools are suggested, but are not mandatory)

Internal Outputs  
(Standard Format, mandatory)

Outputs and Decisions  
(Standard Template, mandatory)



## ■ Stage-Gate Process Model for Technology Forecasting



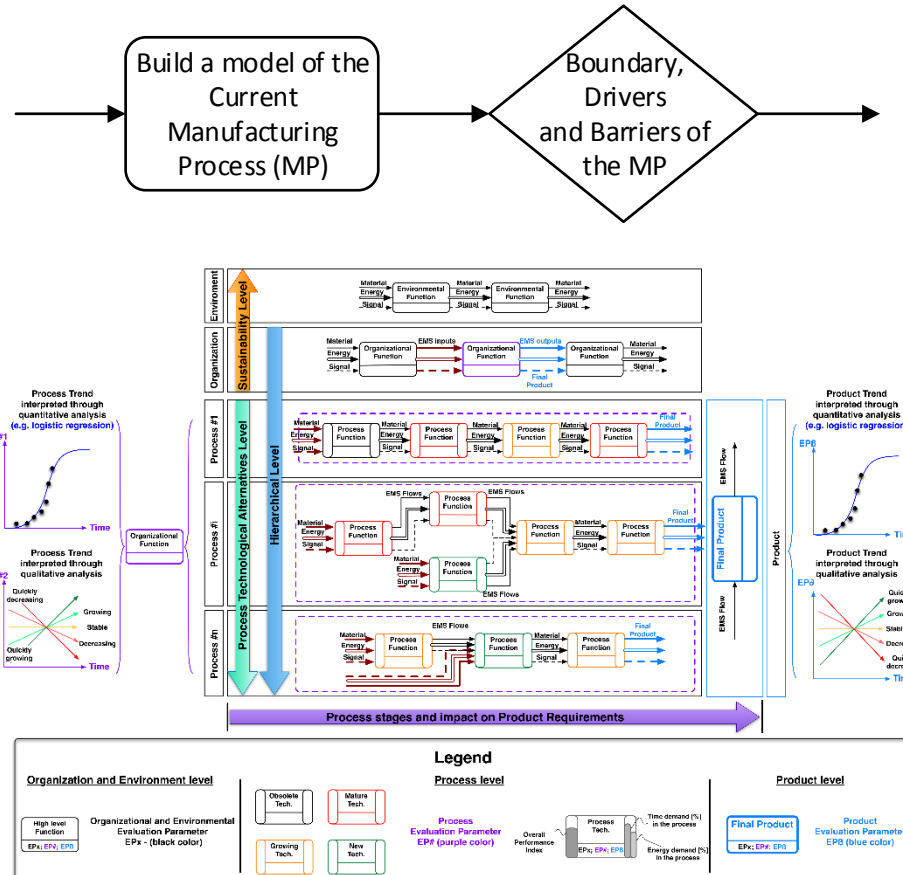
### ❖ Identify the needs of the TF

- What are main objectives and expected outputs?
- How it will be applied for decision making process?
- Can we satisfy formulated needs without TF? → Go / No Go

### ❖ Prepare the TF Project

- What are available and necessary resources to perform study?
- What is an optimal time span to realize project?
- Who are clients, core team, and necessary external participants?
- What are the specific objectives of the TF project?
- What questions should be answered? → Detailed plan of project

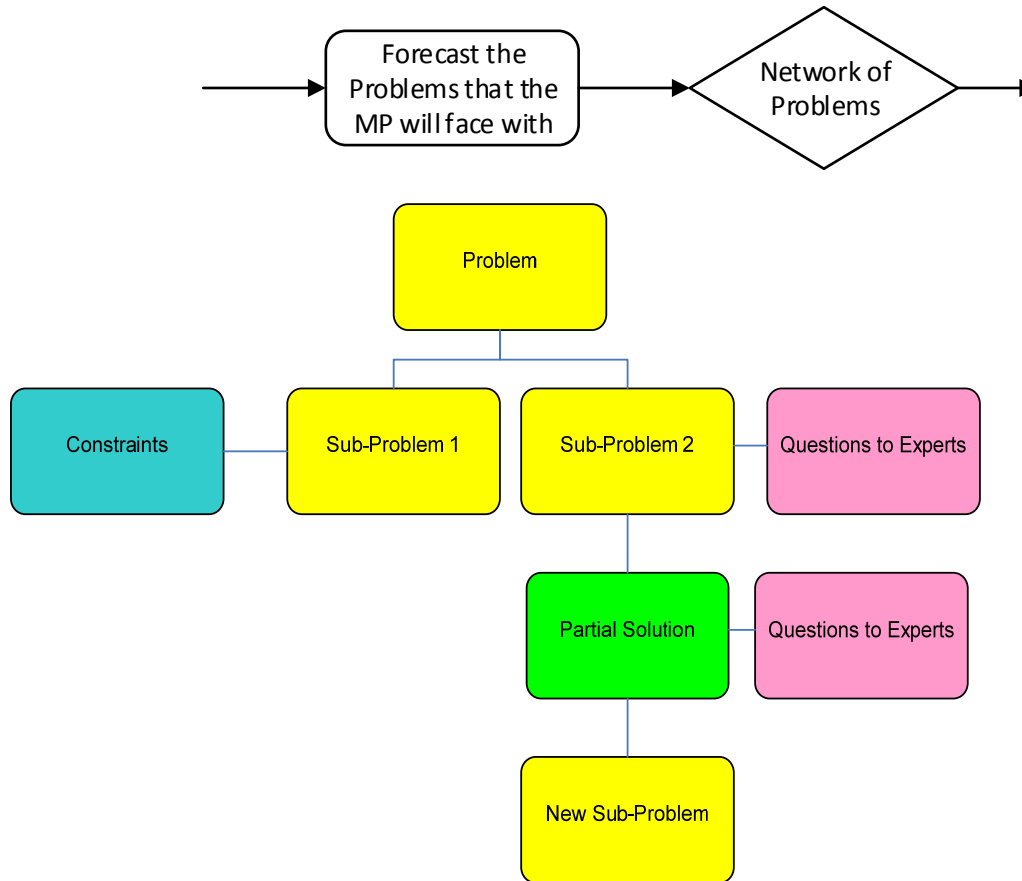
## Stage-Gate Process Model for Technology Forecasting



Source: Becattini N., Cascini G., Nikulin C.: "Modelling the dynamics of products and processes requirements", 13th TRIZ Future Conference, Paris (France), 29th–31st October 2013.



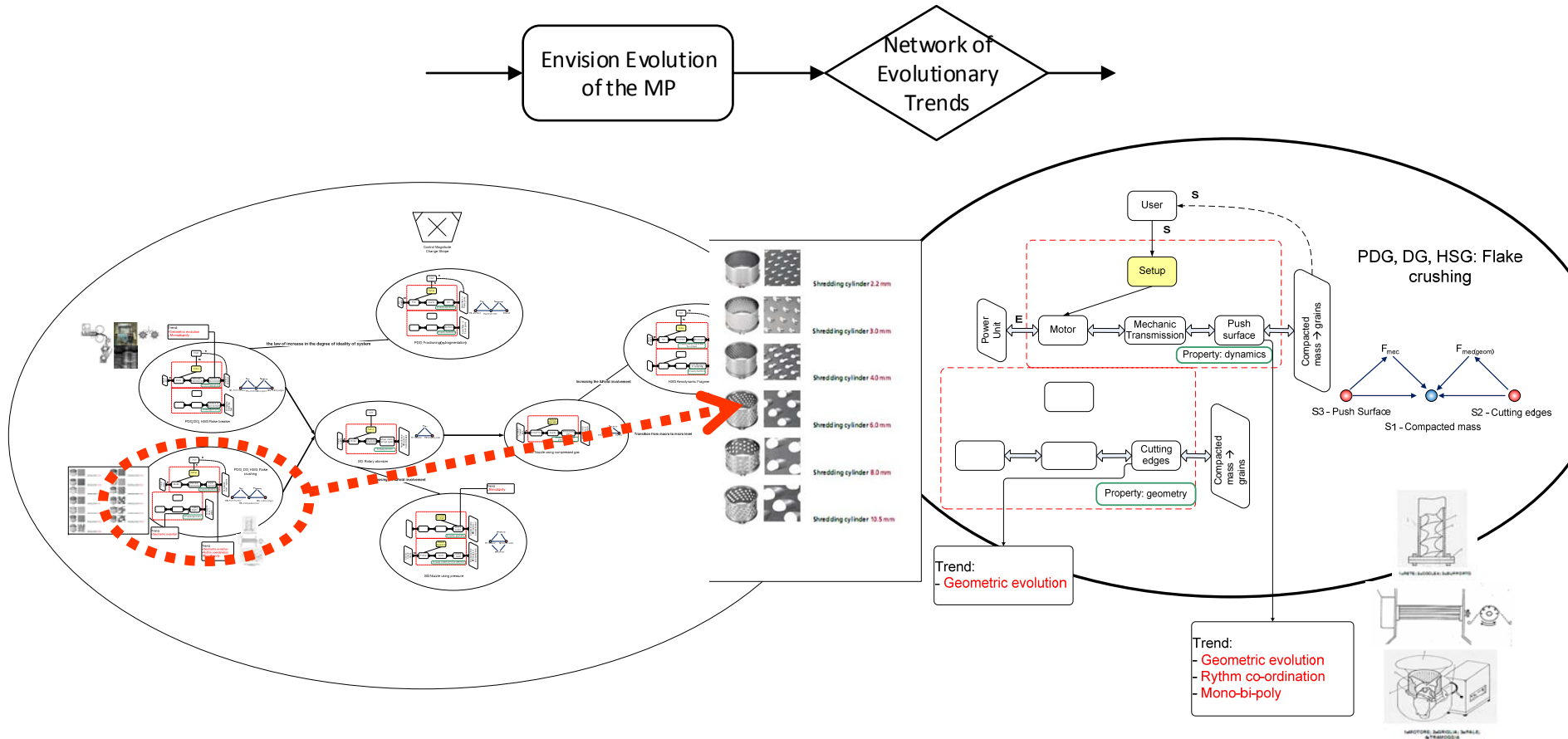
## ■ Stage-Gate Process Model for Technology Forecasting



Nikolai Khomenko

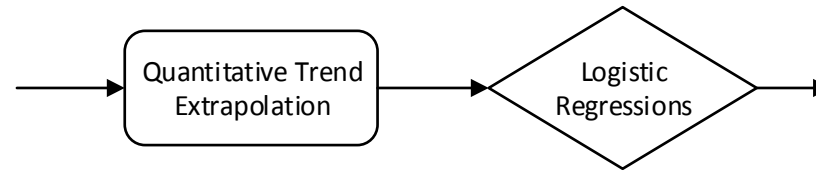
Khomenko N., De Guio R., Lelait L., Kaikov I., 2007, "A framework for OTSM-TRIZ Based Computer Support to be used in Complex Problem Management", Int. Journal of Computer Applications in Technology, Vol.30(1-2) / 2007, pp. 88-104.

## Stage-Gate Process Model for Technology Forecasting



Cascini G., Rotini F., Russo D.: "Networks of trends: systematic development of system evolution scenarios", 8th ETRIA TRIZ Future Conference, The Netherlands, November 5-7, 2008 - Procedia Engineering, Volume 9, 2011, Pages 355-367

## ■ Stage-Gate Process Model for Technology Forecasting

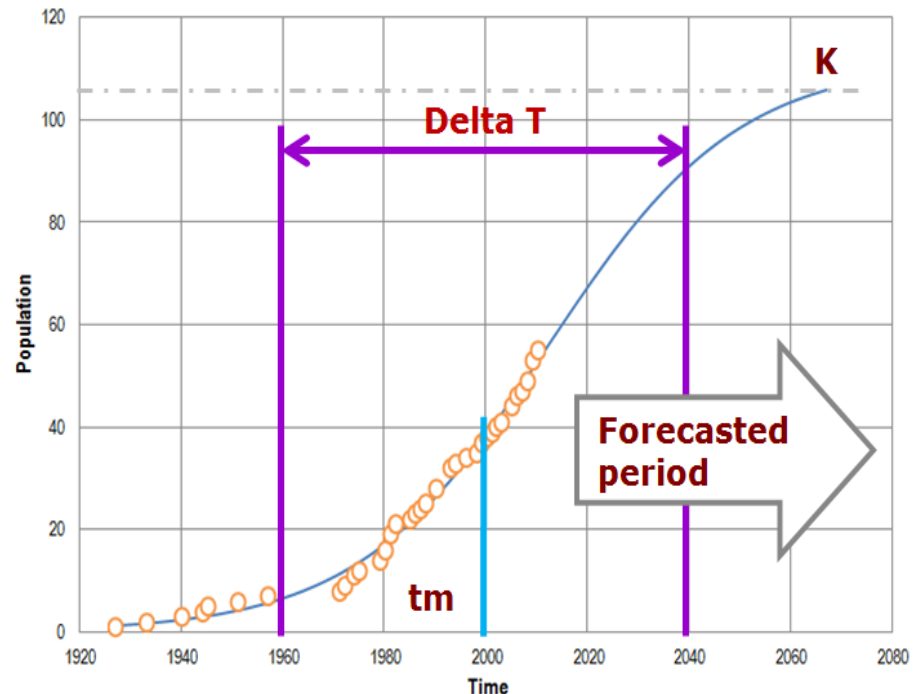


$$N(t) = \frac{K}{1 + e^{\left[-\log\left(\frac{81}{\Delta t}\right)(t-t_m)\right]}}$$

Meyer (1994)

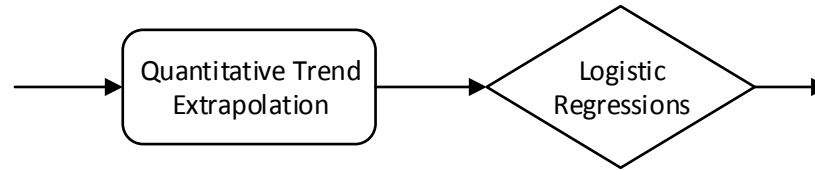
### Growth under competition

- Natural growth of autonomous systems in competition might be described by LOGISTIC EQUATION and logistic S-curve
- Natural growth is defined as the ability of a 'species' to multiply in finite 'niche capacity'
- For socio-technical systems the 3-parameter S-shaped growth model is applied for describing "trajectories" of growth or decline in time



Source: Dmitry Kucharavy

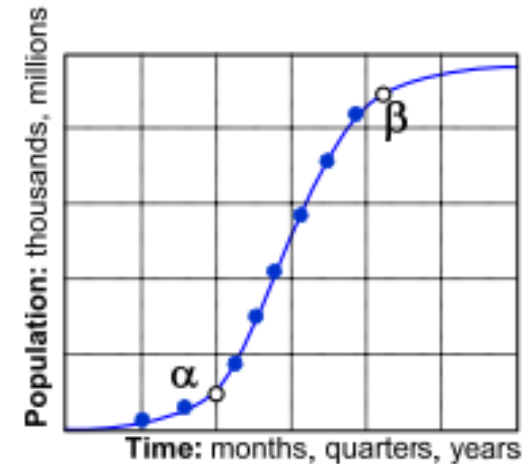
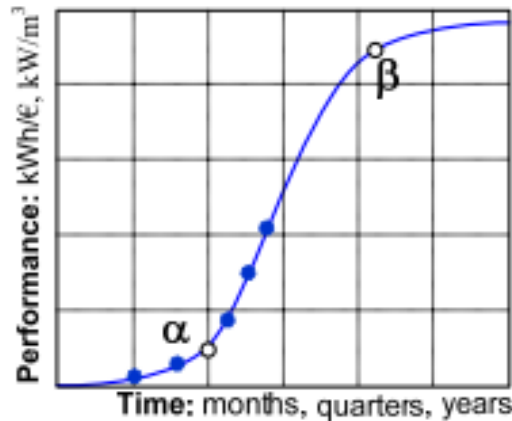
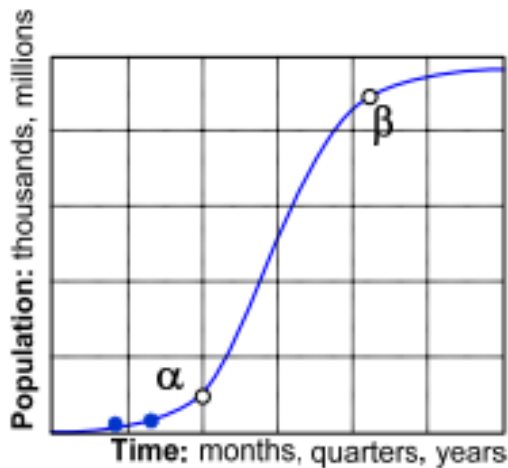
## ■ Stage-Gate Process Model for Technology Forecasting



**new-to-the-world**

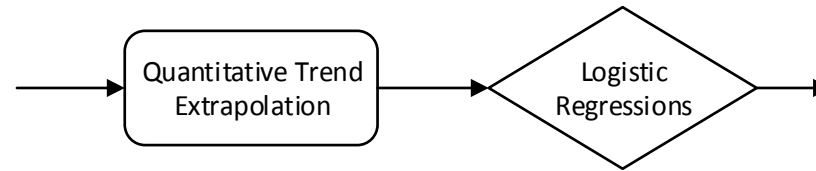
**new family of product**

**new market penetration**

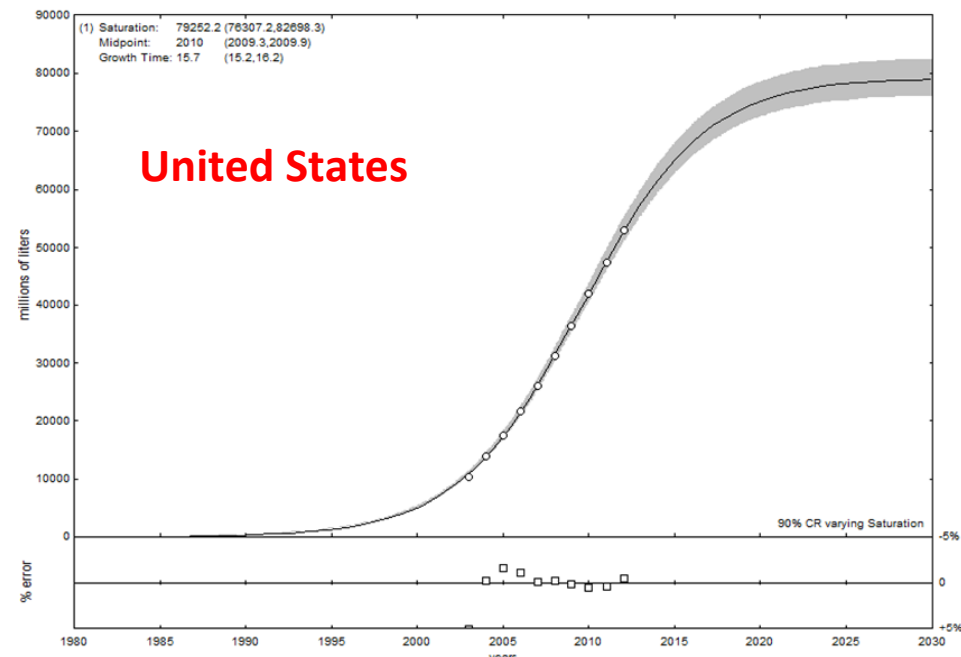
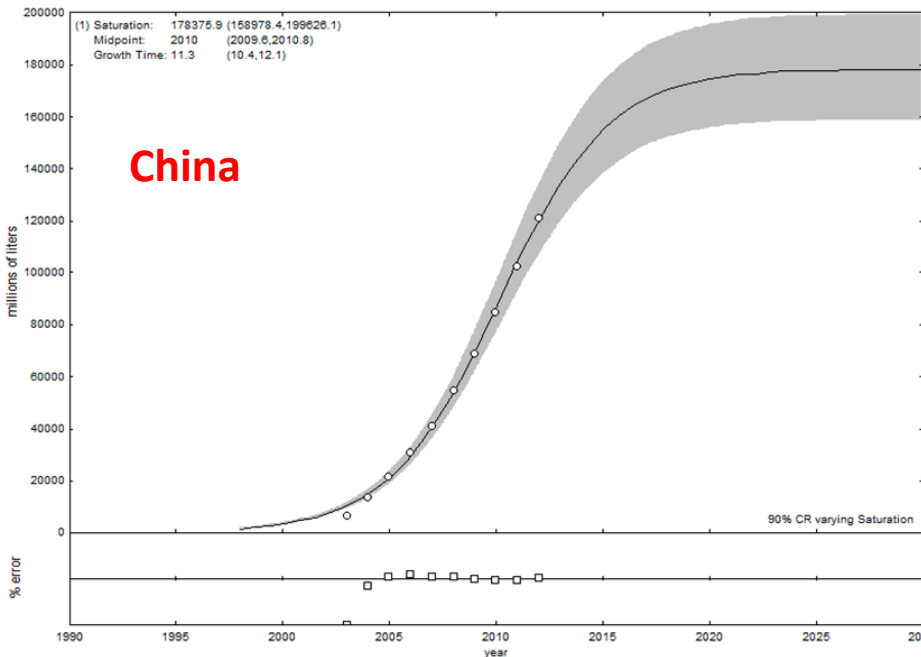


Source: Dmitry Kucharavy

## ■ Stage-Gate Process Model for Technology Forecasting

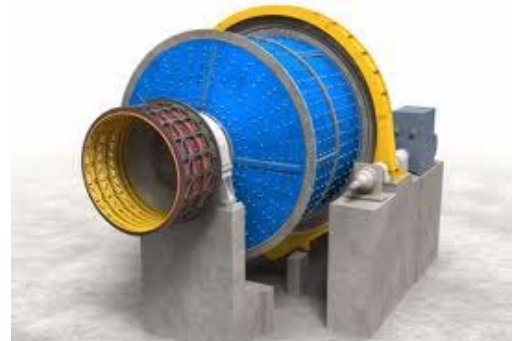
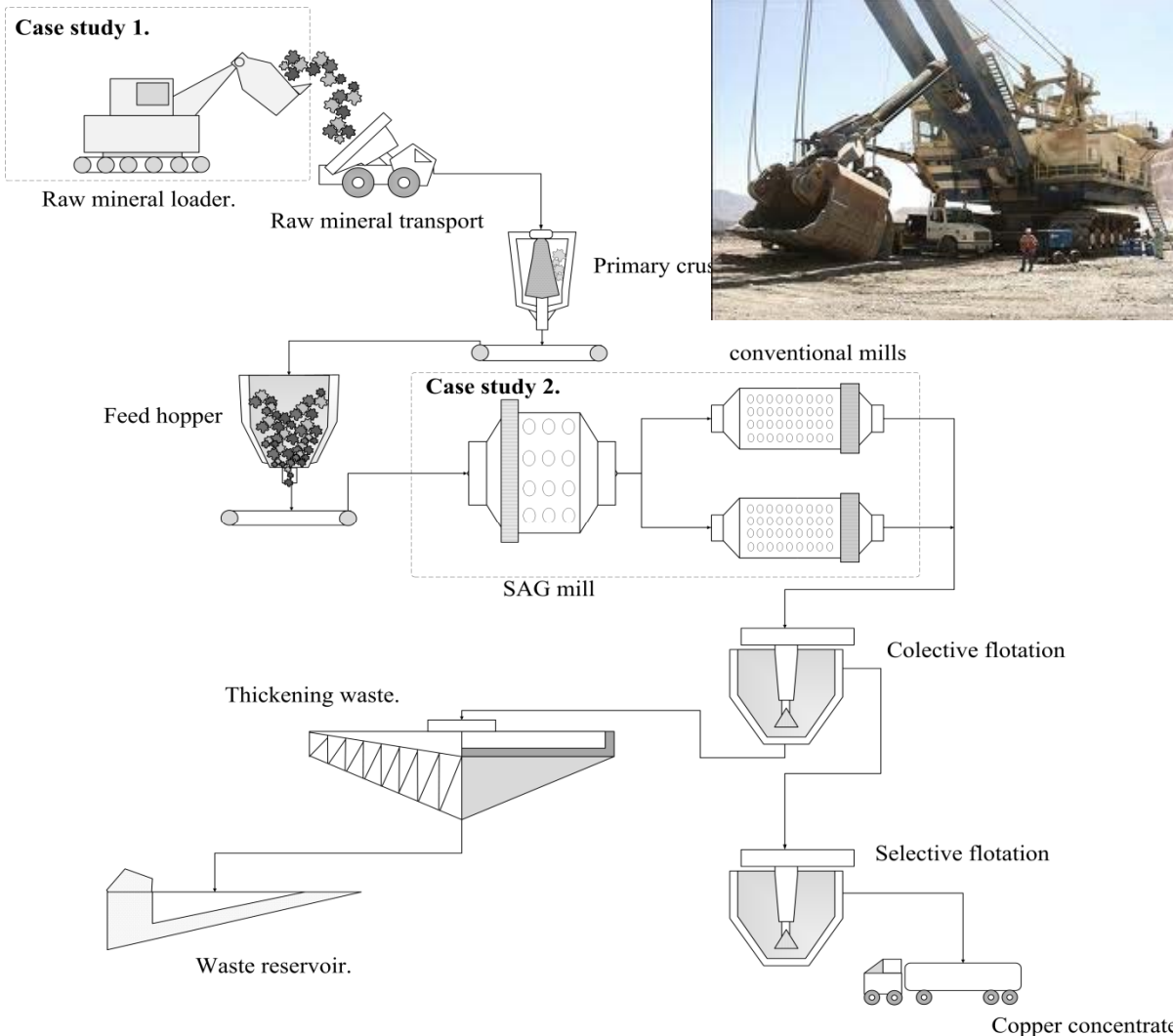


Market Cumulative Growth of Product XXX



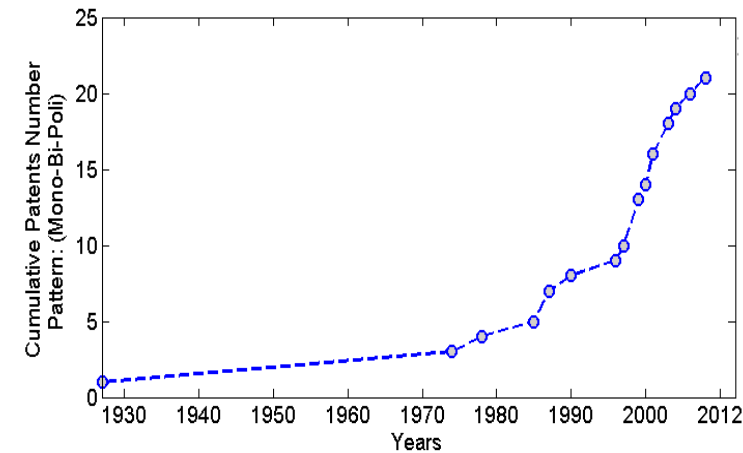
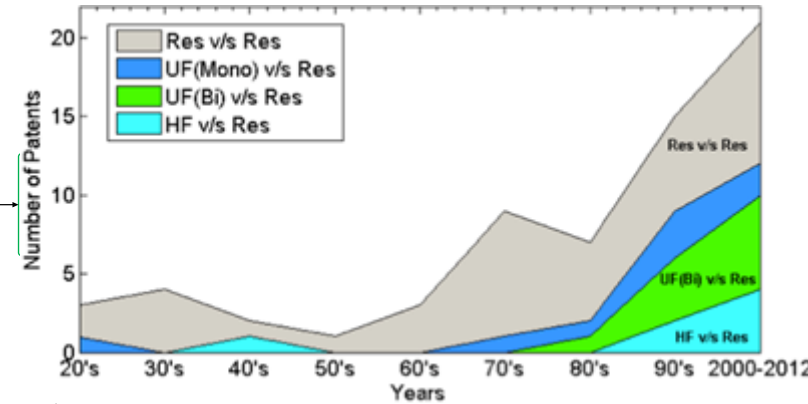
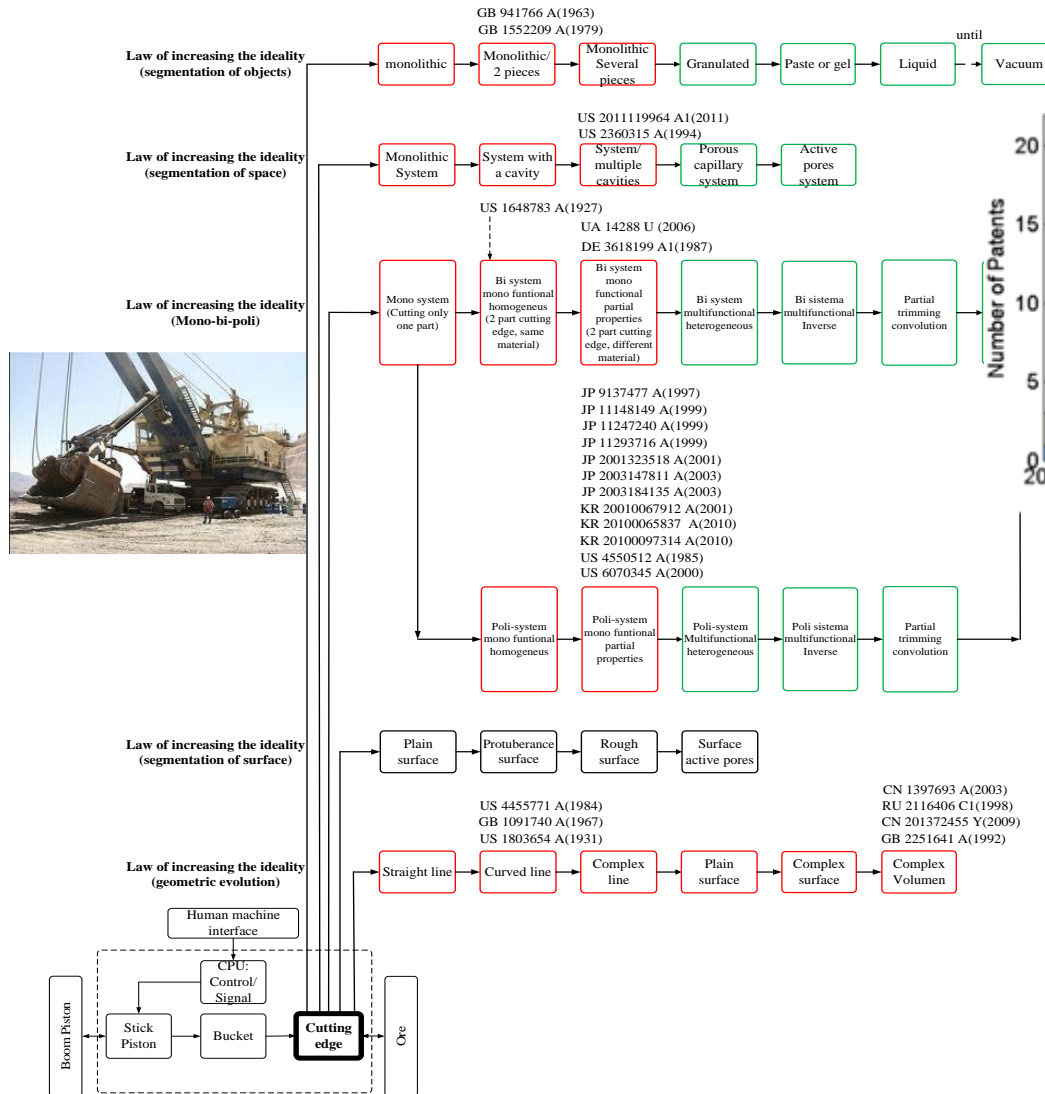
Case Study: European company working in the Food Processing Sector

# Case study: Mining Process (Chile)



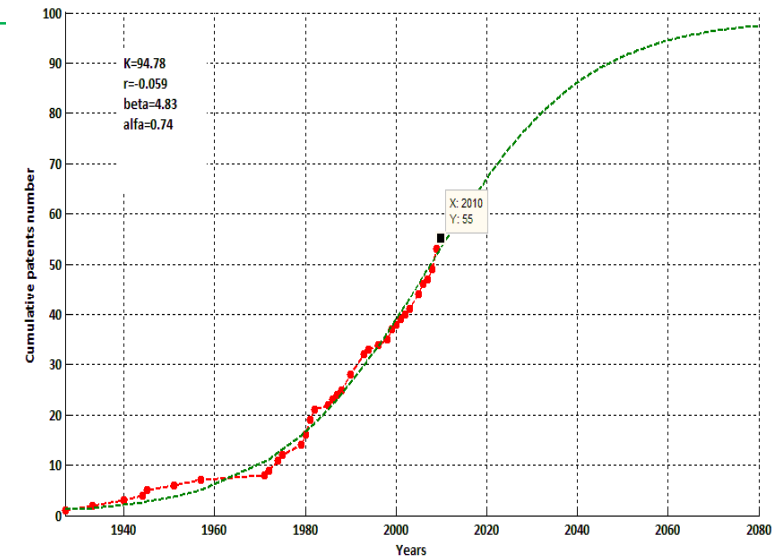
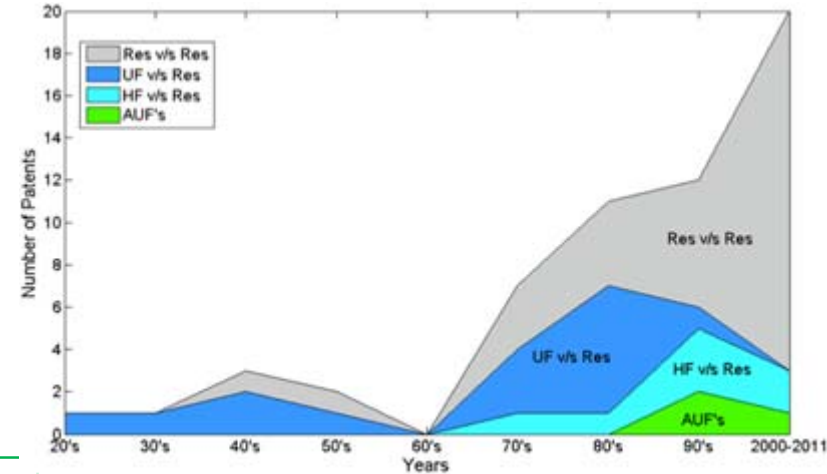
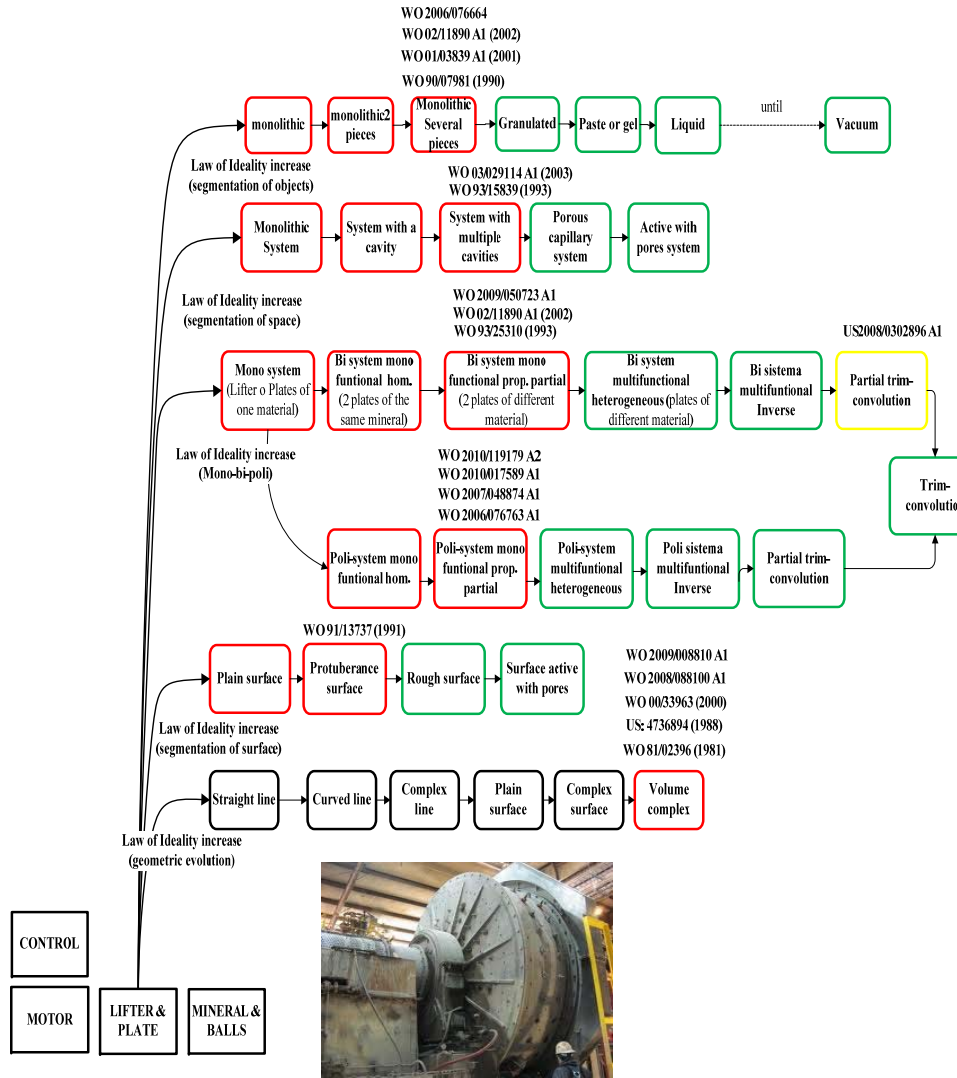
# Case study: Mining Process (Chile)

## Mining shovel



# Case study: Mining Process (Chile)

## ❖ SAG Mill





# Conclusions

- The Investments Risk can be reduced by appropriate forecasting of technological evolution and social changes
- TRIZ provides an effective support to Technological Forecasting, but it is not suitable to address questions like When? Where? (Predictions, not Forecasts)
- Many complementary theories and methods exist in the field
- The integration of models based on the TRIZ Laws of Evolution with mathematical models for trends extrapolation seems to have adequate capabilities to perform qualitative and quantitative Technological Forecast
- Follow the future developments of the FORMAT project on:
  - ❖ Deliverables freely downloadable on [www.format-project.eu](http://www.format-project.eu)
  - ❖ Handbook of the FORMAT methodology *expected on Spring 2014*

Thanks for your time!!



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