Augmented virtual prototyping of an ultra-high-strength hot-stamped steels process. Real time parametric response in closed loop as the gateway for a Hybrid Twin

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Abstract including:

The work presented is devoted to the creation of an Augmented Virtual Prototype of a unique multistage hot-forming process of ultra-high-strength steels developed and patented by using GESTAMP referred to as GES-Multistep®.

With the GES-Multistep® process, we may have several forming operations depending on the product shape, in a similar manner than traditional cold stamping transfer process, enhancing to our product design engineer's freedom for designing much more complex and engineered products than we are doing today. In addition, we may produce sheet metal parts made of Zn coated boron steel, which ensures better corrosion protection also for complex geometries.

The objective of the Augmented Virtual Prototype (A-VP) is to predict the GES-Multistep® process for a rapid and controlled cooling in a wide range of press and process conditions in order to obtain high quality parts with no rejections.

The first part of the study is devoted to automatic creation of reduced models of the 3D parametric multi-component PAM STAMP virtual prototype consisting of heating, stabilization, forming, trimming and piercing stages. ESI's non-intrusive sparse-PGD constructor is used to build a parametric transfer function of each operation in a separated representation to address the difficulty of the high dimensionality of complex processes like GES-Multistep®.

The second part of the study is devoted to the creation of a “real time” runtime model through the encapsulation of the GES-Multistep® MOR models previously created in a 1D-sysem model in closed loop. Control signal fault models are developed and simulated to improve the reliability and understand the system sensitivity to process fault combinations, identify critical measurement parameters, to define sensors strategy and refined controls. The faulted system simulation data will be used to train the appropriate ML algorithms used for anomaly detection and pattern recognition of physical sensor data.

The works developed in this article are the fundamentals for the creation of a Hybrid Twin by combining simulation and incoming sensor data for improved pattern recognition, diagnostics, to ensure the GES-Multistep® best working scenarios and available options for predictive maintenance.

Keywords:

Hybrid Twin, Virtual Prototyping, Press-hardening, MOR, real time, simulation

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