DIMOFAC

PARTNERS

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ABOUT ESI

Founded in 1973, ESI Group envisions a world where Industry commits to bold outcomes, addressing high-stakes concerns - environmental impact, safety & comfort for consumers and workers, and adaptable and sustainable business models. ESI provides reliable and customized solutions anchored on predictive physics modeling and virtual prototyping expertise to allow industries to make the right decisions at the right time while managing their complexity. Acting principally in automotive & land transportation, aerospace, defense & naval, and heavy industry, ESI is present in more than 18 countries, employs 1000 people around the world, and reported 2022 sales of €130 million. ESI is headquartered in France and is listed in compartment B of Euronext Paris.
For more information about ESI, please visit www.esi-group.com.

ESI Group worked on five topics integrating them into the DIMOFAC platform

Plastic Injection

Thermal behaviour of the mould and pressure evolution during the injection are two key parameters for the quality of the produced part. These parameters can be included in a ‘digital signature’ of the produced part, and checked afterwards as an additional information for failure analysis, i.e.
The information to be provided should be ready accordingly with the time requirements of the production line. The computational time is then a challenge, as the time to produce each of the parts can be below one minute. With these constraints, two reduced order models (ROM) of those two parameters evolution were created during DIMOFAC. The figure 1.1 shows a snapshot of the thermal evolution of the mould depending on three parameters: material temperature, cooling flow velocity and cooling temperature. The figure 1.2 shows the pressure evolution for 3 parameters: the material temperature, the mold temperature and the material flow velocity.

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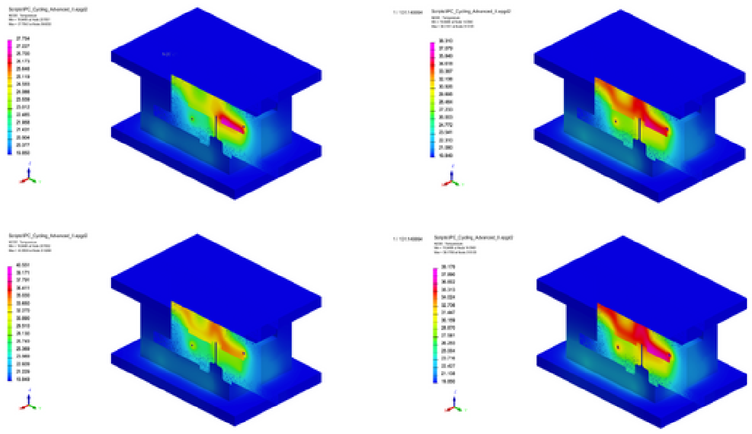

Figure 1.1. Thermal behaviour of the mold for different parameter values, Image Copyright ESI Group

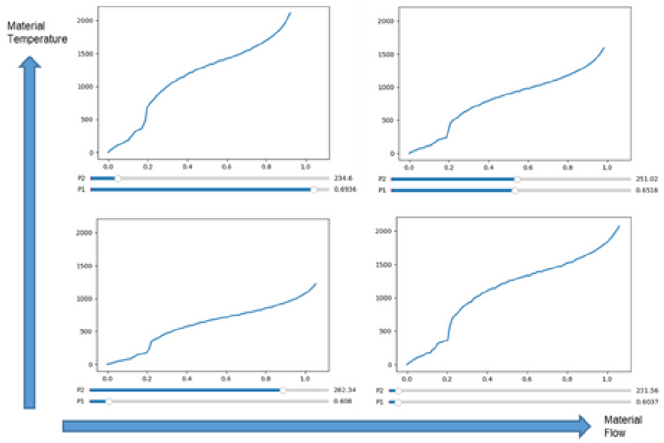

Figure 1.2. Pressure evolution for different parameter values, Image Copyright ESI Group

Induction Welding

The thermal evolution of the composite is the most important parameter to control during the induction welding of composite materials. In order to reach the desired temperature, it is measured by a pyrometer during the welding. Simulation provides the thermal evolution on the whole part to better understand and improve the welding process. In DIMOFAC, this simulation has been improved by reducing the computational time from days to hours.

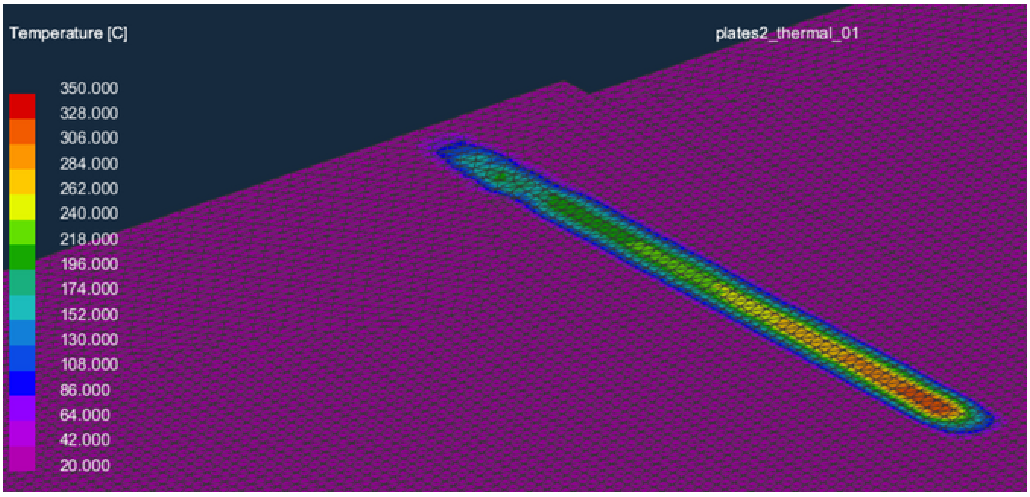

Figure 2.1 shows the thermal evolution on the surface of the part at a speed of 1mm/s.

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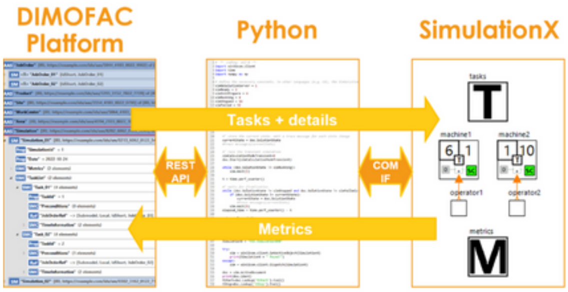
System modelling

These are two graphics of the library we created for the ESI system simulation tool SimulationX. The new library can be used to model processes in the manufacturing hall. Two applications are outlined in the picture: a) the generation and simulation of a model with tasks on different machines based on information from an AAS, to examine machine utilization etc. b) a model for the manufacturing of a vehicle, to examine power and energy consumption



a Coupling of the system modelling tool to the task planner AAS on the DIMOFAC platform, Image Copyright ESI Group

b Power and energy consumption of a (small) assembly line, Image Copyright ESI Group

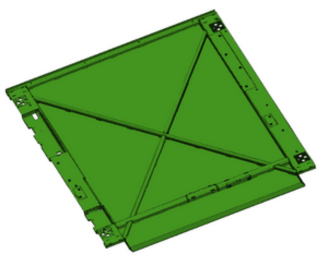
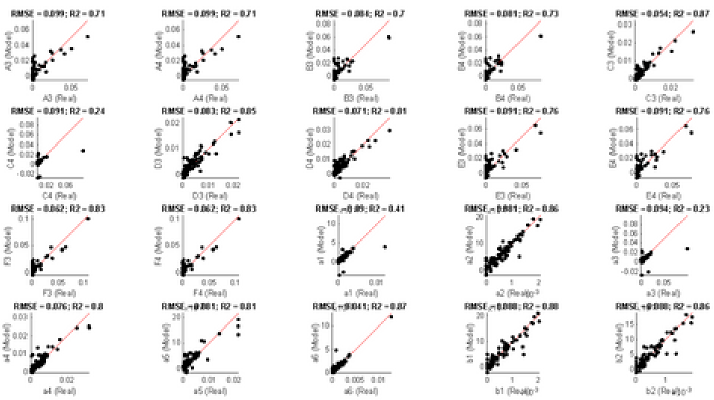


Plate configuration for welding simulations



Baricentric regression model predicting distortion of different points on 2 steel plates. Image Copyright ESI Group

Laser Welding Simulations:

ESI's physics-based welding simulation tools were provided to LMS to conduct parametric studies on welding of different plates. The models predicted the resulting plate distortion at multiple key points of the plates. The process parameters (power, speed, weld seam shape ... etc. as well as plate materials (steel and aluminium) were varied and the predictions were used to train regression models describing distortion. As example of prediction quality for steel is shown in the second image.

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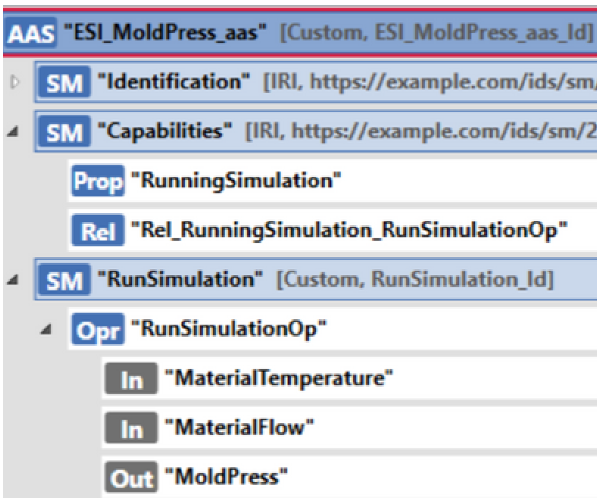
Integration of modelling tools in AAS

ESI tools are integrated in DIMOFAC's ecosystem thanks to an AAS model for each application and a custom REST connector.
AAS simulation software submodel was not available during the project. In consequence, a software modelling group has been organized to understand and develop a software integration modelling strategy accordingly to AAS and DIMOFAC's Common Information Modelling.

The followed approach included mainly three submodels: standard submodels 'Identification' and 'Capabilities' and custom 'RunSimulation'. 'RunSimulation' included the method 'Operation' which was used to trigger the simulations or the surrogate models from DIMOFAC's platform. A clear benefit of this approach is the automatic updating of input parameters by reading the information from the correspondent third party AAS model. Figure 5.1 shows the AAS model for the ROM corresponding to the pressure evolution inside the mold.



INVOLVEMENT IN DIMOFAC

What is your role in the DIMOFAC project?

ESI provides physics- and data-based simulation software tools. The system simulation tool, SimulationX, was used and extended to support a task planning optimization. The welding simulation software SYSWELD was used in a parametric study to provide the data base for machine learning. The regression models were used to predict distortion resulting from welding processes instantaneously. The casting simulation software ProCAST and machine learning technologies were used to study induction welding of composite panels. The slow response of the physics-based electromagnetic solver was augmented with machine learning to increase simulation response speed.

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What are the knowledge or skills that you bring to DIMOFAC?

ESI Group masters physics of material with extensive knowledge in physics-based modelling and machine learning. Predictive simulations are seamlessly integrating in an immersive environment enabling engineering teams to experience their designs and product performance efficiently. Real time simulations are applied during product lifetime to ensure material health, product performance and to manage maintenance and operational aspects.

Why did you decide to participate in DIMOFAC?

The ESI Hybrid Twin platform integrates virtual and physical worlds providing ESI customers the means to optimize design, maintenance cycles and operation. Integrating simulation tools in the overall production scheme and in Industry 4.0 platforms is therefore within the ESI technology road map.

How do you see the DIMOFAC innovation in the Manufacturing Industry?

Industry leading solution making abstract (or academic) industry 4.0 concepts accessible to real life production sites.

What are the learnings you have gained from participating in DIMOFAC?

1. There is a number of potential I4.0 platform to consider
2. Standard and ontology is an important module.
3. Clear communication is very important.

What challenges do you have at the moment in DIMOFAC and how are you overcoming them?

The current focus is to align technological components with strategy of business line to create a commercial hybrid twin platform fulfilling the requirements of ESI customers.

What are the benefits that you have/are taking away from this collaboration?

The integration of hardware and predictive software towards improving design and mitigating operational risks is one of the topics learnt during the span of DIMOFAC. We gained knowledge about technical concepts such as asset administration shells and how to work with them. Furthermore, we became helpful insights on the industry's needs, due to the effort to define the project goals on the pilot lines.

> **"DIMOFAC delivered a hardware software integration platform of high flexibility of interest to ESI road map."**