Managing tolerances at Nissan

Icona Solutions' aesthetica manufacturing variation simulation and visualisation software has assisted Nissan Europe in achieving the high quality targets it set for the new Qashqai.

Using the latest in 3D computer-aided engineering and visualisation software, designers at Nissan Design Europe were able to interactively visualise the extremes in variation of a simulated 50,000 run sample build of the new Nissan Qashqai - before committing to tooling.

The software – aesthetica, from Icona Solutions - enabled them to compile a realistic portrayal of what happens when worst-case tolerance limits combine to destroy the perceived quality of an inherently good design. As a result, they were able to take corrective action, before it became a costly brand-threatening reality.

With its design led from Nissan Design Europe's Rotunda facility in central London, the new Nissan Qashqai hatchback/SUV crossover is the first of the Japanese company's vehicles to be designed, developed and manufactured entirely in the UK by Nissan. As such, it marks an important milestone in Nissan's plans for its European operations.

It also marks a new high in the perceived quality of Nissan vehicles - and a first in the use by the company of advanced new software technology designed to enable the digital simulation and visualisation, during the development process, of the effects of manufacturing variation on the aesthetic quality of the final vehicles that roll off the assembly line. This use of the latest in design engineering software aligns fully with Nissan's constant drive to reduce development costs and lead-times, while maintaining – or indeed, increasing – vehicle build quality.

Both from a final vehicle point of view and from a development process point of view, therefore, the Qashqai design project can be regarded as a major success story for Nissan Europe.

Going digital

Although the automotive industry is one of the leaders in the use of digital tools, it still relies heavily on physical prototypes, with these being complemented by digital models. Nissan's aim is to turn this round and shift the balance more towards digital processes being the critical path, with reduced physical build supporting these processes. The reason behind this is obvious enough: it takes time and costs money to build physical prototypes.

A process within the overall design-to-manufacturing cycle that is critical to Nissan achieving the degree of build quality it aims for is variation control. For key dimensions, this is led by the perceived quality group.

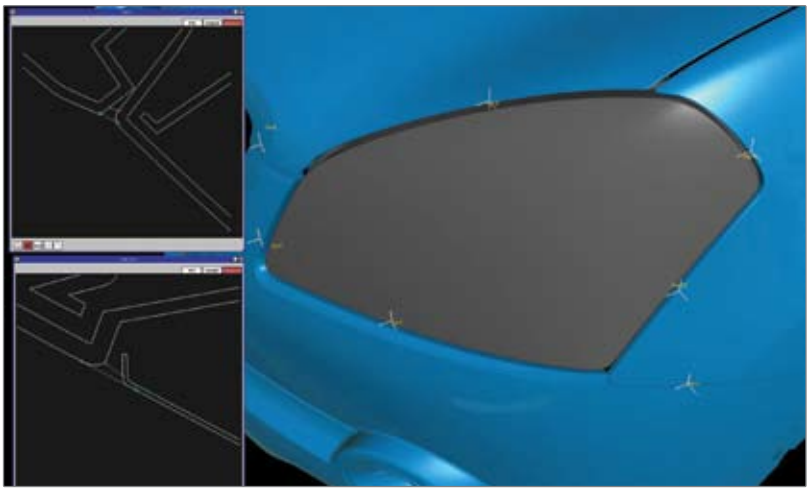
But whereas the designers and engineers working with Nissan's usual CAD/CAM tools tend to work in the ideal world of nominal dimensional values, with perfect models, whether digital or physical, the perceived quality group works in the more realistic world of variation.

Until recently, this meant that to perform variation control exercises they needed to create and model the variations that will occur during manufacturing and assembly using what are essentially long-hand methods.

This relied to a large extent on building physical models – which are expensive to produce and tend to lag the design status. They would then create the variations by physically moving individual components of an assembly model with the use of worm gears. But with the best will in the world, it's just not possible to flex a physical model and bend it and move the individual components in every possible way that could happen during manufacture and assembly. Neither does it allow for the quick turnaround time that Nissan is looking for.

And while some manipulation of the digital model was possible – by re-modelling sub-assemblies and assemblies individually for each condition – this again added time and was by no means a fully satisfactory method.

Nissan therefore set out to see if there was a digital tool available anywhere that was designed specifically for use in variation control. The tool they found was Icona Solutions' aesthetica. And this is the tool that was used on the Qashqai development project to improve the variation control process and to help reduce development time and costs and meet the demanding perceived quality targets.

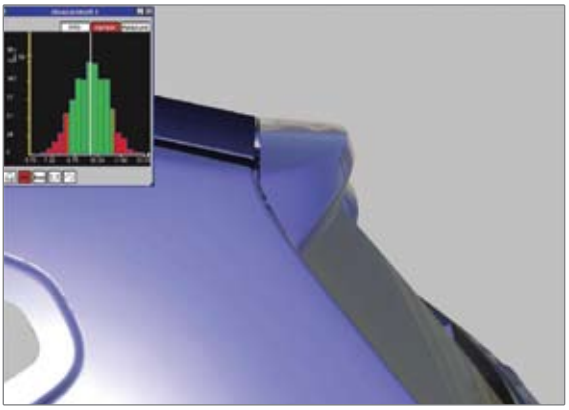


▼ Nissan Qashqai: key variation control sections were identified in aesthetica and target limits set in this visually sensitive zone; the junction of the headlamp, metal fender, moving hood, plastic grille and plastic bumper.

Digital variation control

aesthetica is a unique software tool that combines two quite separate skill-sets: high quality, real-time design visualisation and tolerance analysis. It provides an accurate, visual simulation of the effects of component variation, assembly variation and component deformation in manufactured assemblies in order to resolve issues of fit and finish quality. It presents results using a high quality interactive 3D virtual reproduction of a product so that both the designer and the engineer can visualise it at different states within its geometric tolerance range, in real-time, and precisely as the customer will see the final product.

By using aesthetica, designers and engineers at Nissan Design Europe today can get greater insight than was previously



possible into the visual impact of manufacturing variation, thereby improving perceived quality while saving time and costs and improving communication in the design process.

Although some physical models are still produced - in clay, foam, Uryal and metal - for certain processes at Nissan, the focus of the company's perceived quality group today is very much on the digital model rather than physical models, with variation control being undertaken in parallel with the design development and engineering feasibility processes. This enables everyone involved to appreciate the issues and therefore, to make a more informed decision on whether or not they can commit to tolerance targets.

The use of aesthetica has also introduced a greater degree of realism into the overall design-to-manufacture process, with the software being used both to set and analyse new tolerance targets and to analyse pre-set targets adopted from previous set-ups for other vehicles.

Controlling variation in the critical dimensions of the vehicle structure is the key to achieving acceptable quality from an aesthetic standpoint in the finished vehicle. In addition, the way in which different materials behave under manufacturing and assembly conditions also needs to be accounted for. An example of this is the area where the flexible plastic bumper, pressed steel wing, headlamp assembly and a hinged, pressed steel bonnet all come together. Gap and flush control here during manufacture and assembly is critical to perceived quality.

Cross-functional design reviews using aesthetica are therefore undertaken at different milestones in the development process. These design reviews involve people from design engineering, production engineering, manufacturing, parts quality assurance, vehicle quality assurance and marketability and are used to ensure that everyone involved understands the conditions so that a decision can be reached on whether or not they are acceptable.

During the design of the Qashqai, aesthetica enabled the development teams to uncover issues in their design review sessions that almost certainly would not have been discovered under their earlier digital processes. It enabled them to simulate all potential conditions and to create many more high-quality visualisations of those conditions than could ever have been physically built in the time-scale.

In fact, they were able to interactively visualise tolerance conditions and manufacturing criteria that previously would most probably have had to wait until the first physical build in manufacturing, using production tooling. And it goes without saying that mistakes at this late stage are not allowed!

Quality aims achieved

In striving to deliver with the Qashqai its highest level yet of perceived quality, at the same time as reducing development lead times and costs, Nissan recognised that a shift to a vehicle development process based more on a digital master model rather than on physical models was required. However, they also recognised that for this to succeed it was essential that the design and engineering teams could have confidence in the accuracy and integrity of the vehicle digital model.

The introduction of Icona Solutions' aesthetica software into the overall vehicle design-to-manufacturing process not only enabled the Qashqai design and engineering teams to uncover issues much earlier in the development process than would otherwise have been the case – with the cost implications that this has. It has given them that necessary confidence in the results of the variation control analysis processes – and therefore in the integrity of the digital model.

In addition, manufacturing engineers and design engineers are now better able to appreciate what can and cannot be achieved and what the final product will look like, from a visual quality perspective.

One important by-product of this is that Nissan's management no longer needs to worry about that time during production when all the manufacturing tolerances are at their extremes and when that 'Friday afternoon car' comes off the line. It's a thing of the past. ●

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▲ Nissan Qashqai: an aesthetica visualisation of key variation target limits at the junction of the headlamp, metal fender, moving hood, plastic grille and plastic bumper.

◀ **(Top)** Nissan Qashqai: before committing to tooling, Nissan used aesthetica for a digital build of 50,000 vehicles to visualise maximum variation and distribution through the manufacturing tolerance range.

(Bottom) Nissan Qashqai: an enhanced rendering in aesthetica of key variation target limits to show photo-realistic image including reflection.