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## Why new approaches are needed for innovation - and brainstorming won't help!

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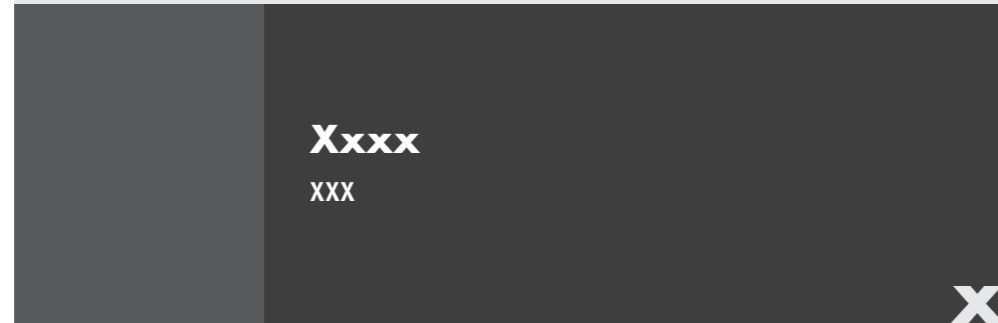
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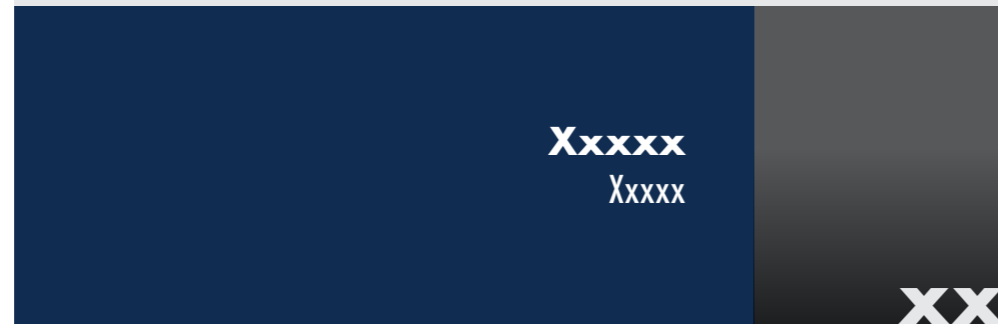
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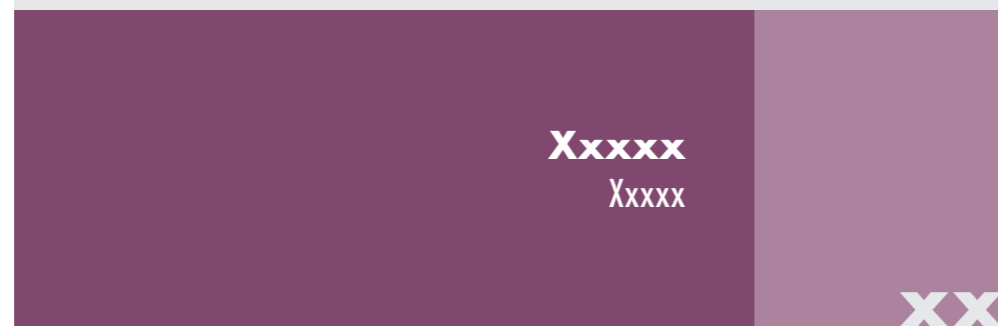
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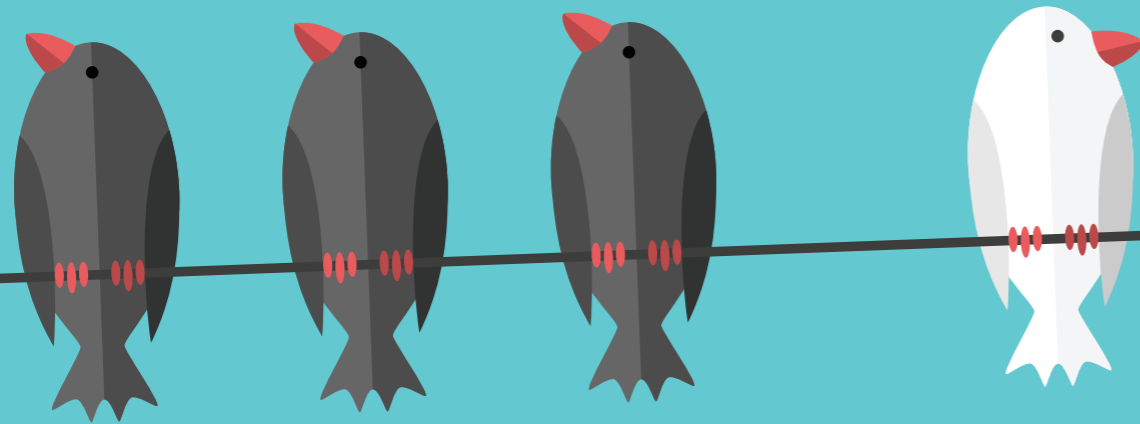


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# WHY NEW APPROACHES ARE NEEDED FOR INNOVATION AND BRAINSTORMING WON'T HELP!

*When Prof Pascal le Masson comes to the EAGE conference in Paris to provide the annual motivation speech, students should expect to be challenged about their ideas. He holds the chair of Design Theory and Methods Innovation at the Mines ParisTech-PSL Research University leading a team that is trying to disrupt old theories of innovation based on the new C-K theory. We asked him about the basics.*

"EXPLAM, SI RE CONE VOLORPORE PERRUMQUIAE

## HOW WOULD YOU BRIEFLY DEFINE THE PURPOSE OF CONCEPT-KNOWLEDGE (C-K) THEORY?

To answer your question it is important to remember what is innovation today. To be competitive, a company today can't only rely on improving its products and services. It has to propose new definitions of things. Everybody is aware of this when it comes to 'mobile phones' that have regularly changed their own identity in the last decades, becoming 'smart phones'.

This is also true in other industries: a company will propose automobiles that are not automobiles (electric cars, autonomous cars, etc.), bikes that are not bikes (see Velib in France), vacuum cleaners that are not vacuum cleaners. This new design regime has been unfolding since the mid 1990s. It calls for new methods or processes that are far different from the ones of the R&D departments of the 20<sup>th</sup> century.

In a sense this is an industrial revolution. C-K theory is born from the crisis of traditional innovation management: let's remember what was an engineering department in the 1990s, for instance in the automotive industry: these were 'white-collar factories' where 10,000 engineers and technicians saw their creative energy 'fixed' in the refinement of existing products and services and not really in a position to invent the disruptions and breakthroughs that ensure a sustainable future for the company and for society.

In the 1990s, when this regime begins to emerge, practitioners and researchers are confronted by an enigma: how can one account for the paradox according to which design results in something whose identity is different from everything that existed before, yet it is made of building blocks that existed before?

Resolving the enigma was an area of critical competition for scientists. The issue was to propose a theory that accounts for the design of new identities, new definitions

of objects, or, more generally, that account for the 'generation' of the new out of the 'known'. This theory should, of course, present all the features of a 'good theory', i.e., rigour, consistency of the reasoning, capacity to account for facts, capacity to enlighten original phenomena. Such a theory could for instance offer a better understanding for fundamental phenomena that are described under the names of 'creativity' and 'invention'.

Hence C-K theory was born at the crossroads of the crisis of industrial innovation and the scientific challenge of new 'models of thought' that account for generativity.

## WHICH DISCIPLINES ARE INVOLVED IN C-K THEORY?

When Armand Hatchuel and Benoit Weil first formulated the C-K theory (Hatchuel and Weil, 2003, 2009), they wanted to articulate two separate research fields: works on ontology and the theory of knowledge and works on creativity. They remark that fuzzy notions such as the designer's 'brief', the 'technological challenge', the architect's 'vision' actually form propositions of a same kind that is called a 'concept' (C) in the C-K theory.

A concept is a perfectly rational and rigorous proposition but, contrary to propositions in 'knowledge' (K), it has no logical status: it is impossible to say whether the proposition is true or false, it is undecidable with available knowledge. A concept can be 'there are chairs without legs'. A concept C is hence clearly different from the propositions in K which all have a logical status (true or false).

C-K theory relies on the idea of distinguishing two spaces, C and K. And the great discovery is that these two spaces have very different structures and interact through clear operators. Their interaction provokes a dual expansion, leading to the generation of new objects and new knowledge.

This distinction reveals the logics of 'innovative design' that link the logics of creative ideation, chimera and desirable unknowns (C-space) and the logics of knowledge, modelling, inference, laws, rules and belief (K-space). Innovative design is neither limited to creativity nor reduced to an increase in knowledge about existing things. C-K theory models a process of dual expansion on the unknown and the known, stimulating each other. Knowledge stimulates creation and creation stimulates knowledge.

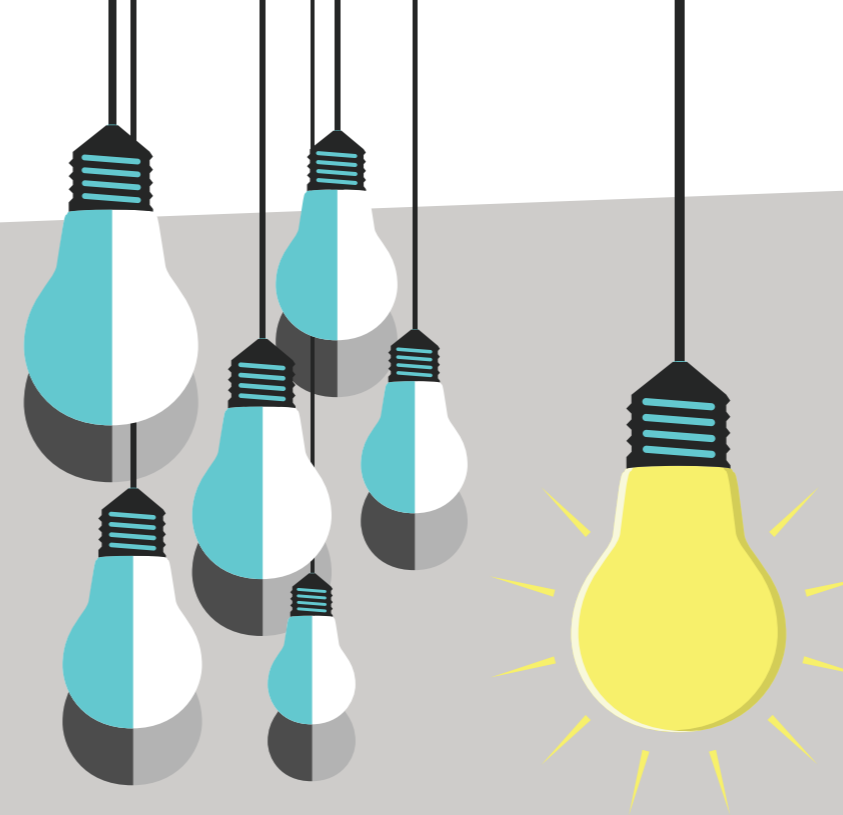
Hence C-K theory belongs first to the stream of works on 'models of thought' –just like 'decision theory' in its time. But it provokes a paradigm shift: from decision to design. The question is no more to 'take the right decision' (to optimize) between existing alternatives, in a given model. It consists in generating new and better alternatives. A manager is no more constrained to be a 'decision maker' – he can be a design maker (being a designer himself or organizing and supporting rigorous efficient design processes).

This 'model of thought' is strongly generic to many disciplines: it helps management science to enter a 'post-decisional' paradigm (Hatchuel et al., 2010; Le Masson et al., 2010); it also supports much research in engineering sciences to shift from modelling and optimizing to designing (Potier et al., 2015; Le Masson et al., 2017). Beyond engineering design and management science, it has several implications and uses today in many disciplines such as cognitive science, philosophy, logics, history, economics, sociology, agronomics, chemical engineering, mechanics and more.

### CAN C-K THEORY EXPLAIN HOW NEW IDEAS POP UP, E.G., EUREKA MOMENTS?

C-K theory is today widely used in the analysis and experiments on ideation. Let's mention two recent results.

1. In the world of creativity and ideation, one issue is the so-called 'fixation'. There is 'fixation' when people in an ideation challenge, tend to propose similar ideas and are unable to explore more 'original' ideas. Agogué et al. (2014) have shown with C-K theory that it is possible to 'reinforce' or 'overcome' fixation just by showing to ideating people relevant examples. Some of the examples being purposefully chosen to be 'fixating' and others to be 'de-fixating'. C-K theory was used to generate the referential to evaluate fixation and to generate the 'fixating' and the 'de-fixating' examples. This paper was a first step for using design theory to address issues in creativity and ideation. This is now a very powerful stream of research.
2. Another stream of work was done to understand how the structure of knowledge influences creativity. Recent research on C-K theory and mathematical models have shown that knowledge space should follow the so-called 'splitting condition' to support expansion. We have tested the hypothesis in several situations. For instance, we studied how students are taught in 'industrial design' schools, which are supposed to be a place where creative people acquire knowledge to be more creative. And we have shown that in Bauhaus, one of the most famous industrial design schools, courses consisted in teaching splitting knowledge (Le Masson et al., 2016). We have studied how architects use drawing to split their own knowledge base (Brun et al., 2016).



### C-K THEORY EMPHASIZES COLLABORATIVE DESIGN. WHAT DOES THAT MEAN?

One of the issues in organizing innovative design consists in helping to work together in a creative way: how can one mobilize experts coming from different disciplines to propose creative concepts. It is well known that in such situations, fixations are reinforced and people tend actually to propose a consensual solution that is only poorly innovative. And brainstorming is not a solution – on the contrary – it has long been shown that brainstorming decreases the creativity of people put in a group instead of working separately!

So how to overcome collective fixation? C-K theory helped to understand the multiple causes of collective fixation and led to propose original processes to overcome them. This is the so-called 'KCP process'. KCP is a way to 'linearize' a C-K design process, preserving generativity as much as possible. To make things simple, it reverses the logic of brainstorming: first share and accumulate knowledge and make a 'state of the non-art' (instead of 'forgetting what you know' or 'make a state of the art'); then force exploration to overcome fixations (instead of letting people explore without directions); and finally build a design strategy that manages the portfolio of projects (instead of selecting a couple of attractive ideas and rejecting many others). The results are very impressive (Hatchuel et al., 2009).

### ARE THERE PRACTICAL APPLICATIONS OF C-K THEORY FOR GEOSCIENCE AND ENGINEERING IN OIL AND GAS EXPLORATION AND PRODUCTION?

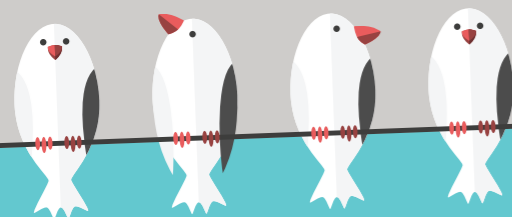
There are today many practical applications of C-K theory (Hatchuel et al., 2015). Many companies are supporting the Chair of Design Theory and Methods for Innovation: big companies like Airbus, Dassault Systèmes, Renault, RATP, SNCF, ST Microelectronics, Thales; but also smaller one like Urgo, Ereie, Helvetia and Nutriset. We work with them to develop methods, processes and organizations that are adapted to the 'innovation departments' created in many companies.

Innovation directors are in need of methods, and they want to go beyond project management or brainstorming. With C-K theory, they can enrich and evaluate innovation projects more rigorously, they can evaluate the variety and originality of the proposed alternatives, they can evaluate the level of disruption and value creation (see Elmquist and Le Masson, 2009).

In the oil and gas industry we have had many fruitful partnerships, in particular with Schlumberger, Vallourec and Technip. The recent experience with Technip is really impressive: this is the first time that social networks inside a company were used to support an innovative design process. Several hundreds of designers all over the world were able to collaborate in an innovative design process. This was a world first!

### WHAT WOULD YOU LIKE STUDENTS TO TAKE AWAY FROM YOUR PRESENTATION AT EAGE PARIS?

I am sure that many of them are working on great innovative projects, or will have to in the future. And I hope that they will find in design theory a wellspring of methods and 'models of thought' that could help them to be more 'defixed' in their engineering work. Science and engineering is today a fantastic field for innovative design – and design theory and design methods aim at supporting the efficient development of new concepts that support sustainable growth and progress for our societies. Moreover the students will tomorrow be managers of scientists, engineers and designers. And I hope that they will keep in mind that managing innovative design is today a critical challenge. It requires new talents beyond 'intuition' and 'decision making'. I hope to give them the pleasure and the taste for innovative design!



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## ARE THERE OTHER AREAS OF RESEARCH THAT YOU ARE INTERESTED IN?

When you work in innovative design you become a 'polymath' (as one of my colleagues Georges Amar said): you are interested in all fields of knowledge!

## YOU SEEM TO HAVE MANY ACADEMIC AND OTHER PROFESSIONAL COMMITMENTS. DO YOU HAVE ANY INNOVATIVE IDEAS FOR MANAGING YOUR TIME?

There is no mystery: this is just because I am not alone! We are actually a full team of researchers working in innovative design – and what you see and what I have described is a very, very collective work. We try to apply our own theories and develop 'collaborative design' in research!

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