ALMA MATER STUDIORUM
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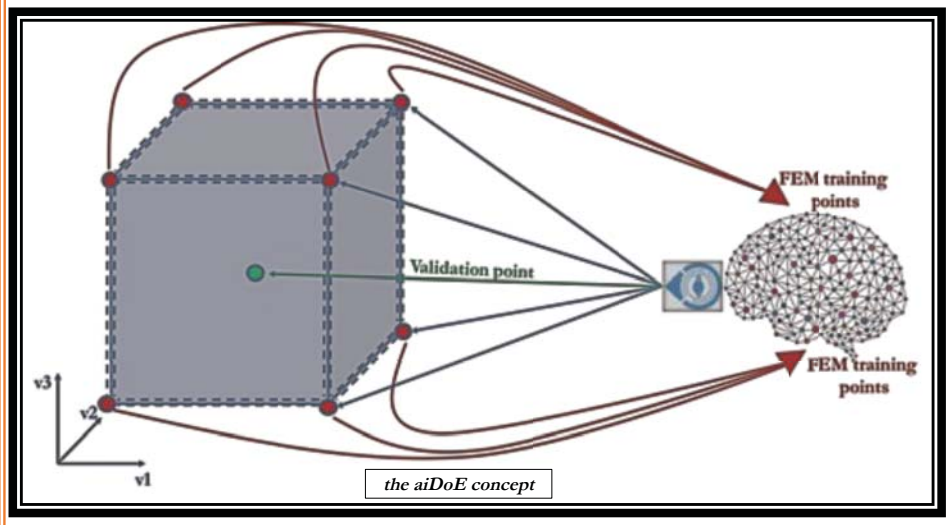
33rd International CAE Conference and exhibitions
***CAIMan* (Centre for Artificial Intelligence in Manufacturing)**
University of Bologna
CAE International Poster Award

CAIMAN

aiDoE (artificial intelligent Design of Experiment) A Combination of Finite Element Method (FEM) and Artificial Neural Networks (ANNs)



the aiDoE concept

***aiDoE** concept:*

-***Definition*** of the boundaries of the problem;

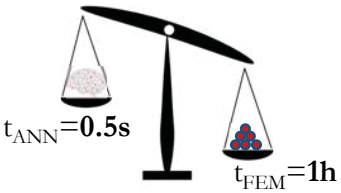
-***FEM simulation*** of the furthermost points;

-***Training*** of the Artificial Neural Network with *FEM* results;

-***Validations*** of the Artificial Neural Networks;

- ***Scans*** of the whole domain solutions by *ANNs*.

FEM results are used to train and validate ANNs thus reducing computational time for calculating the solutions in the whole domain

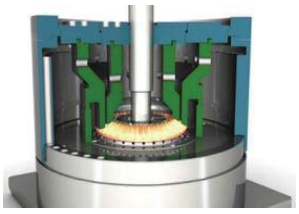


Comparison in terms of computational time between FEM and ANN

Case study

Process

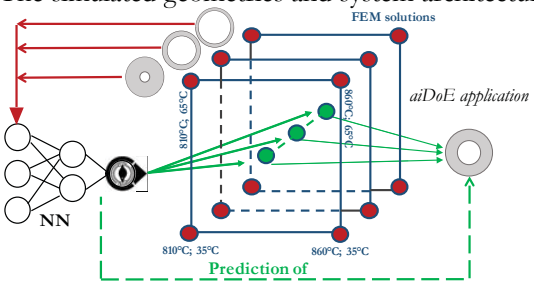
aiDoE was implemented for a *Die Assisted Oil Quenching* (DAOQ) technique in order to understand the effect of process parameters in terms of virtual displacements.
DAOQ involves the use of a press, a die and the quenchant that surrounds every parts of the equipment thus ensuring the best cooling conditions.



Cross sections of DAOQ process. The quenchant flows from the bottom to the top within the equipment. (The fluid is not illustrated).

Modelling

A mathematical model was built. The simulated geometries and system architecture are the followings:



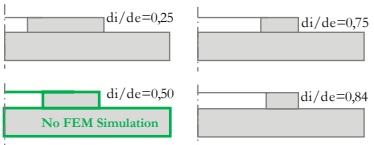
aiDoE

Factors & Application

$810°C < T_{components} < 860°C$

$35°C < T_{quenchant\ and\ die} < 65°C$

<Geometries<



2D axisymmetric models for FEM analysis

Models of different geometries that are implied for the aiDoE application. The samples are characterized by the same thickness and different diameters ratios

The displacement induced by metallurgical transformation and the effect of the press were not considered in this first preliminary test.

Results

- The validated ANN can extrapolate a solution for a specific geometry after the forward calculation phase.
- The aiDoE application points out a maximum error on displacements equal to 0.026 mm and an average value of 0.003 mm for the predicted geometry. These results are based on punctual predictions made by ANNs on those geometries that were simulated by FEM but not included in the training set.
- aiDoE is the proof that FEM simulations and ANNs can coexist thus reducing the time for the multiple simulations.

Authors

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