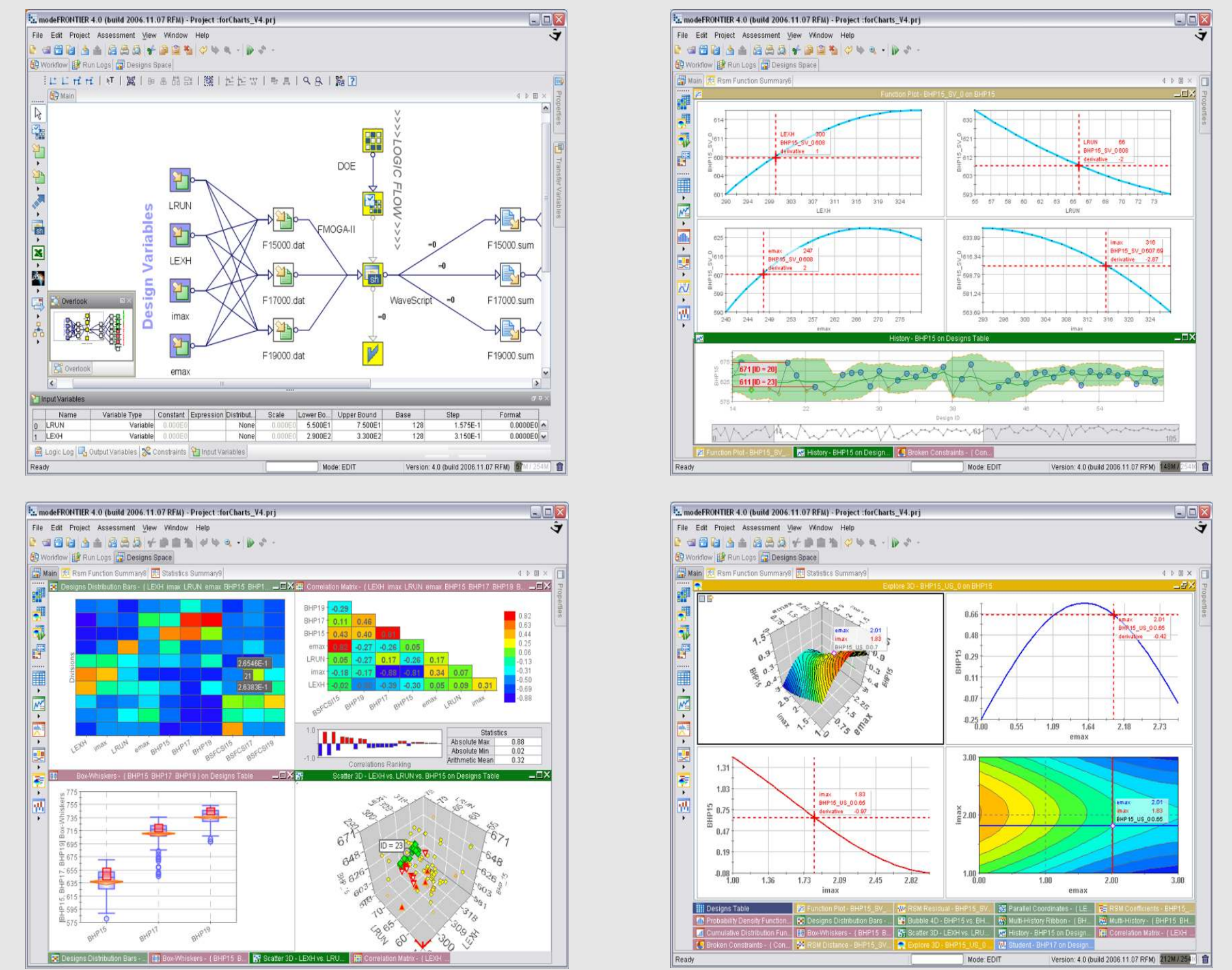


modeFRONTIER: THE OPTIMIZATION TOOL

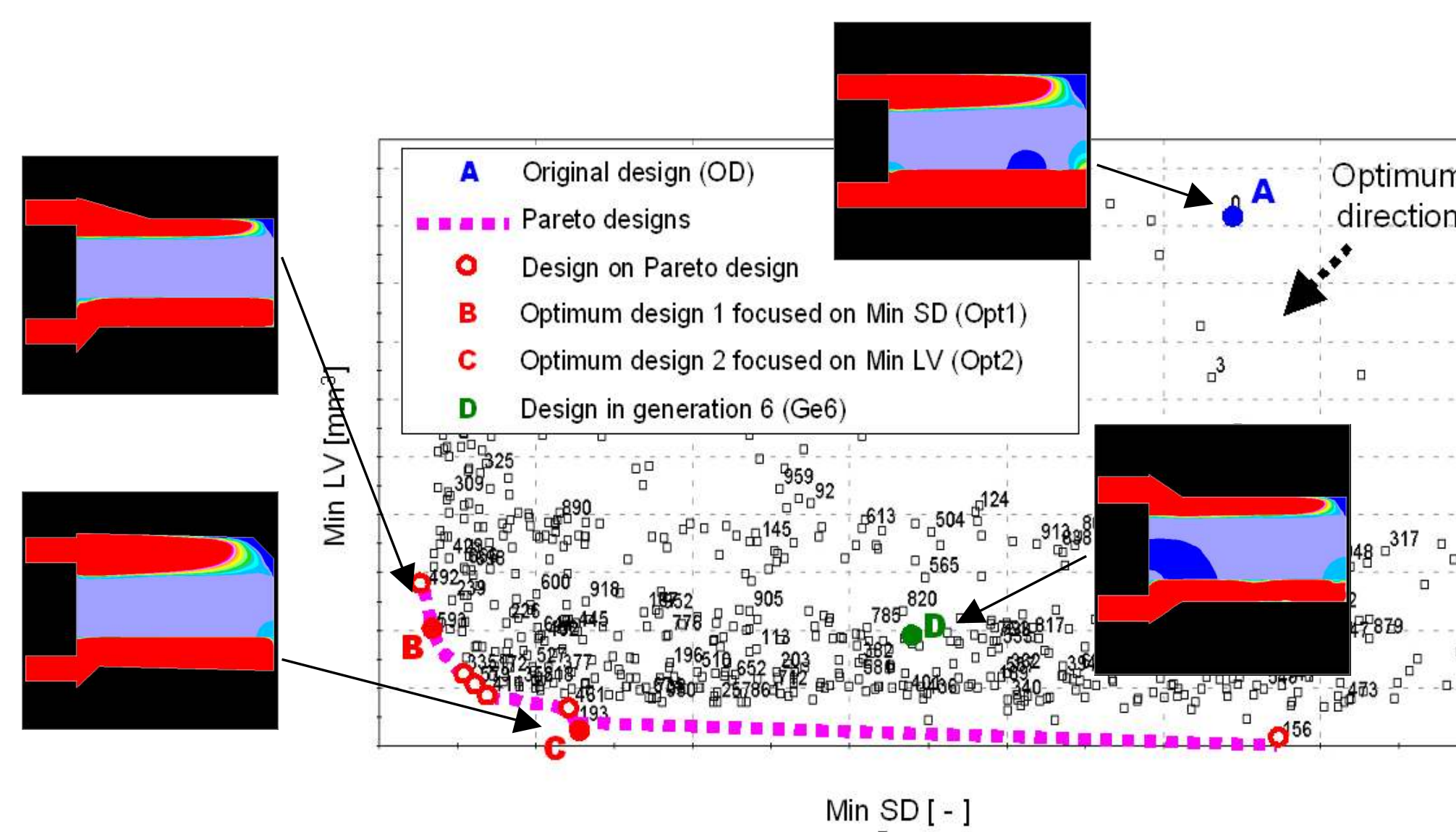
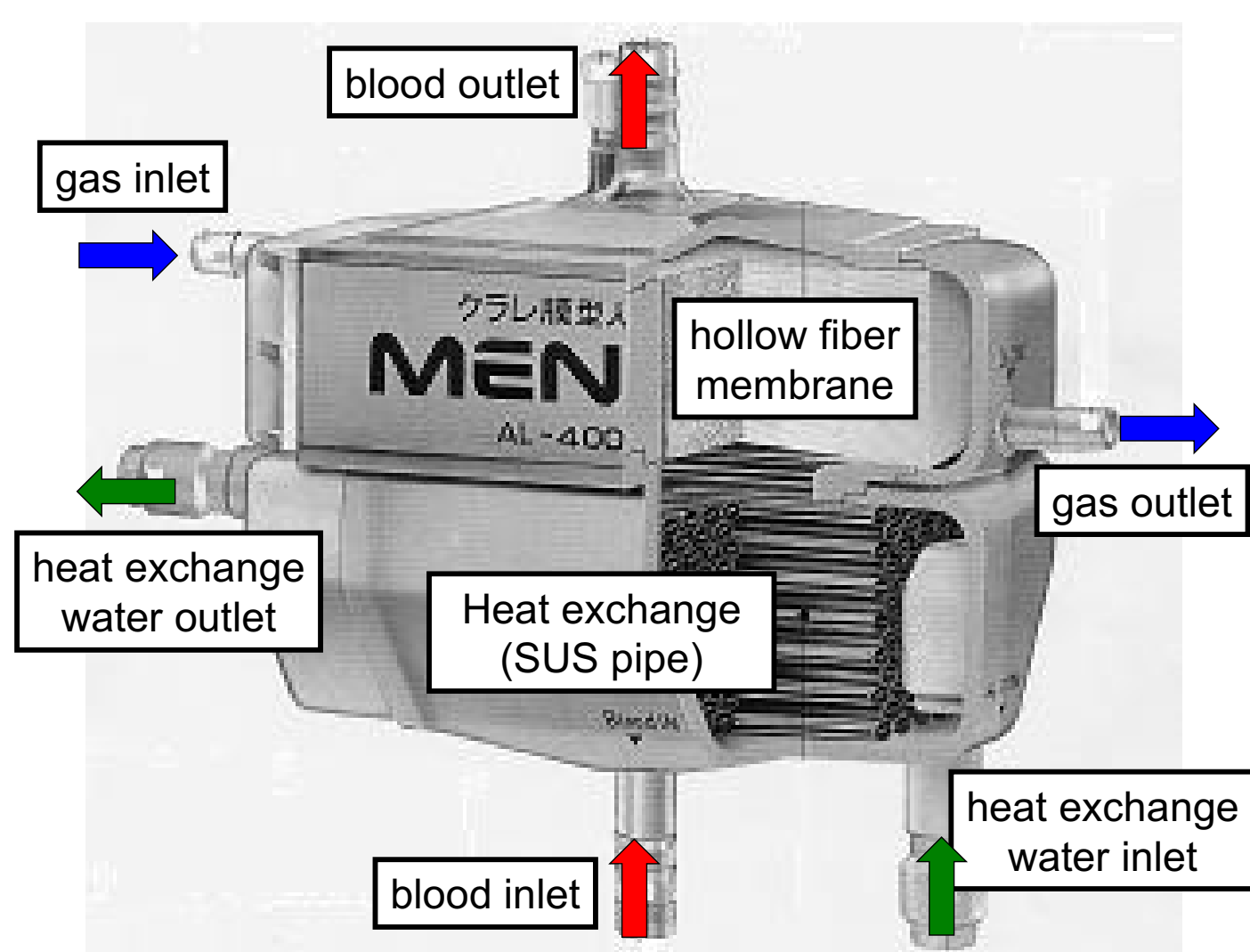
The demand for accurate and efficient design techniques motivates research institutions and universities to innovate and improve simulation methodologies and techniques faster than ever before.

Numerical optimization, in combination with simulation, has a significant impact on this context: together, they allow, simultaneously, to improve the design, to shorten development times and to cut costs. The same design of experiments and optimization techniques can be indeed crucial to tune numerical models over experimental reality, or to handle correctly uncertainties that affect them. In fact, exploiting the full potential of numerical simulations and increasing their predictive accuracy, requires a correct assessment of load cases, boundary conditions, material laws, physical models, and so on.

Esteco's modeFRONTIER optimization tool plays an important role in this scenario: the software has the ability to couple and steer most of the commercial CAE tools and in-house codes, and can be easily integrated in the simulation and testing standard procedure.

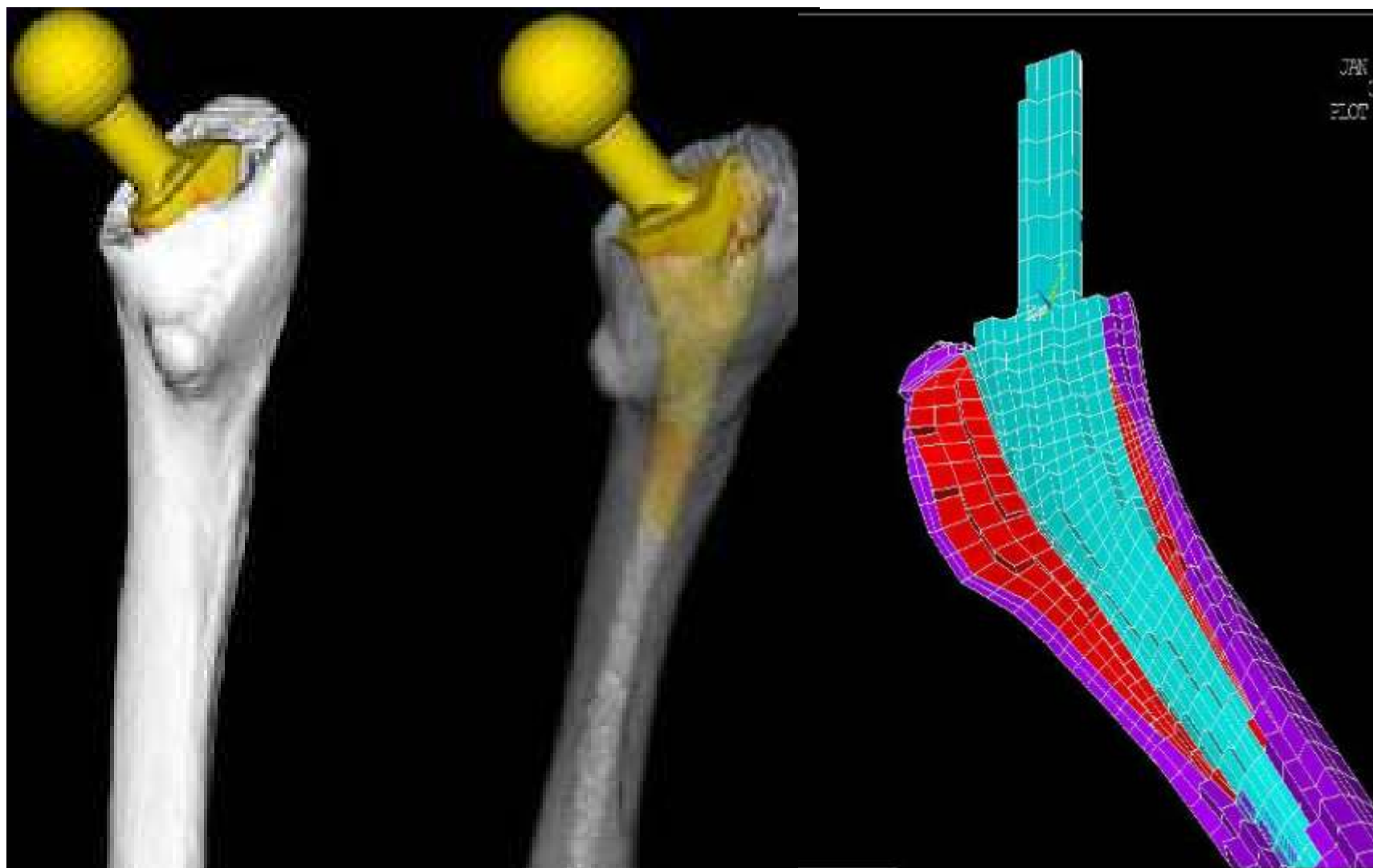


ARTIFICIAL LUNG DESIGN OPTIMIZATION



Multi-objective shape optimization techniques were applied to improve the design of an artificial lung: an improved Multi-Objective Genetic Algorithm (MOGAI), automating a computational chain made by CAD, mesher and CFD commercial software, designed a solution with volume of stagnation zones (anti-thrombogenicity) reduced by 70% and a flow rate standard deviation (gas exchange performance) reduced by 30%.

BONE IMPLANT FEM MODEL STOCHASTIC VALIDATION

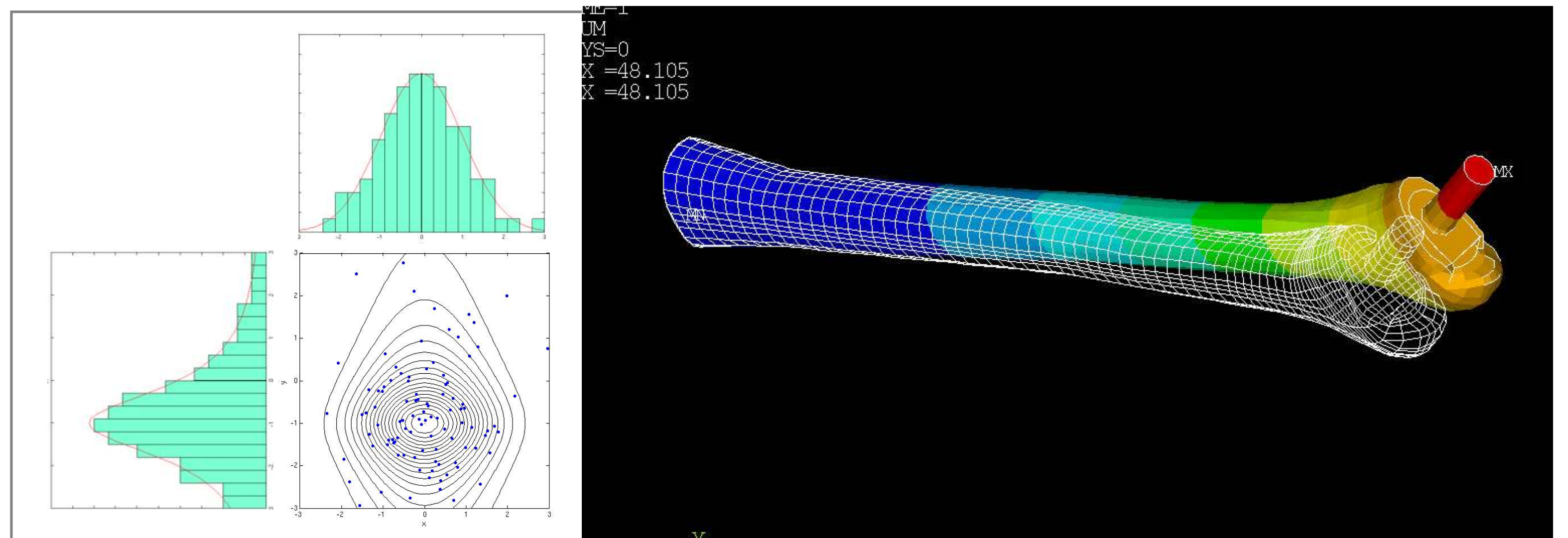


Considered parameters were:

- bone mechanical proprieties (Gaussian distribution)
- implant stem (uniform probability distribution between 9 different sizes commonly used in surgery)
- bone/implant interface conditions (assigned to each one of the seventeen contact zones defined, with a uniform probability between the fully osseous-integrated condition and the presence of fibrous tissue)
- magnitude of the hip contact force (Gaussian distribution)

Qualitative and quantitative effects of such variabilities were evaluated on outputs such as: Von Mises strain and stress, relative peak micro-motion, peak detachment, contact pressures and frictional stresses at the bone/implant interface.

Design of experiments techniques were applied to assess the influence of some parameters affected by uncertainties on the predictions of the FE model of a human femur implanted with a cementless anatomical stem, taking into account frictional contacts at the bone/implant interface.



Conclusions

The DOE, optimization and robust design technologies proved to be effective in several biomedical applications. Their implementation, based on the modeFRONTIER environment, is straightforward, and can guarantee great improvements in design efficiency, time and cost savings, and productivity, without neglecting the achievements in terms of numerical model accuracy and the management of uncertainties.