

Mathematical modeling, simulation, optimization and control in science and engineering

Brief description

Our group develops and studies mathematical models for the design of prototypes and processes in science and technology. We develop software packages for the required simulation as well. Our research lines cover a broad spectrum: risk analysis, epidemic propagation, oil spills, lithium-ion batteries, high-pressure processes, image processing, combustion, elasticity, structural mechanics, lubrication, new materials, catalysis, homogenization, freezing, climatology, nuclear fusion, and more.

How does it work?

The interested party explains to us the process or prototype they wish to model. Starting from this information, a mathematical model is developed based on appropriate physical laws (such as the laws of conservation of mass, etc.).

The resulting model is then analyzed, and a discrete mathematical model is developed to obtain its numerical solution. If necessary, an algorithm for solving those discrete model is also developed and implemented in a language suitable for simulation software. The numerical results are validated with experimental data (if available). Finally, studies can be conducted to optimize or control the simulated processes or the prototype.

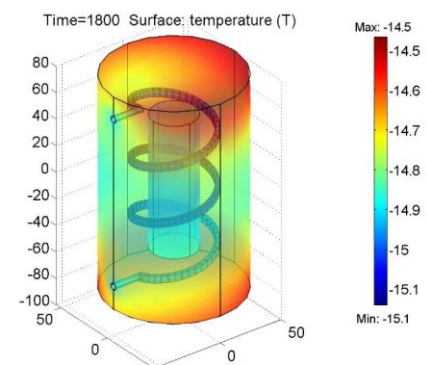


Figure 1. Simulation of a prototype of a high pressure equipment.

What problem does it solve?

Money and time saving in the design of prototypes and in the decision making task for processes of different types.

The money savings are due to the fact that having a mathematical model that allows the prototypes and processes to be simulated on a computer avoids the need for numerous experimental tests, which are usually very expensive. Saves time because obtaining results is usually almost immediate once the simulation software is available. However, conducting experiments and collecting data (when possible) often requires a considerable amount of time.

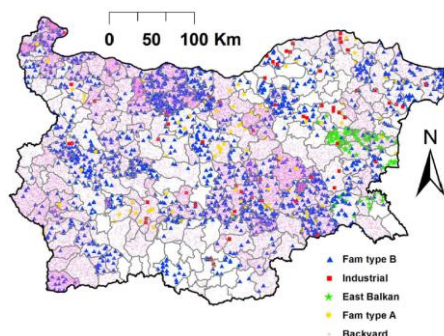


Figure 2: Simulation of the development of a Classical Swine Fever epidemic in Bulgaria.

Additionally, The use of simulation software allows to compare, in a very short time, potential changes in the design of a prototype or process. Therefore, it can be a very helpful tool for decision making processes, without the need of only relying in the experience and intuition of the responsible team.



Where has it been developed?

The development is made in the research group MOMAT (Modelos Matemáticas en Ciencia y Tecnología). Among its main activities we can find: Development of Research projects, software, contracts with companies and agencies.

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