# IRON-MAN's Jarvis, the Architect assistant

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## 1 Introduction

Systems engineering and architecture must adapt to today's complex and uncertain world. Systems can no longer be thought of in isolation from their contexts. Innovative solutions must be found to avoid reproducing what already exists. As identified by several researchers [CRA 01] [WIP 01], a new design and architecture approach for complex systems needs to be proposed to enable a paradigm shift. The current paradigm, going from a problem to solutions thanks to engineering, will be enhanced by this new paradigm. With this one, the aim is to go from a present (with its affordances and existing capabilities) to enviable futures thanks to architecture. In line with the state of the art, we propose a innovative approach (helped by tools) centred on the exploration of ecosystems to apprehend their scope and complexity [CLA 01]. To achieve this, Jarvis, our assistant, will enable us to take an overall view of an ecosystem, explore it and consider possible alternative architectures. This approach allows us both to control data and knowledge and to visualize the impact of decisions and their justification.

## 2 Methods

What if Jarvis (the assistant of Iron-Man) wasn't just for Iron-Man, but also became the best assistant for engineers and architects? This is why we proposed an innovative architectural approach for complex (eco)systems. We illustrate it with a PoC (Proof of Concept) called Iron-Man about the hydrogen (h2) ecosystem in Occitanie (French region).

This approach is based on three messages as illustrated on figure one:

- Grounding Engineering on knowledge

We are in the era of data. We aim to build strong and trustable data bases by using computational AI and experts' knowledge. This capability will help navigating uncertainty and complexity.

Our PoC approach is based on architectural profiling. It consists of a multi-dimensional exploration of the present, the resources available, the systems already in place and the challenges present in our ecosystem. The aim is to take an in-depth snapshot of the present. To achieve this, we combined giga-mapping, systemic thinking and computational AI (*Wolfram Alpha*) to build data bases.

- Set-based Attitude / What if attitude

We are sure you often wonder "What if …?" What if tomorrow we had an instant answer to our what ifs? Today, only a few solutions of system architectures are explored, in several months. What if we can explore thousands of alternatives in few hours? You are sure to include some game changer alternatives and do not need months to study them. By building simplified model of the ecosystems, based on the previous data bases, we can explore the uncertainty and perform instantaneous what if. We can take decisions and see their impacts on our objectives. What if the Occitanie decide to convert all its trains to h2? What is the impact on the budget and on the carbon footprint? Some tools of augmented intelligence (*Geeglee*) allow us to explore these alternatives to select the preferred ones. By exploring multiple alternatives, we are selecting the enviable architectures we want to detail [HOL 01]. System engineers, with process, method and tools, will then detail these architectures.

- Systemic tools for system thinking-oriented engineers and architects

Thanks to systemic tools, Iron-Man allows multi and trans disciplinary work and subjects. More than the different engineering disciplines, it also answers to strategic, sociologic and business challenges in large ecosystem. [BOU 01] Figure 1 shows examples of the tools used for PoC (from top to bottom: *Wolfram Alpha, Obsidian, Chat GPT, Geeglee, Kumu*).

The aim is now to develop an assistant for this approach: Jarvis. It will not only collect and manage data, explore the ecosystem and possible alternatives, but also create new alternatives using genAI.

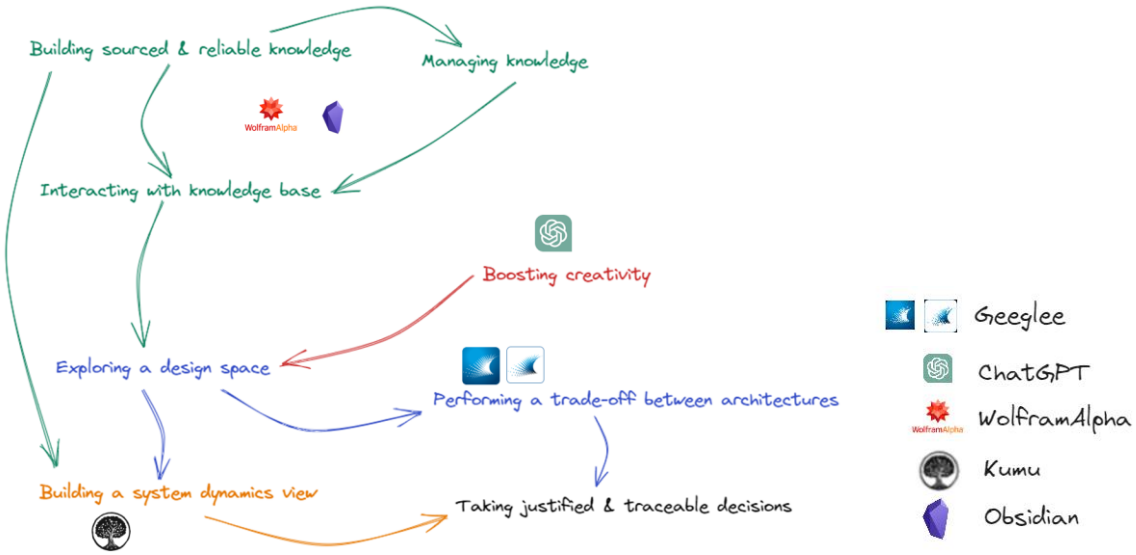


Figure 1: Main messages of the architecting complex systems method

## 3 Results

With the PoC Iron-Man, we built in one month a strong data base. We explored thousands of possible architectures for the ecosystem of h2 in Occitanie. Our model included technical aspects (storage, production and transport) but also criteria about sustainability (carbon footprint), economy (price of h2, public investment), strategy (conversion to h2 transports for the region) and even sociology (acceptance).

We have identified significant gains in terms of coverage, return on investment and time to market.

This is a comprehensive approach to system design and modelling, enabling the optimization of different possible architectures. The design space is explored using augmented intelligence, and constraints allow us to reduce the architecture space within a trade-off situation.

## 4 Discussion

This new approach to architecture enables us to meet the new challenges posed by the explosion in data and complexity. It enables us both to capitalize on and encode knowledge, and to explore architecture spaces. Architecture is no longer based on a problem-solving paradigm, but on a present/future vision. The architect draws on the present and the surrounding ecosystem to propose a system that responds to multidimensional constraints, demands and challenges [REC 01]. By adopting a set-based attitude, the architect ensures that he doesn't replicate what already exists but proposes a disruptive, innovative and enviable architecture.

This approach has only been illustrated on a theoretical case study, and now needs to be put to the test on a concrete one. New tools also need to be integrated into this approach. Today's ecosystems are highly complex, with hundreds of dimensions. Human intelligence is unable to grasp this complexity. We have therefore used augmented intelligence tools, but artificial intelligence tools would be more appropriate here. These tools would enable us to imagine relationships between artifacts that are not yet linked, but also to imagine new architectures. AI would also greatly facilitate knowledge management.

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