MAKING ITS MARK

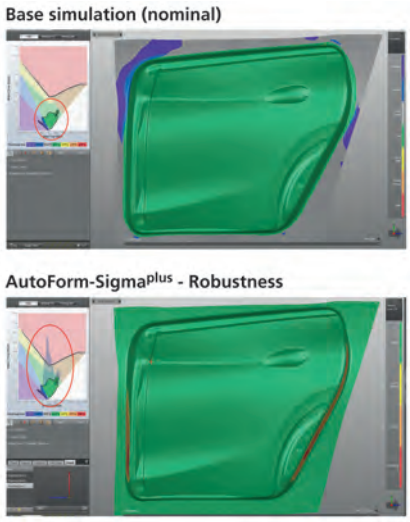
Robustness and Tryout Mapping simulation software has been successfully evaluated at Nissan's Sunderland Plant

ISMR SAYS: *"AutoForm software is helping press tool designers to systematically engineer robust stamping processes"*

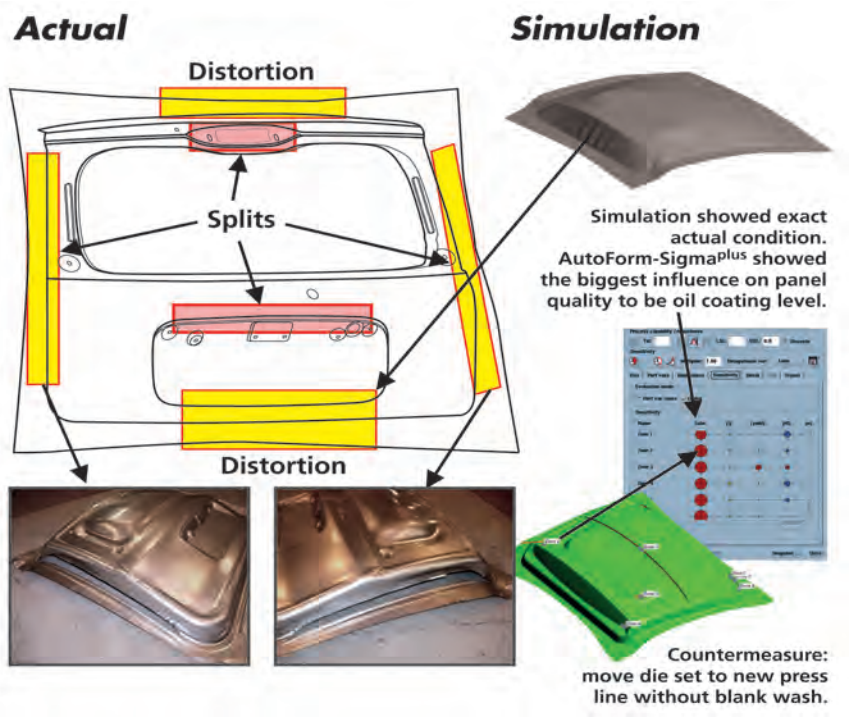
Current high production volumes at Nissan has put strong demand on its large press lines, which are being used to maximum capacity. The reliability of press production has therefore become increasingly important as there is simply no time to make corrective press adjustments during a press run to minimise waste. There is also very limited press time available for trials of non-production parts/tools. Reductions in vehicle development lead times can be achieved by reducing the number of costly, time-consuming tryout loops and by accelerating the ramp-up to production volumes with SPC-based process capability.

Nissan, as well as many other companies, adopt "Six Sigma", a system that is designed to improve the quality of process outputs by identifying and removing the causes of defects and minimising variability in manufacturing processes. To address such variability in sheet metal forming, AutoForm has developed AutoForm-Sigma^{plus} to help press tool designers to systematically engineer robust stamping processes. Nissan NMUK Sunderland is the first press shop in the UK to adopt the AutoForm-Sigma^{plus} methodology and has begun to see considerable success with this approach.

The key objective of the NMUK Press Shop is minimising splits outflow. The objective limit is one part per million (trim shop) and, to support this challenging target, the die maintenance department aims to improve the forming window/range in the draw process. Historically, draw die adjustment (blank holder force, blank position and bead) during the Tryout and Production phases was based on experience (trial and error) and Nissan recognised that a Systematic Process Improvement method was required.



A split free panel showing issues after robustness study



Robustness study – oil coating level cause of problem

Successful strategies

The initial application of AutoForm-Sigma^{plus} was on an unreliable part, typically a "bad runner". Back door outer parts were splitting intermittently in production and, despite various engineering countermeasures put in place, the problem was not eradicated. The robustness study indicated the greatest influence on panel quality was "oil coating" level and significant improvement and stability was achieved by moving the die set to a new press line without a blank wash.

Sigma was also used to determine whether a material could be downgraded to achieve cost reductions on a different component. Whilst the nominal simulation showed that there would be no issues, a robustness analysis demonstrated that further problems would result from the downgrade. Nissan was keen to utilise AutoForm-Sigma^{plus} to avoid problems in the press shop. It therefore developed a robustness standard and an engineering process for identifying and recording root cause analysis on formability and surface defect concerns for new model tooling arriving from Japan.

From theory to practice

"AutoForm has huge potential for us in the sheet metal forming environment. The AutoForm-Sigma^{plus} software allows us to simulate actual production conditions. Using Robustness (noise variables), we can provide early feedback to the Production department for high risk focus areas on the panel. The sigma SPI Tryout Map can be used in conjunction with robustness to confirm potential die modifications before actually modifying the tool. Working in the press shop, validation of the AutoForm software is clear as we see actual conditions on the panels that are highlighted by AutoForm simulation. Basically, it provides a more systematic approach, rather than 'it's a black art' mentality," said Graeme Haggon, Die Maintenance Supervisor, Nissan Sunderland Plant.

NMUK receives the draw dies (known as PB dies) for new models directly from Japan, for all in-house produced parts. The robustness analysis begins with a representative process. A key point is that the base simulation draw–in/inflow should match the inflow on the actual master PB panel.

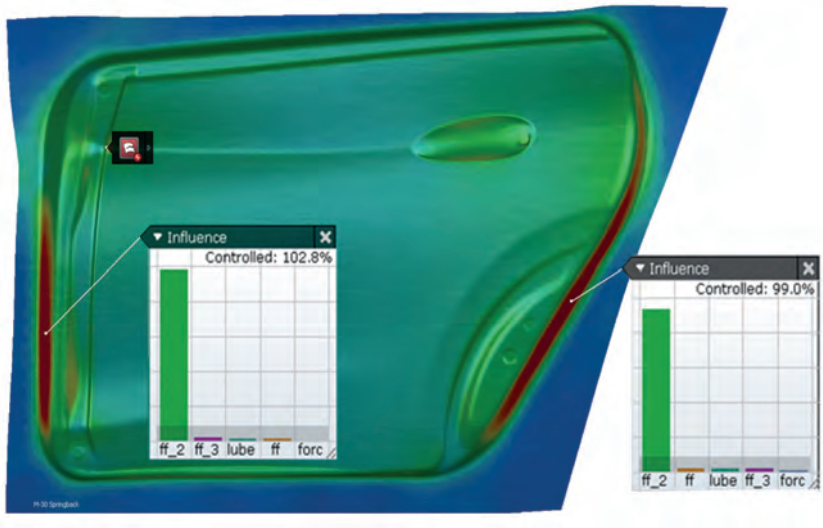
Typically, the simulation received from Japan shows a split-free nominal simulation. However, a robustness analysis is conducted which considers a range of inputs for variables such as material thickness, tensile/yield strength, yield point, r value, force and lube. This results in a range of outputs, including the possibilities of splitting. So, whilst a single simulation provides a process point (supplied by Japan), it is clear that for successful tryout as well as production, a process range is required. A detailed study of the problem areas identified in the robustness study can indicate which variable has the highest influence in such areas and effective countermeasures can be determined.

fluence plots showing result of Tryout Map

Robustness uses noise variables in the process that realistically cannot be controlled. SPI, based on AutoForm-Sigma^{plus} (Systematic Process Improvement), is also used at Nissan to systematically evaluate the influence of design parameters on the robustness. SPI uses design variables which can be adjusted. To improve the draw process, SPI is used to create a Tryout Map which can then be used in conjunction with robustness.

A typical NMUK Tryout Map would include such variables as draw bead restraining force, blank position, pressure and lube. Influence plots can also be analysed for SPI variables. Tryout Map results are shown in the image below.

It is important that the work done in the Sunderland Press Shop is fed back to Japan for problems to be acted upon and eradicated as early as possible. Therefore, the feedback from the PB study is now fed back as a focus area to an NMUK 'buy-off' team in Japan. In this way, countermeasures can be put in place, thus closing the loop.



Variables with the highest influence in problem areas

Future of robustness prediction at NMUK

"Robustness simulation enables the verification of the proposed current model die adjustment before actual change. Material grade change and blank reduction activities can be conducted. The approach can be used to support new model tooling developments. It provides the capability to feedback any formability issues to Japan and obtain early and effective countermeasures, based on a clear understanding of variables influencing formability repeatability," AutoForm told *ISMR*.

"A concerted effort will take place to encourage Nissan Japan to supply Nissan UK with Sigma Robustness results which are not just nominal. The internal development of Robustness and Tryout Map evaluation will continue, increasing the reliability and benefits already reaped."

Nissan Sunderland Plant: The UK Press Shop

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AutoForm Engineering GmbH

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