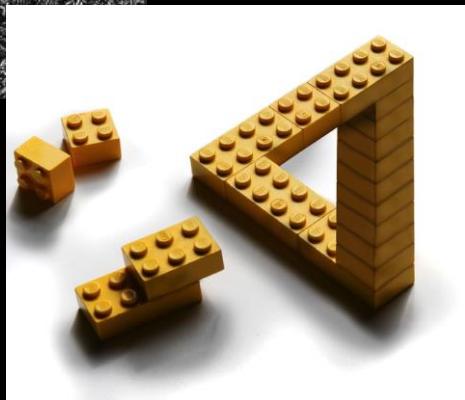
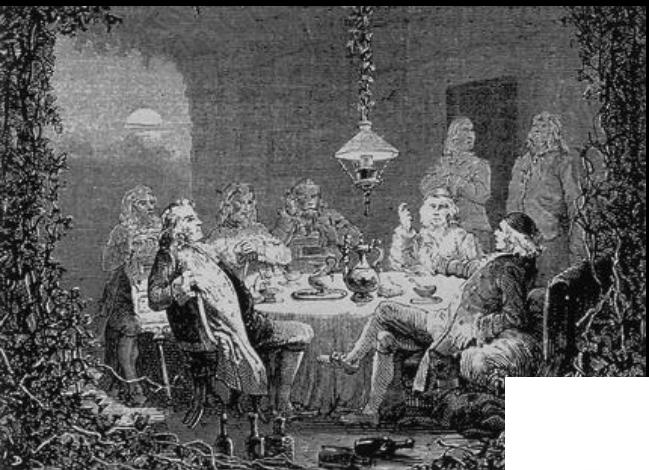


5th European Energy Forum session 2: RDI choices and consequences on the organization



Designing new energy systems:
beyond decision and optimization,
design theory and methods to manage R&D and innovation

Pascal LE MASSON

Prof. MINES ParisTech, Chair of Design Theory and Methods for Innovation
Head of the Center of Management Science – i3 UMR CNRS 9217

MINES ParisTech – PSL Research University
Pascal.le_masson@mines-paristech.fr



The chair of Design Theory and Methods for Innovation



International networks: design theory SIG network, Euram innovation SIG, Chalmers, Imperial college, HEC Montreal, MIT, Harvard, Stanford,...

The Design theory community

The collage includes:

- Design Society International Desig**: University of Bath, Carnegie Mellon University, ParisTech.
- 2nd international Design Theory Spec**: University of Paris, Mines ParisTech.
- 2nd International Workshop on DESIGN THEORY**: Special Interest Group of the Design Society. Carnegie Mellon University, Cornell University, INRIA Strasbourg, INRA, NCSR, University of Paris, Stanford University, Technical University of Delft, Technion Israel Institute of Technology, University of Bell.
- 3rd International Workshop on DESIGN THEORY**: Special Interest Group of the Design Society. Aalto University, Carnegie Mellon University.
- 31st January - 1st February 2011 Mines ParisTech**.
- 5th International DESIGN THEORY**: Carnegie Mellon University, CMU, CNAM, Delft University of Technology, Europeancopter, Grenoble INP, IKBM, INRA, INSA Lyon, INSA Strasbourg, JAST, KIT, KIT, Krasnow Institute for Advanced Study, Mines ParisTech, Mount Sainte Victoire.
- 6th International DESIGN THEORY**: Carnegie Mellon University, CMU, CNAM, Delft University of Technology, Europeancopter, Grenoble INP, IKBM, INRA, INSA Lyon, INSA Strasbourg, JAST, KIT, Krasnow Institute for Advanced Study, Mines ParisTech, Mount Sainte Victoire.
- 7th DESIGN THEORY**: Carnegie Mellon University, CMU, CNAM, Delft University of Technology, Europeancopter, Grenoble INP, IKBM, INRA, INSA Lyon, INSA Strasbourg, JAST, KIT, Krasnow Institute for Advanced Study, Mines ParisTech, Mount Sainte Victoire.
- 8th International DESIGN THEORY**: Carnegie Mellon University, CMU, CNAM, Delft University of Technology, Europeancopter, Grenoble INP, IKBM, INRA, INSA Lyon, INSA Strasbourg, JAST, KIT, Krasnow Institute for Advanced Study, Mines ParisTech, Mount Sainte Victoire.
- 26th January - 1st February 2014 Mines ParisTech**: Carnegie Mellon University, CMU, CNAM, Delft University of Technology, Europeancopter, Grenoble INP, IKBM, INRA, INSA Lyon, INSA Strasbourg, JAST, KIT, Krasnow Institute for Advanced Study, Mines ParisTech, Mount Sainte Victoire.
- the Design Society a worldwide community**: Organized by the Chair of Design Theory and Methods for Innovation. Contact: temasson@mines-paristech.fr - stephanie.brunet@mines-paristech.fr
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9th International Workshop on DESIGN THEORY
Special Interest Group of the Design Society

1st-2nd February 2016
MINES ParisTech

A collage of logos from various institutions represented at the workshop, including:

- Aachen University
- Airbus
- WSP/Sveriges AB
- Carnegie Mellon University
- CERN
- Chalmers University
- CINER Nanotech
- Clemson University
- CNRS
- Colleges International
- CRIParis
- Ecole Centrale
- ESCIennes School of Business
- George Washington University
- GREPS
- IKBM
- INRA
- INRIA
- Iowa Institute of Technology
- LGR, CentralSupélec
- Lund University
- MINES ParisTech
- Open University
- Orion Consulting
- Polytechnic di Bari
- Royal Military College of Canada
- SNCF
- SNEEMA
- STMicroelectronics
- Stanford University
- TecnoIngenieria
- Tel Aviv University
- Télécom ParisTech
- The Open University
- Tokyo University
- Universitat de Barcelona
- Universitat Politècnica de Catalunya
- Universitat de València
- University of Amsterdam / EURIN
- University of Columbia
- University of Michigan
- University of North Carolina at Charlotte
- Université Paris Sorbonne
- Université de Dauphine
- Université de Grenoble
- Université de Montréal
- Université de Saintes
- Universität Regensburg
- University of Cambridge
- University of St Andrews
- University of Michigan
- Technische Universität Ilmenau
- Telecom Paris Tech
- University of Sussex
- UNC Charlotte
- Université de Montréal
- Université Paris-Dauphine
- Université Paris-Sud 11
- University of Huddersfield
- University of Leicester
- University of New South Wales
- University of Venice
- Warren Centre for Engineering Innovation

the Design Society a worldwide community
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Contact: akin.kazakci@mines-paristech.fr - stephanie.brunet@mines-paristech.fr

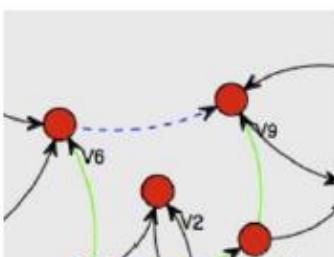
PSL RESEARCH UNIVERSITY
MINES ParisTech

- A growing community : **90-100 participants each year; more than 300 people connected to the SIG; more than 35 institutions represented...**
- Under the auspices of the Design Society
- **Support an strong renewal of research on Design Theory and Methods for Innovation:**

A transdisciplinary research program

AXE 1

fondements des théories de la conception et du raisonnement dans l'inconnu



8th International Workshop on DESIGN THEORY

Special Interest Group
of the Design Society

Carnegie Mellon University
CEA
Columbia University College
Copenhagen Business School
Cesky Univerzitaet
Delft University of Technology
INRA
INRAE
ISCP Paris School of Management
KTH Royal Institute of Technology
Laboratory for Applied Technology, ISTC-CNR
Linköping University
Massachusetts Institute of Technology
Metasysic
MINES ParisTech
Politecnico di Milano
Politecnico di Milano
SHEMAG
Sohayli
Stanford University
Technion
Tel Aviv University
The Open University
Tokyo University
Universitat Politècnica de Catalunya
Universitat de Girona
Université de Montréal
Université Paris-Saclay
University of Cambridge
University of Dundee
University of Edinburgh
University of Edinburgh

26th – 27th January 2015
MINES ParisTech

the Design Society
a worldwide community

design theory and methods for innovation
PSL MINES ParisTech

Organized by the Chair of Design Theory and Methods for Innovation | CGS - MINES ParisTech
Contact: akin.kazak@mines-paristech.fr - stephanie.brunet@mines-paristech.fr

AXE 2

outils, méthodes et organisation de la conception innovante

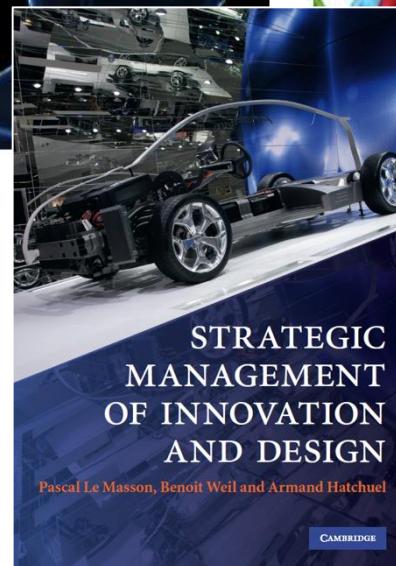
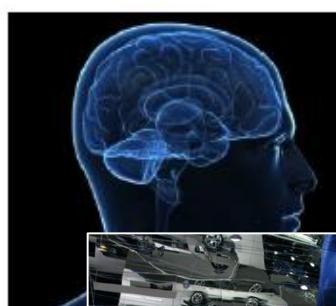


Théorie, méthodes
et organisations
de la conception

Sciences de la Conception
Presses des Mines

AXE 3

approches cognitives neuropsychologiques et culturelles de la conception innovante



STRATEGIC
MANAGEMENT
OF INNOVATION
AND DESIGN

Pascal Le Masson, Benoit Weil and Armand Hatchuel

CAMBRIDGE

Technology Analysis & Strategic Management

Volume 10 Number 4 December 1998



Research in Engineering Design

Theory
Application,
and Methodology

Springer

AXE 4

régimes de conception, économie et histoire de la conception



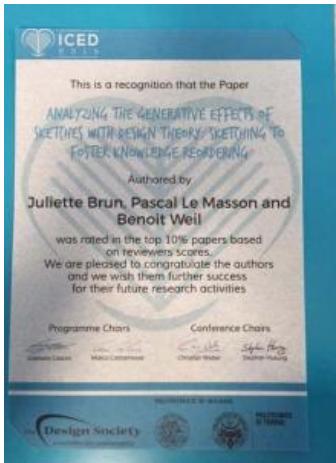
AXE 5

création et réception, identité des objets et nouveaux discours critiques



Leading to multiple awards...

○ Voir : <http://cgs-mines-paristech.fr/category/actualites/prix/>



ICED'15 Reviewers' favourite paper pour Brun et al. 2015 (non verbal et générativité)



E. Berthet médaille vermeil de l'Académie d'Agriculture



villain et al. Prix du SIG business ethics EURAM



EURAM 2013
University is a Great Opportunity
Wroclaw, Poland, 10-13 June 2013

Second Winner of the Best Paper Award
in the "Innovation" Special Interest Group is presented to
Juliette Brun, Philippe Etienne and Benoît Weil
For their paper
"Managing the Impact of Non-Fiscal Devices on Mac-Governance: A New Challenge for Creative Leaders"



Award implemented by
 IMD INSTITUTE OF MANAGEMENT DEVELOPMENT
 HHL LUDWIGSBERG INSTITUTE FOR MANAGEMENT

Brun et al. Prix du SIG innovation EURAM



Dubois et al. AIMS best paper

Dubois et al. IPDM Hustad best paper

Prix de thèse de l'Association Internationale de Management Stratégique 2013

Sources

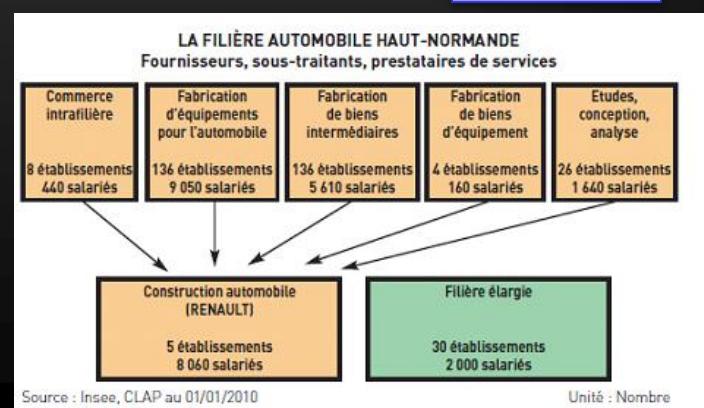
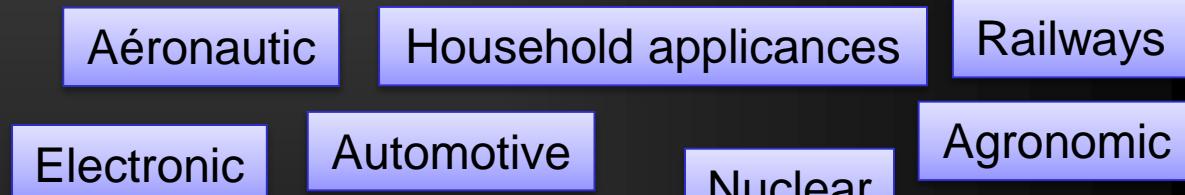
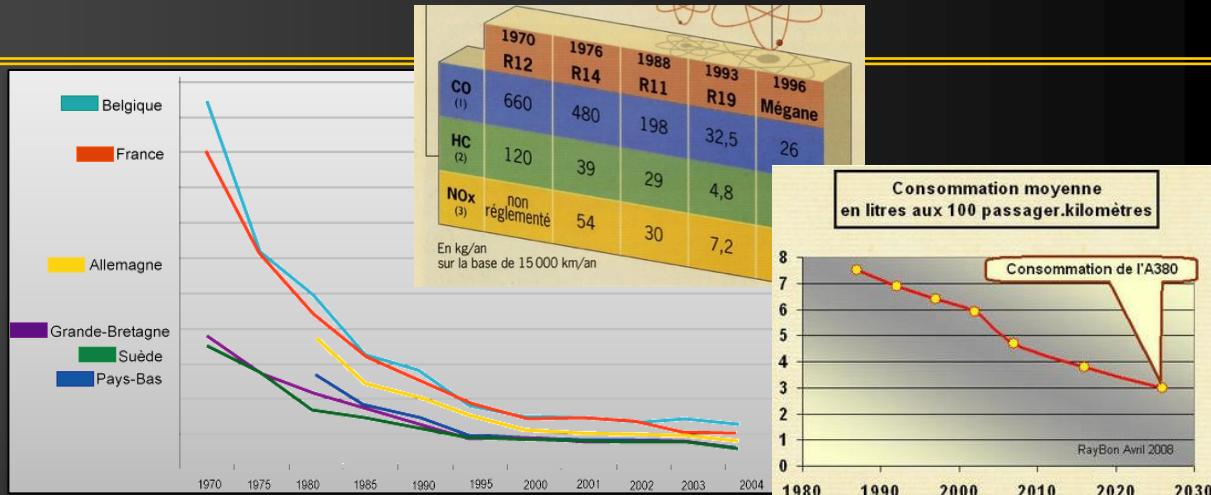
- Research program on design regimes (French National Research Agency – ANR)
- Papers:
 - **Agogué, M., Le Masson, P., et Robinson, D. K. R. (2012).** “Orphan Innovation, or when path-creation goes stale: missing entrepreneurs or missing innovation?” *Technology Analysis & Strategic Management*, 24, (6), pp. 603-616.
 - **Le Masson, P., Weil, B., Hatchuel, A., et Cogez, P. (2012).** “Why aren’t they locked in waiting games? Unlocking rules and the ecology of concepts in the semiconductor industry.” *Technology Analysis & Strategic Management*, 24, (6), pp. 617-630.
 - **Robinson, D. K. R., Le Masson, P., et Weil, B. (2012).** “Waiting Games: innovation impasses in situations of high uncertainty.” *Technology Analysis & Strategic Management*, 24, (6), pp. 543-548.
 - **Agogué, M., Yström, A., et Le Masson, P. (2013).** “Rethinking the Role of Intermediaries as an architect o f collective exploration and creation fo knowledge in open innovation.” *International Journal of Innovation Management*, 17, (2), pp. 24.
 - **Hooge, S., Kokshagina, O., Le Masson, P., Levillain, K., Weil, B., Fabreguette, V., and Popolek, N. (2014).** “Designing generic technologies in Energy Research: learning from CEA technologies for double unknown management.” European Academy of Management, Valencia, Spain.

Designing new energy systems: beyond decision and optimization, design theory and methods to manage R&D and innovation

1. Characterizing the transition challenge: **shaping the unknown**
2. A paradigm shift in collective action: **from decision-making to innovative design**
3. Consequences: new firms and ecosystems organizations – **cooperative architectures**
4. Conclusion: public policies in transition – from « incentives » policy to « capacity » policy

Contemporary innovation: from planning and optimizing to...

- Stabilized valued, continuous improvement of performance
- Stabilized competences – technical schools, R-labs,...
- Industrial « filières »
- Value-chain (intégrator, OEM, 1st tiers suppliers, 2nd tiers...)



Contemporary innovation: from planning and optimizing to... shaping the unknown

- Changing the identity of objects
- Renewing design rules and competences
- New collaborations: alliances, platforms, communities, open innovation, networks...



Digitalization

Cloud computing, internet of things...

Lab-on-a-chip

Microfactories

Big data

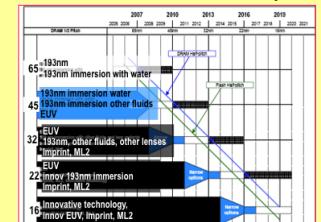
Additive fab

Negawatt & process

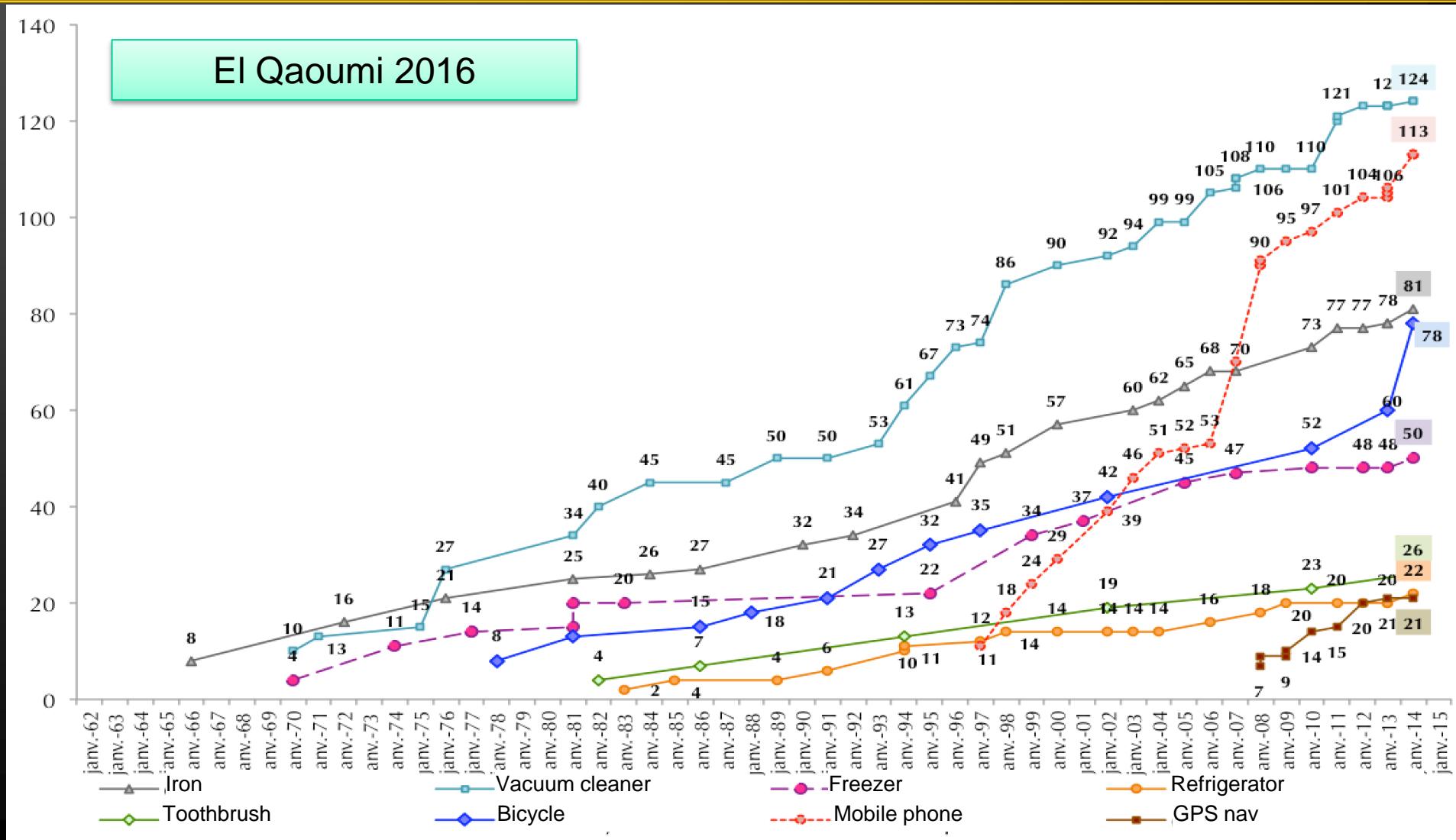
Apple Apps,
Android
developers

Intel
Architecture Lab
(Gawer et al)

ITRS (International
Technology Roadmap
for Semiconductor ind.)



Functional expansion – a strong phenomena



Critical issues for expansion

- **Fragile giants...**
- **(Innovation) bubbles** – hype and disappointment
- **Limited success of incubators and start-ups**
- **Unsuccessful, costly innovations**
- **Orphan innovations (Agogué 2012)**
- **Forever technologies of the future**

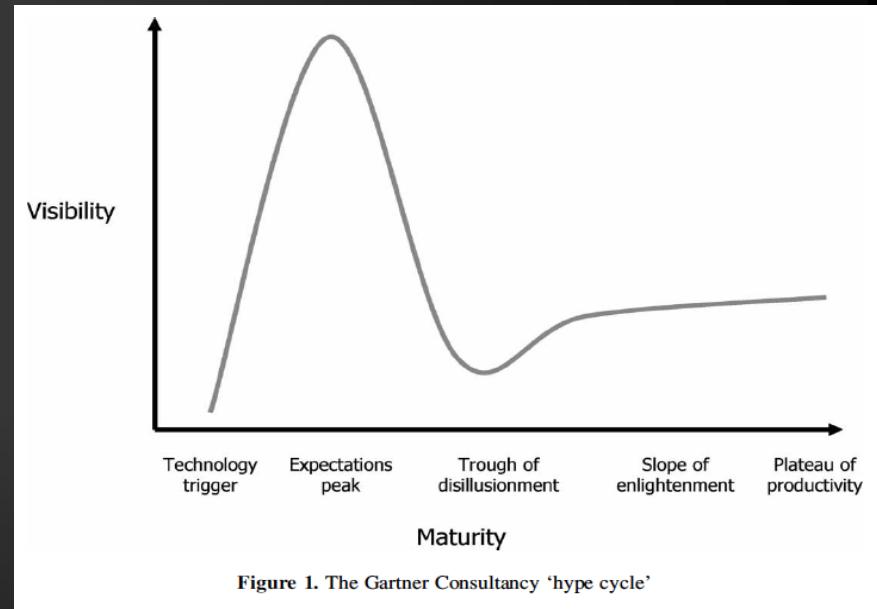
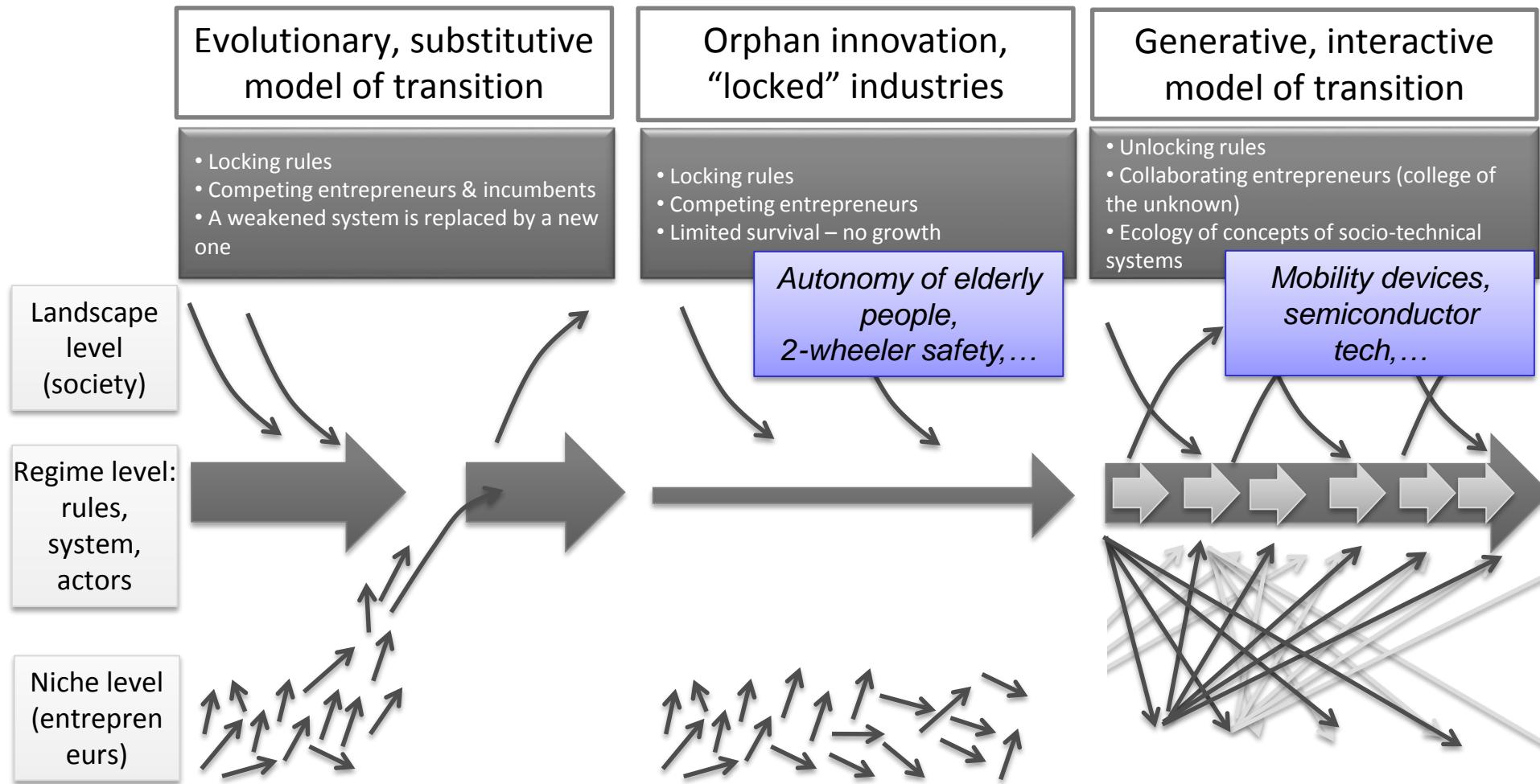


Figure 1. The Gartner Consultancy 'hype cycle'

Regime transition? Not only one trajectory...



Neither market, nor planning warranty one trajectory...
How can we *manage* transition? Collectively?

Designing new energy systems: beyond decision and optimization, design theory and methods to manage R&D and innovation

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Cognitive obstacles to collective expansion

- Open innovation, co-design, design thinking, brainstorming, fablab...
- Is it efficient?

A « productivity gap » phenomenon in brainstorming !
Individual and collective cognitive causes

How to make a square by moving ONE match?

Cognitive fixation on « square » :
Square = geometrical shape
Square = mathematical operation (2×2)

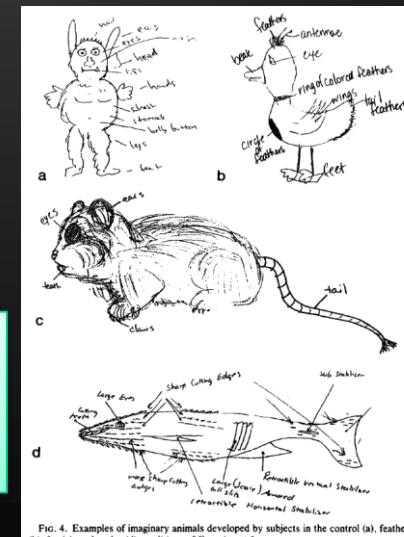


FIG. 4. Examples of imaginary animals developed by subjects in the control (a), feather (b), fur (c), and scales (d) conditions of Experiment 2.

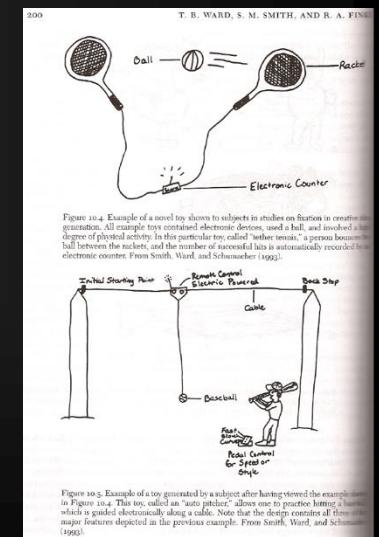


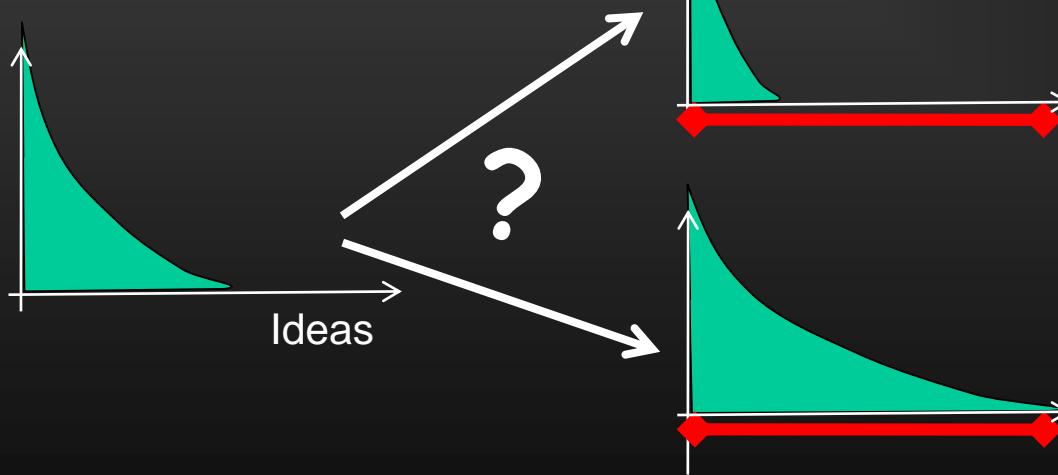
Figure 10.5. Examples of toys generated by a subject after being shown the example in Figure 10.4. The top, called an "auto pistol," uses one remote battery, 2 batteries which are guided electronically along a cable. Note that the sketch contains all the major features depicted in the previous example. From Smith, Ward, and Schmeidler (1993).

A paradigm shift in collective action: from decision making to design

In the 50s : optimization capacity? → decision theory.
Today : expansion capacity? → design theory

Suppose that a set
of “ideas” is given

Frequency



Is there a bias? How
to measure it?

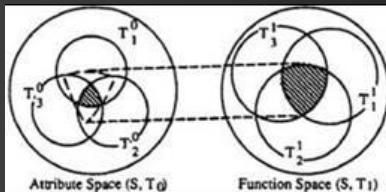
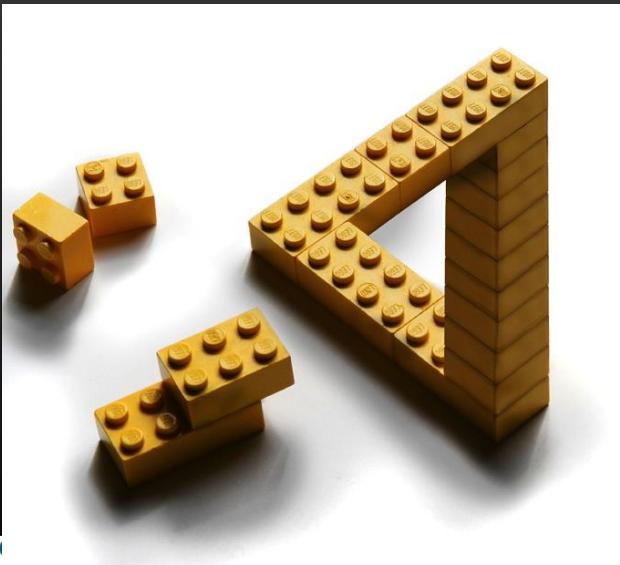
If there is a bias, what
are the causes?

How can one
overcome the bias?

« Models of thought » : new design theories for expansive reasoning



Hatchuel, Le Masson, Reich and Weil 2011 ICED (reviewers favorite)

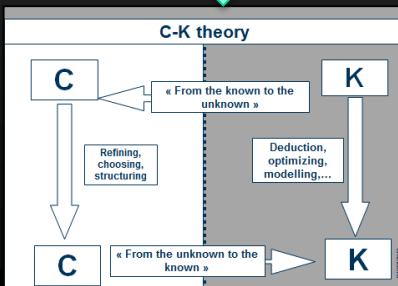


General design theory
(Yoshikawa 1981)

Axiomatic Design
(Suh 1988)

Coupled design Process (Braha & Reich 2001)

Infused Design
(Reich & Shai 2001)



C-K theory
(Hatchuel & Weil 2002)

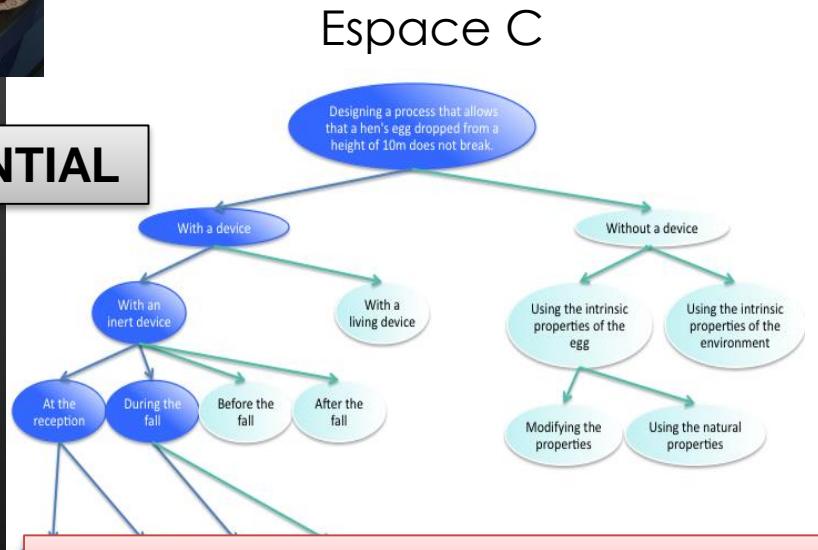
One example – individual fixation (Agogué Cassotti et al 2013)



You are a designer – propose as many creative solutions as possible on the following design issues:

Make that an hen's egg launched from 10m height doesn't break

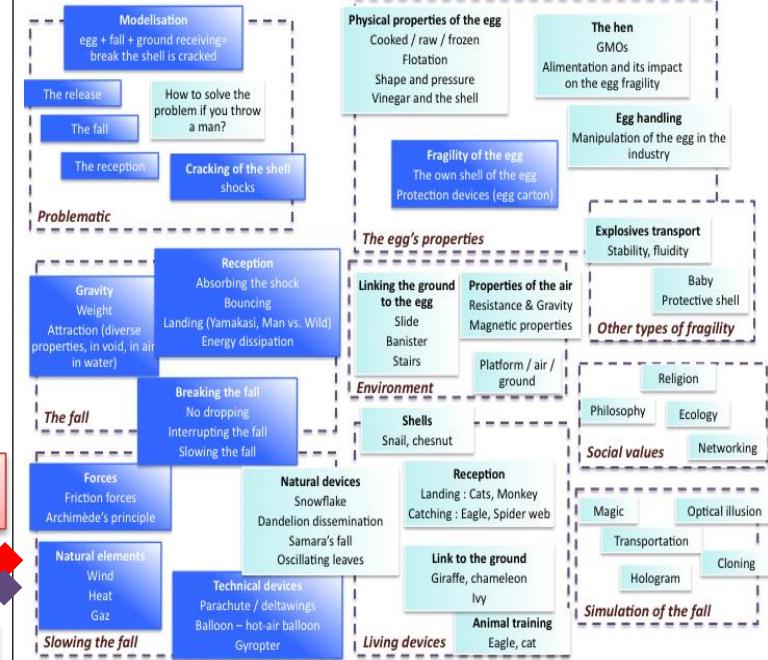
REFERENTIAL



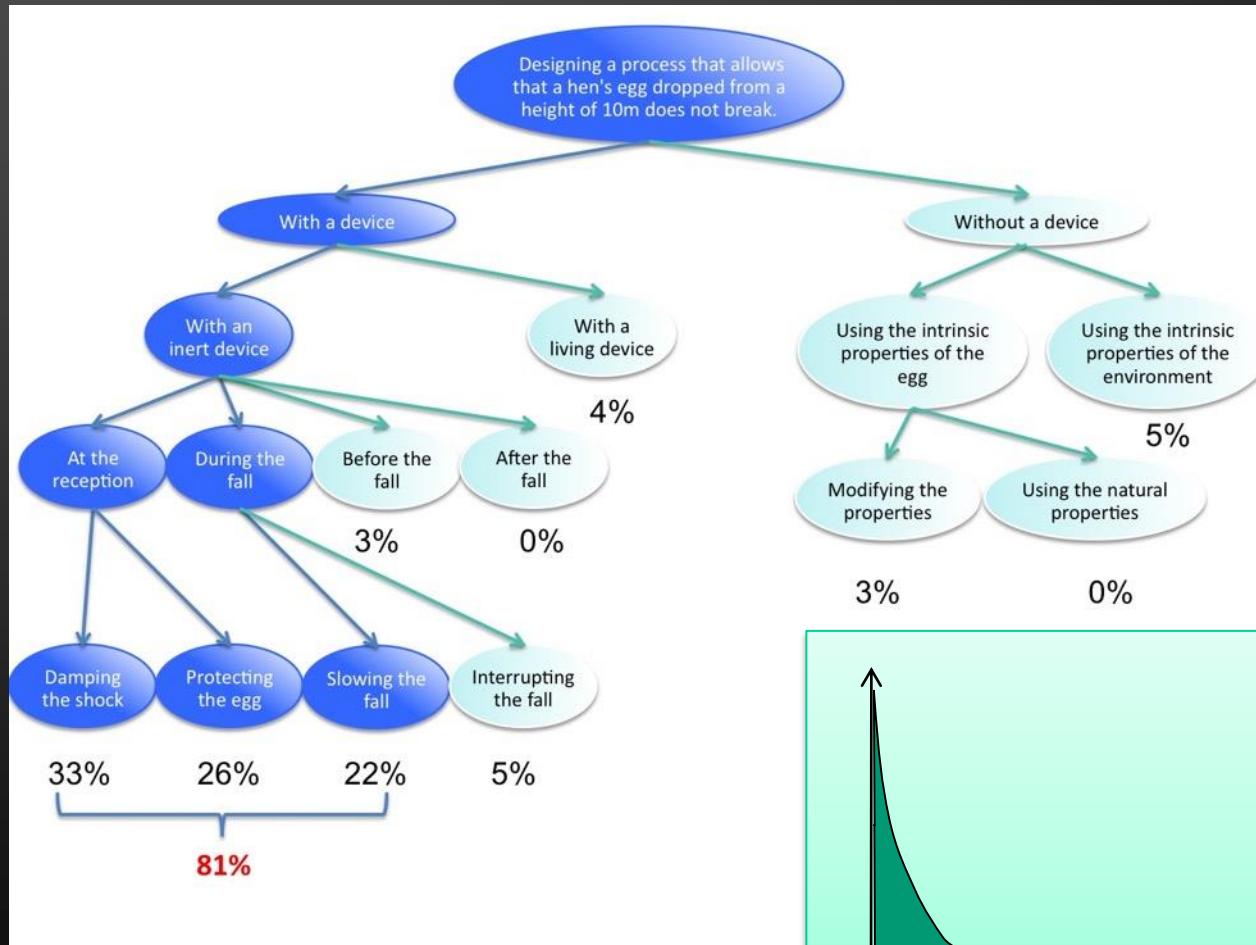
Restrictive
reasoning

Expansive
reasoning

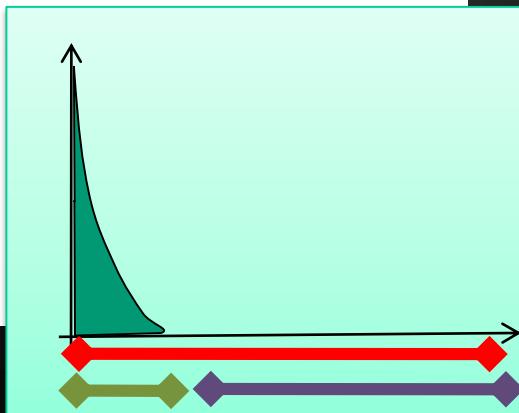
Espace K



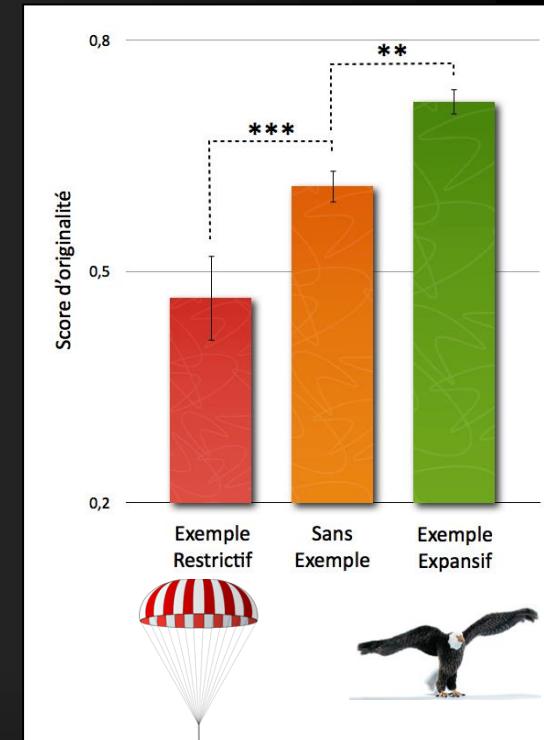
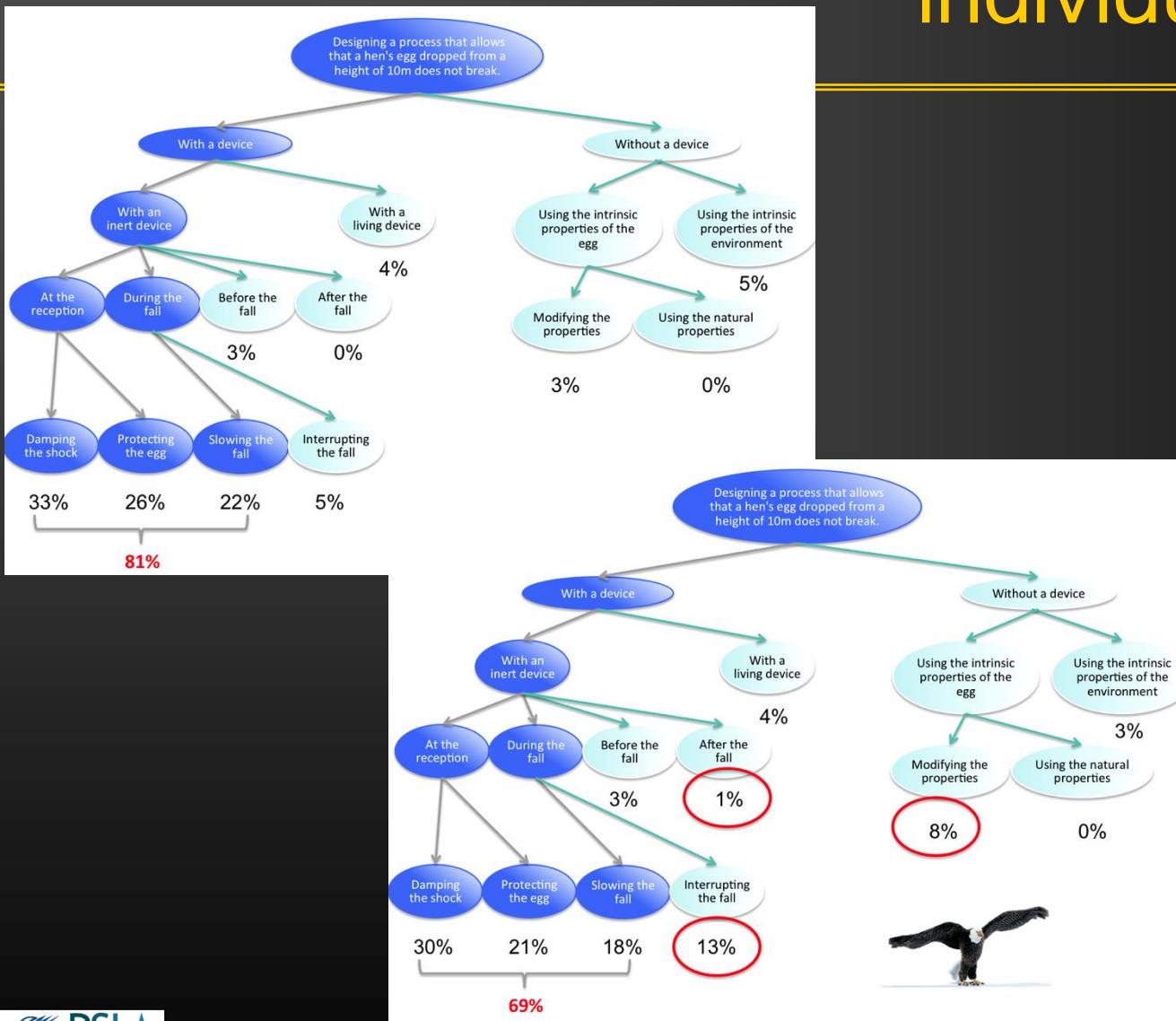
One experiment: the egg's task



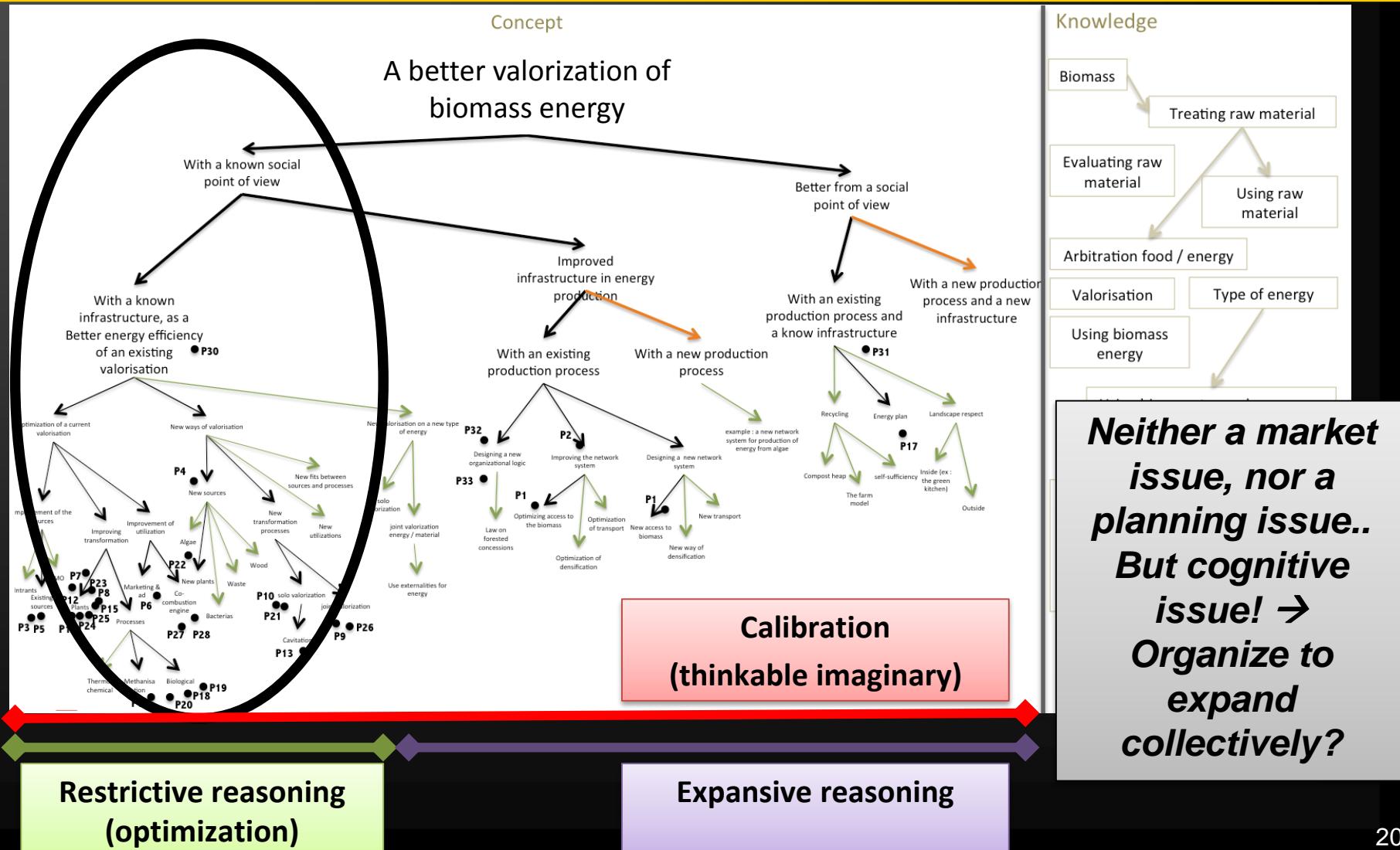
- 1- There is a bias
- 2- The bias is related to restrictive reasoning



The impact of example on individual creativity

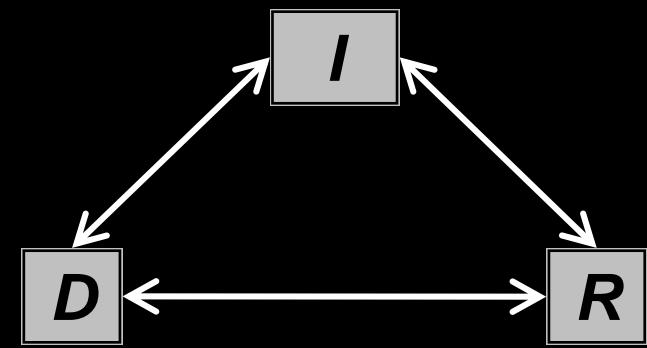


One example: identify fixations in biomass energy with C-K theory



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From R&D to RID

- New methods,
- New organizations
- New strategies



Renault Innovative Design Lab

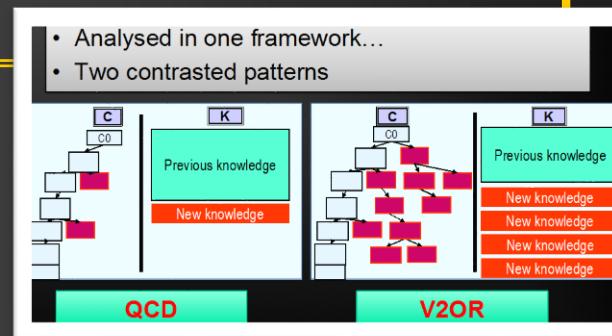


From R&D to RID

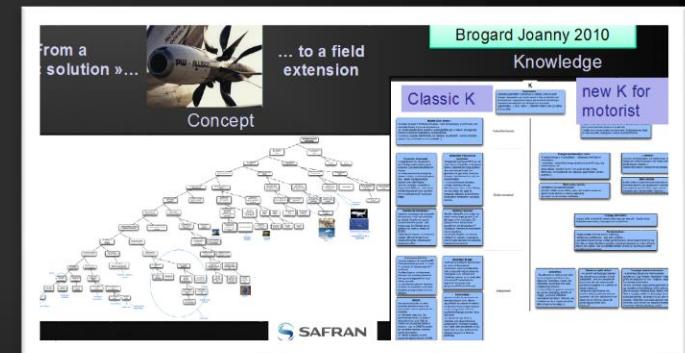
	Research (R)	Innovative design (I)	Rule based design (D)
Mission	Scientific autonomous question	Innovation field	Customer specifications
Goals	Validated knowledge	Design strategies (platforms, lineages...)	Project fulfillment
Ressources	Laboratories, competence teams, universities, literature...	Coordinated exploration groups and value management	Project team, tasks
Horizon	Depends on the investigation techniques	Contingent & strategic (strategic milestones)	Project deadline, standardized milestones
Economic value	Value of the initial question	Risk and optional strategies + knowledge	Project value

Innovative design methods and processes

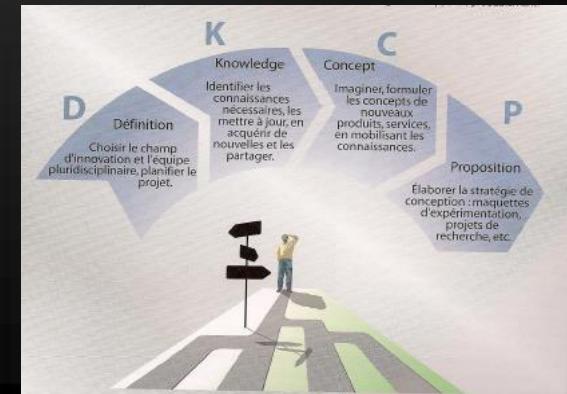
- Evaluation criteria



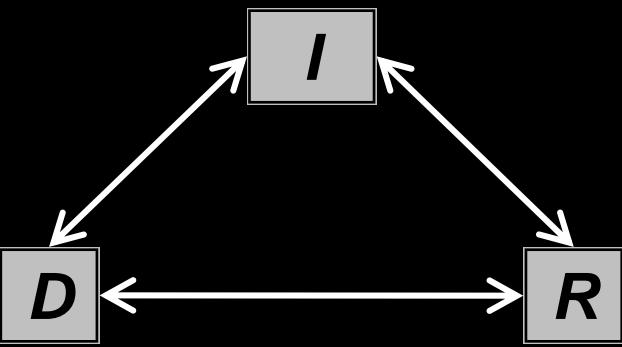
- Tuning breakthrough



- Creative leadership



- Collaborative innovative design



From R&D to RID

- New methods,
- New organizations
- New strategies



Renault Innovative Design Lab

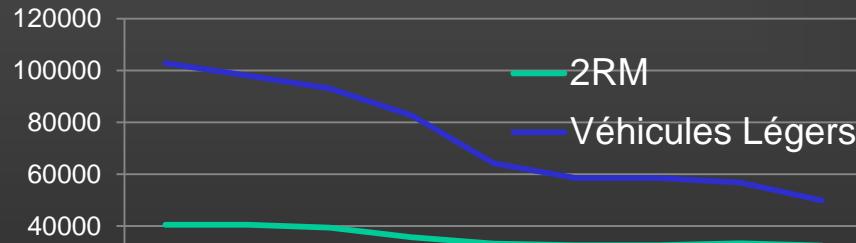


But the firm alone can not overcome all innovative design issues
→ new ecosystems?

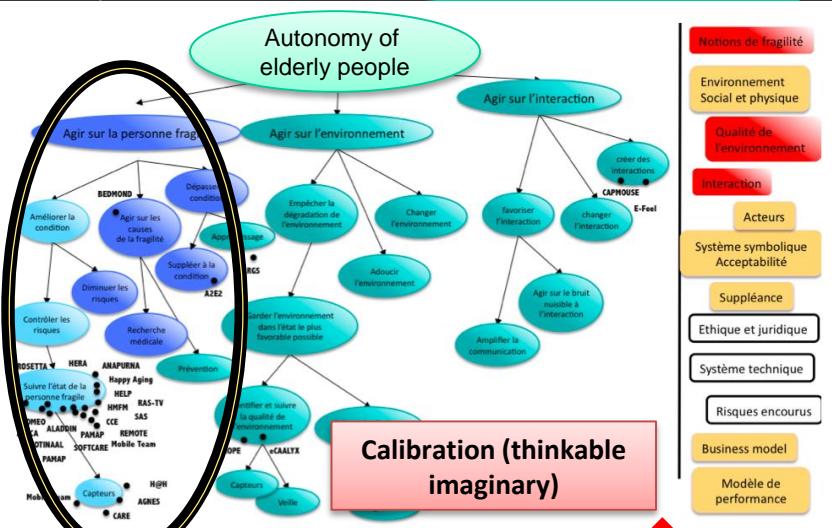
The firm alone can not overcome all innovative design issues → new ecosystems?

Without cooperative architectures:
orphan innovation

Road victims



Autonomy of elderly people

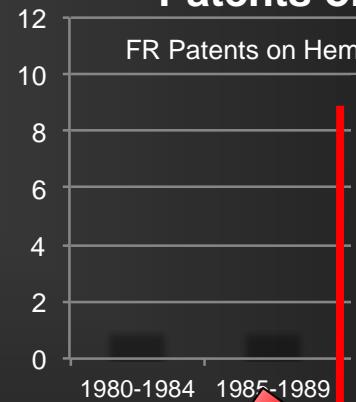


Restrictive reasoning

Expansive reasoning

Agogué et al.
2012)

Patents on hemp & construction



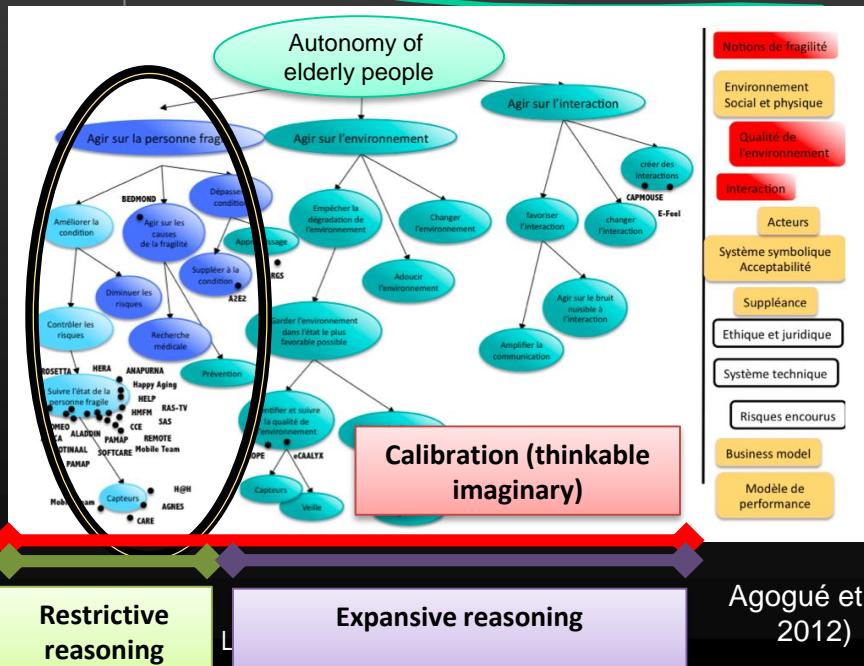
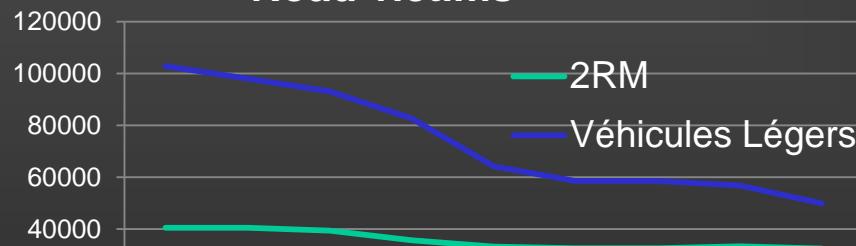
Without: only
one path
explored

Hemp for
middle age
houses
restoration

Cooperative architectures for innovative design

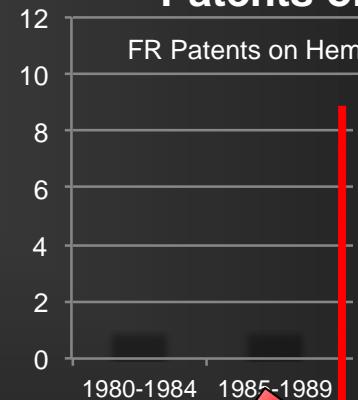
Without cooperative architectures:
orphan innovation

Road victims



With cooperative architecture:
expansion & growth

Patents on hemp & construction



Without: only one path explored

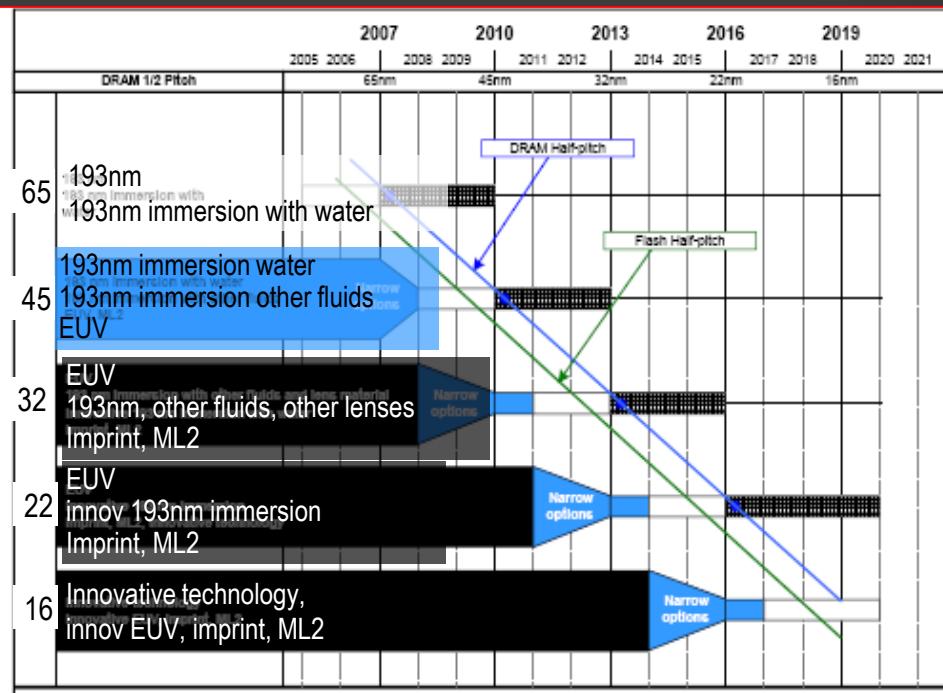
Hemp for middle age houses restoration

With cooperative archi: creation of multiple paths

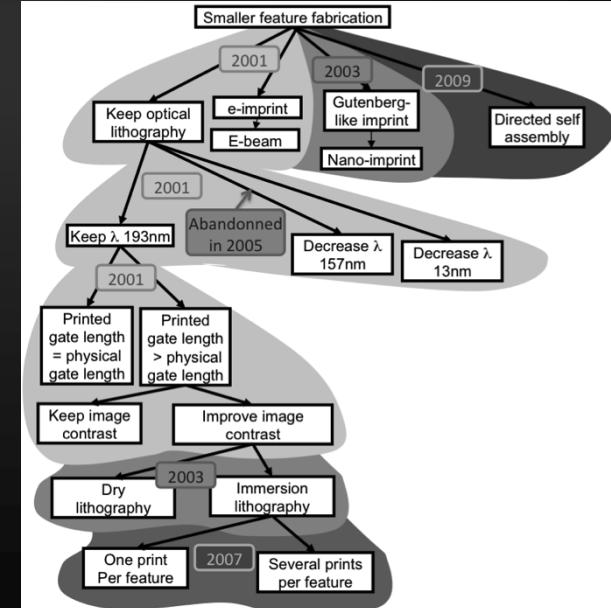
Hemp beton, hemp for roofs, for walls, hemp coating, multi-functions (weight, isolation, hygro-inertia,...); with new processes ; for bricks,...

Cooperative architecture to address Moore's law: ITRS

- Involve the *whole industry* every 4 months
- Free map of all the « unknown », needed technologies: *open agenda of innovations!*
- « We are not picking winners or losers » - NOT planning a single path → NOT decision, but *cooperation for expansion*



Example photolithography →
cooperative, expansive reasoning





The logic of cooperative architecture for innovative design

Cooperation of innovative designers (firms, labs, users,...) to expand « common unknown »

- Larger set of concepts, increase defixation
- Improved methods at the archi level
- Improve innovative design capacities inside companies
- Limit false expectations
- Better risk management at the ecosystem level
- Open to new partners

Variety of forms: « pôles », NGOs, professional associations, (some) research labs, schools, universities,...



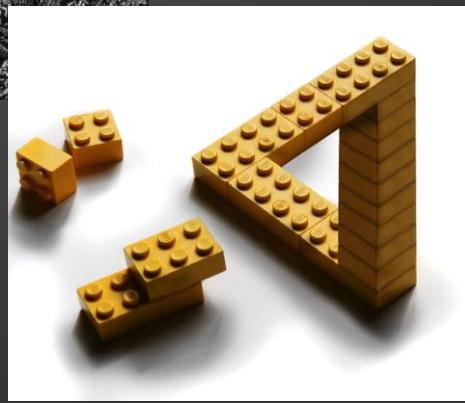
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1. Characterizing the transition challenge: shaping the unknown
2. A paradigm shift in collective action: from decision-making to innovative design
3. Consequences: new firms and ecosystems organizations – cooperative architectures
4. **Conclusion: public policies for system design–from « incentives » policy to « capacity » policy**

Public policies for system design– from « incentives » policy to « capacity » policy

- Issue: collective venture into the unknown
- Optimization & planning: fixation, low hanging fruits, no knowledge regeneration, orphan innovation
- Incentives ? → risks: reinforce fixation, speculative bubbles
- Capacity building policy ? → education, « innovation quality » reports, design referential at ecosystem level

5th European Energy Forum session 2: RDI choices and consequences on the organization



Designing new energy systems:
beyond decision and optimization,
design theory and methods to manage R&D and innovation

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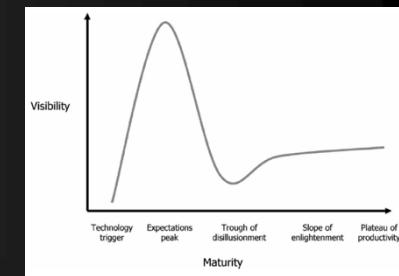
Characterizing the capacities needed for transition

	Optimization... and its risks	Innovative design
Reasoning	Decision-optimization → fixation	Expansion
Organization	R&D → no regeneration	RID
Governance	Asset mgt → « low hanging fruits »	Growth
Ecosystem	Value chain → orphan innov, self-destruction	Cooperative architecture

What kind of public policy for innovative design?

Risks of an « incentive » public policy

	Optimization... and its risks	Innovative design	Incentives policy?
Reasoning	Decision-optimization → fixation	Expansion	Fixation ++
Organization	R&D → no regeneration	RID	Only delay collapse?
Governance	Asset mgt → « low hanging fruits »	Growth	Perverse incentives
Ecosystem	Value chain → orphan innov, self-destruction	Cooperative architecture	Speculative bubbles



« Incentive » public policy: support to entrepreneurs, to research,...
 → Not adapted to innovative design and transition
 → And even risky

L'enjeu de politiques « capacitaires »

	Optimization... and its risks	Innovative design	Incentives policy?	Capacity policy?
Reasoning	Decision-optimization → fixation	Expansion	Fixation ++	Education
Organization	R&D → no regeneration	RID	Only delay collapse?	« Innovation quality » norms
Governance	Asset mgt → « low hanging fruits »	Growth	Perverse incentives	Innovation report
Ecosystem	Value chain → orphan innov, self-destruction	Cooperative architecture	Speculative bubbles	Design referentials

○ R2: La transformation des biens de consommation est permanente

