Multidisciplinary Optimization (MDO) problems represent one of the hardest and broadest domains of continuous optimization. By involving both the models and criteria of different disciplines, MDO problems are often too complex to be tackled by classical optimization methods.
We propose an original approach for taking into account this complexity using a self-adaptive multi-agent system. Our method agentifies the different elements of the problem (such as the variables, the models, the objectives). Each agent is in charge of a small part of the problem and cooperates with its neighbors to find an equilibrium on conflicting values.

As an MDO problem implies different disciplines, several engineers (one per discipline for instance) may have to intervene in the global optimization process of the problem. We propose that each engineer may directly interact with the system during the solving process in order to change, to test, to adapt or to add elements to the parts of the problem inherent to its discipline. This implies offering the engineers with an easy way to modify their own constraints of the problem, to set specific values to some variables or change their definition domains and to automatically take these changes into account. We call this vision of MDO Integrative and Interactive Design as stated by the ID4CS (Integrated Design for Complex Systems) project, regrouping 9 academic and industrial partners, including Airbus and Snecma (Safran Group).

The work we present aims at showing that our approach is able to solve classical MDO problems, in spite of this radically different solving process. Since each variable, each objective, each constraint, each model is associated with its own representative agent, by describing the behaviors of these agents we will describe the solving process. In fact, each modification affects directly one agent of the system which is in charge of managing each modification locally on the base of cooperative interactions with, from neighbor to neighbor, all the other agents of the system. Consequently an autonomous adaptation appears at the global level from the self-organizing interactions of the agents, without any global knowledge: the relevant information they constantly exchange, the cooperative choices of the agents when deciding how to act and their self-tuning capacities, which will be shown to converge towards desired solutions.

The work presented here has given birth to a first prototype. This prototype, based on the Eclipse frameworks, allows engineers to define the different elements corresponding to their domain and build MDO problems using them. They can then launch the solving and interact with the system at runtime. The prototype is currently tested with promising results on various test cases: four test cases provided by our industrial partners Airbus and Snecma, and several well known academic optimization problems, such as Rosenbrock's valley. The size of these test cases ranges from few elements up to sixteen models and more than eighty variables.