technology

Digital modelling for stamping

Virtual die technology embraced in the past decade has grown by quantum leaps, and those who embraced the technology in the early stages of its development are starting to realise superiority in competitiveness, productivity and profit margins

Images courtesy of Daimler, Schuler and Volvo Cars Body Components

Stamping dies are a substantial investment for automotive manufacturing, costing in the range of $80 million to $100 million per vehicle programme. Unlike powertrain and transmissions which remain relatively unchanged over long periods, stamped parts are continuously evolving for styling. Design standards change to meet stringent targets in performance criteria for fuel economy, weight reduction and safety, while also adapting to the latest materials and production methods.

This results in major redesign of stamping dies for each vehicle programme. Twenty five model launches worldwide translates into a yearly investment of between $10 billion and $15 billion for stamping dies. With the growing emphasis on lower-volume niche vehicle programmes by OEMs, this investment will certainly increase. To meet this demand from OEMs, core improvements that up until now remain untapped need to be investigated, and once the technology is proven, OEMs need to understand how these can be sustained with new technology solutions and enterprise workflow refinements.

Life-cycle harmony

The current frenzy on cost reduction – at any price – has largely neglected the impact on quality, lead-time and throughput, resulting in a higher real cost per part. Because of the relative ease of calculating upfront costs, compared to the lack of ability to project effects on quality, delivery and morale, this impact goes unnoticed. Further, the time lag between these early decisions and realised impact can be several months or years, which makes closing the loop on these assumptions impossible to track.

For example, a spot reduction of between 15 per cent and 20 per cent on die-cost might cause an unstable process leading to excessive scrap and unplanned downtime at the plant – far exceeding the intended savings. Executions of such metrics runs counter productive, creating a profoundly negative impact on market timing, profit margins and long-term relationships with OEMs and suppliers. Over time, this also leads to a breakdown of internal team cohesiveness and motivation within the organisation.

Decision drivers and dependencies in vehicle development life cycle

A unified vision for fast-to-market production of quality parts at lowest cost – requires the complete life cycle to be harmonious – that is, to reinforce deep collaboration across the multiple disciplines of costing, engineering and operations. An orchestrated work culture must be used to drive an entire enterprise, that is greater than the sum of its parts. Accurate data and dependencies must be factored into each decision metric. A disciplined adherence to these decisions is needed, to look beyond smaller increments for the greater good.

Technology enablers

Over the past decade, design and simulation software for metal stamping has become indispensable in concurrent product and die engineering. For all types of parts including Class A, BIW, structural or hydro-formed, the technology is routinely used to certify part formability, develop a feasible process concept and validate that the process will in fact produce an acceptable part in the press (transfer, line or progressive).

The speed and reliability of these tools – designed to complement shop-floor expertise – has dramatically reduced lead-time in engineering change and die-tryout by an acknowledged 50 to 60 per cent. More importantly, it has produced a revolutionary shift from legacy-based tweaking to a data-driven decision toolkit aligned closely with the die-shop and stamping plant environment.

Technology also augments in-house die expertise, especially with the emergence of newer materials (for example high strength alloys and aluminium) as well as alternative processes such as progressive dies and hydroforming. Nowadays, tool engineers routinely design and validate four to five die concepts a day on a standard desktop computer. The software helps slash raw material costs through blank-reduction and down-gauging studies which provide significant return on investment for high volume programmes. Clearly, this technology has become a mainstream necessity for world-class die-making competitiveness.

With this paradigm shift in lead-time reduction and concurrent die development, software vendors have introduced cutting-edge technologies to directly address total cost and quality in a unified vision. These innovations generate a harmonious balance of all key metrics using an enterprise-wide collaborative effort.

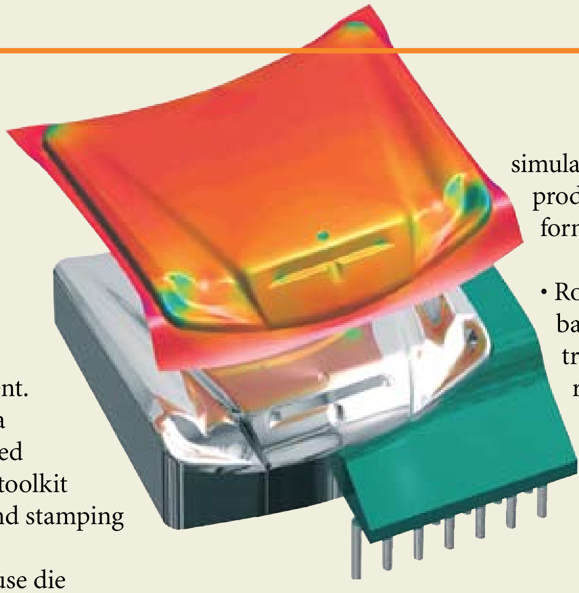
These are aligned to four major solutions as follows:

• Feasibility solution: starting with very early 3D data, product and die engineers establish part manufacturability and optimum material usage (blank-sizing, nesting). They also initiate feasible die-processing, for example binder/ addendum development, secondary operations, flange layout, etc to further refine the stamping process. This solution is characterised by very quick turnaround time and reliability – most parts will run in between five and 30 minutes, identifying more than 90 per cent of potential forming issues very early on

• Bidding/planning solution: the estimating group starts with a process layout (created automatically from the 3D part features) or can import this from the feasibility solution stage. Total die-cost is that calculated from a database of operations, labour hours and material costs. Different press lines and process sequences can be instantaneously modelled for cost comparison. The cost output accurately reflects a real die-process, the feasibility of which has already been established

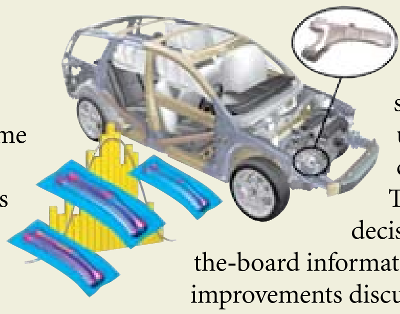
• Tooling/ tryout stage: the chosen optimal-cost process from bidding/planning is then further refined by tool engineering for detailed die layout and design. Very precise tryout simulations and process optimisation produce a superior part with acceptable forming (thinning, strains, etc)

• Robustness solution: finally, the baseline die-process in tooling/ tryout undergoes a deeper robustness study to highlight and potentially correct part quality issues that could result from real-life plant variances, for example, the blank shifts, inconsistent materials, lube breakdown, die wear, etc. This is accomplished by a multi-variable simulation study with hundreds of iterations compiled to graphically represent dominant parameters and their quantitative influence on part quality.



Above: At Daimler AG, process simulation became a standard many years ago

Below: Volvo started using AutoFom's robustness solution in 2005 for the Volvo S40/V50



Holistic benefits

This portfolio of solutions integrates seamlessly with one another via an underlying data structure that is continuously updated and maintained. This allows for consistent data-driven decisions using objective and refined across-the-board information. Over and above the lead-time improvements discussed earlier, there are several compelling benefits of this enterprise technology method.

It gives freedom from having to rely solely on experience-based standards that may become obsolete by not reflecting newer criteria, materials and methods. Then, the common 'tweak and check' approach to die engineering that yields unsustainable improvements is fully replaced by a state-of-the-art discipline of virtual engineering, which produces the lowest real cost per part for every part, every time. Finally, true die and production costs can be compared to an enterprise-wide costing structure which closes the loop between estimates and reality. Process decisions can be reviewed at every phase for impact on quality, cost and delivery of the finished product.

Virtual die technology embraced in the past decade has grown by quantum leaps. However, this continues to be limited to the small (but important) subset of tool engineering, with little or no vision to enterprise standards. Between the resultant pockets of localised efficiency, there is still a large vacuum in which much of the enterprise gains remain untapped.

Senior management at some OEMs and suppliers have become true champions for sustainable excellence by driving technology-refined work culture deep into the hearts of their organisation. The early adapters are already starting to realise superiority in competitiveness, productivity and profit margins with no compromise. This holistic approach, from product concept to full production within a contiguous environment, allows the forward thinking enterprise to chart its brighter future, while discarding a legacy of history-based decisions to become the new benchmark of manufacturing excellence. ✱