ALTAIR

Sustainability & Climate Protection Through Digitalization

A step-by-step guide for transforming your plastics engineering value chain to develop solutions that optimize performance, minimize carbon emissions, and gain a competitive edge.

An educational resource from Altair and the Altair Partner Alliance for all involved in the design, engineering, and manufacturing of injection molded plastic components and products

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Table of Contents

Designing **Sustainability** into the **Value Chain**

By Dr. Ming Zhou, *Altair Chief Engineer - Structures, CFD, Optimization*

Welcome and thank you for downloading this e-book. It's designed for people like you, if you're involved in the lifecycle of creating injection molded plastic parts. While reading, you will view a new way to help your organization and those you serve. See design engineering through the lens of sustainability and climate protection – while using advanced simulation tools and methods to meet demand and remain competitive.

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Design engineers have always been required to balance multiple performance metrics to optimize physical designs, thermal and fluid dynamics, electromagnetic interference, and many more performance factors. It has become common, if not universal, that many simulation methods and tools will be used to optimize not only materials but mold and tool creation, manufacturing processes, and the performance of the finished part — whether that part will be used in a motor vehicle, medical device, computer, a Mars rover, or a child's toy.

Increasingly, when designing parts for such products, design engineers must factor-in one more performance metric: sustainability.

This development is in keeping with industry trends and corporate imperatives long in coming. A case in point: At K 2022, the world's largest trade fair for plastics and rubber, climate protection and the circular economy were two of the trade fair's "Hot Topics." Digitalization, using integrated technologies to move to a digital business. Here, it relates to making data and workflows available for the product development lifecycle for plastic injection molded parts.

With sustainability joining the list of pressures on companies to compete, industry leaders are increasingly investing in simulation for its ability to create sustainable parts and products with reduced defect rates, manufacturing and warranty costs, cycle times, all of which drive revenue and profitability. This is a part of what's driving the global simulation software market to grow, according to the latest market research, from US $12.7 billion in 2020 to $26.9 billion by 2026.

Sustainable design is a major driver of that growth. The articles in this e-book will guide you step-by-step through fundamental concepts, solutions, and best practices for success in the "virtual world" of simulation and modeling – and the real-world results that follow. ■

Consistent Material Data:
A Prerequisite to **Sustainable Design**

Material selection's strategic role in sustainable design begins with a holistic, globally standardized database, testing, and CAE environment.

By Dr.-Ing. Erwin Baur, *Altair Chief Material Scientist*
& Dr. Kamila Flidr, *Altair Director of Material Information*

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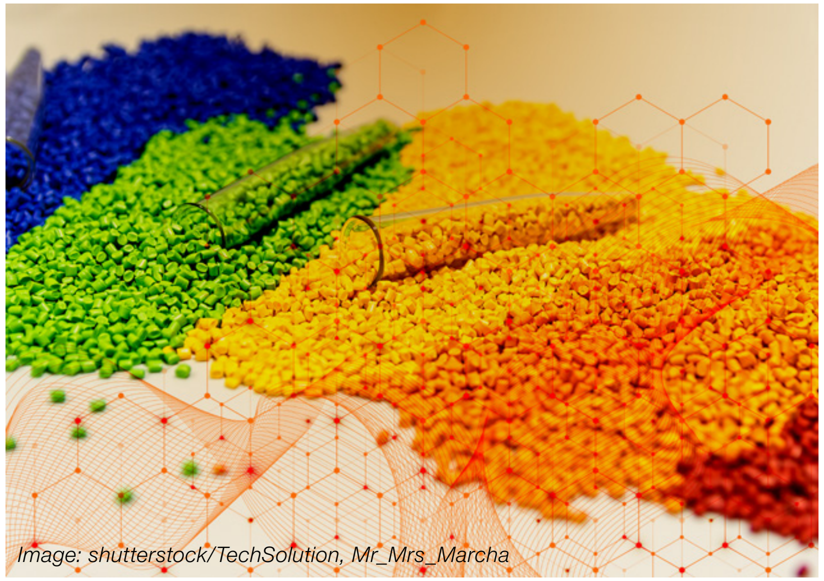
At the most fundamental level of material selection, it is critical to have robust data for investigating the vast array of thermoplastic and thermoset polymers. When it comes to sustainable design additional considerations and performance requirements come into play, whether testing a new biopolymer or planning a material substitution to further optimize performance and cost for an existing product.

Competitive pressures, often elevated by greater sustainability demands, heighten the need for up-to-the-minute data and additional capabilities that stretch those of conventional databases. These factors call for a new material data strategy with more sophisticated database management with access by multiple disciplines and departments and functions that include virtual testing, simulation, computer-aided engineering (CAE), and accessibility and security features.

Overcoming Traditional Material Data Challenges

The industry has spent decades confronting the inefficiencies of working with incomplete data, using generic data, using non-standardized data from commercial suppliers, and differentiating between materials from different suppliers. Along with those challenges came uncertainties of verifying the sources and timeliness of data and working with multiple software tools that do not easily connect and communicate with one another.

Over time, a solution emerged and coalesced around international and national standards as well as CAMPUS, the Computer Aided Material Pre-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selection by Uniform Standards consortium for the plastics industry. Today, CAMPUS is a world leading plastics database. It is free, online, and provides a uniform set of test conditions and instructions for plastics providers in a manner consistent with recognized international standards. Its standardized structure for test specimens, test conditions, molds, and processes sets the bar for standard material selection requirements, and provides a baseline for further development by solution providers.

In 2020, Altair acquired M-Base Engineering + Software, the official developer of CAMPUS software, while the consortium and its services remain wholly independent.

Effective Material Investigation Environment

The concept of a material database has matured to a more comprehensive solution known as the Altair® Material Data Center™ (AMDC). It brings together all material data; a literature database; tradename directory; resistance database; biopolymer database; application database; and a CAE toolbox to work with single-point data and multi-point data. Furthermore, it automates the creation of detailed curves to simplify research using advanced software technology; provides a unified software environment; and includes an IT infrastructure that makes data accessible to users in new ways.

This approach also improves efficiency for tasks such as:

- Performing quick material searches or browse different categories, ever increasing numbers of thermoplastics from multiple producers.
- Visualizing advanced material properties relating to various temperature dependence properties, thermal properties, and viscosity; curve plots (e.g., raw data on shear rate over viscosity); and CAE modeling using multiple tools.
- More sophisticated searching beyond basic keywords to advanced searches with logical operators such as chemical composition (e.g., Al, Cu, Ni) and performance factors (e.g. plasticity yield stress, cyclic yield strength, number of cycles at endurance limit), and even greater depth when searching for specific values within those categories.
- Comparing properties and curves for two or more materials in data and graphic plots by supplier, quality, type; and more detailed comparisons including density, equivalent strain, Poisson's ratio, ultimate tensile strength, yield strength, and Young's modulus.
- Global text search to keyword-based searches of a complete knowledge base, which eases material datasheet look-up by producer tradename and material brand name, an application database, and literature and tradenames from industry providers. The resulting "hit list" includes direct links to the relevant sources.
- Employing a toolbox of solvers for testing materials for analyzing cooling times, flow length, bending, snapfit, and unit-of-measure converter. To consider sustainability alongside other performance metrics, there is a CO_2 footprint calculator (See the next article in this e-book, "Reducing the Carbon Footprint of Plastic Components.")

→

The ability to add custom or proprietary materials along with physical test data to the database, including properties developed using tools such as a Altair® Multiscale Designer®. (See article, "How to Improve Manufacturability using Multiscale Modeling," later in this e-book.)

The Continuous Nature of Material Selection

While sustainability has been driving new designs for years, optimizing parts with sustainable materials is still relatively new. Once materials are chosen, they may still be revisited in later stages of product development.

Because multiple disciplines are involved in a single project, it is especially important to maintain a single, consistent source of material data, also known as "single version of the truth." Achieving this assures accuracy and consistency across design, material selection, testing, simulation, successive design iterations, production, and even post-production optimizations.

Creating that "single version of the truth," provides a holistic, multi-disciplinary development environment shared by design offices; simulation engineering; procurement and costing; and others.

Beyond uniform, standardized data users should expect testing, simulation, and other CAE tools to integrate easily with their material data.

In the case of the AMDC, with its broader user interface and toolset, further development has enhanced productivity across product design and development with a family of solutions that integrate into a single IT infrastructure. For example, the AMDC offers native connectivity to families of applications for structural analysis and dynamic motion Altair® Inspire™ and Altair® MotionSolve®; multiphysics workflows for complex CAD models (Altair® SimLab®); and a full, unified CAE environment for product development (Altair® HyperWorks®).

IT innovation, from AI to the cloud

While terms such as "integrated" and "unified" are often overused and ephemeral, be aware of ongoing information technology (IT) innovations that are improving material data science. Software solutions can now address challenges in modern day material science with advanced algorithms employing artificial intelligence (AI) and machine learning (ML) for automated material testing. This advanced technology addresses some common challenges:

Challenge: Gaps in data provided by material suppliers resulting in curves that are missing from the database. This is a relatively common occurrence, perhaps more common when seeking data for such things as alternative →

bio-based materials for compounds.
Solution: Use AI to predict the behavior of a material with missing data by scanning potential thousands of tests of similar materials from sources ranging from test equipment, laboratories, suppliers, and in PDFs or on websites.

Challenge: Too many material candidates and no way to test them all to isolate the best candidates.

Solution: Use AI to reduce the amount of physical testing required – especially for long lead-time creep tests and aging studies, which can delay a project my months.

While there's no substitute for actual high-quality physical testing, the advanced technology provides accurate predictions for many applications.

As product development requires more computing power to accommodate product development requirements, the nature of the IT infrastructure has also evolved with innovations such as physics-driven digital twin technology hosting virtual models; and high-performance computing (HPC) platforms that allow for a broader implementation of a more sophisticated, secure cloud infrastructure for "anytime/anywhere" problem solving 24/7 across the product development lifecycle. ■

Reducing the **Carbon Footprint** of Plastic Components

How to evaluate the Global Warming Potential of materials alongside traditional performance and cost metrics.

By Dr.-Ing. Erwin Baur, *Altair Chief Material Scientist*
& Dr. Kamila Flidr, *Altair Director of Material Information*

Image: shutterstock/Flexd Design, Meryll

With sustainability a growing requirement in many industries for parts under development, calculating the global warming potential (GWP) for a material or a compound is now possible using metrics, such as:

- Global warming potential per kilogram
- Tensile strength versus global warming potential
- Price and performance

From the earliest stage of the material selection process, determining sustainability can eliminate undue time spent using trial and error downstream. This knowledge can help arrive at the right, strategic choice for a particular project.

Sustainability of Plastics

Let's start with looking at the AMDC for molding and mechanical investigations, where the tool functions are useful to determine the energy, material and environmental impact of a design and its processing. It includes databases for biopolymers, natural fibers, simulation of natural fibers, and the lifecycle analysis (LCA) of plastics.

There is already good news regarding CO_2 savings when designing with plastics: Their global warming potential (GWP) is lower by orders of magnitude compared with other materials. For example PLA and PA6 have much lower carbon footprint than stainless steel, aluminum. (See **Figure 1**.)

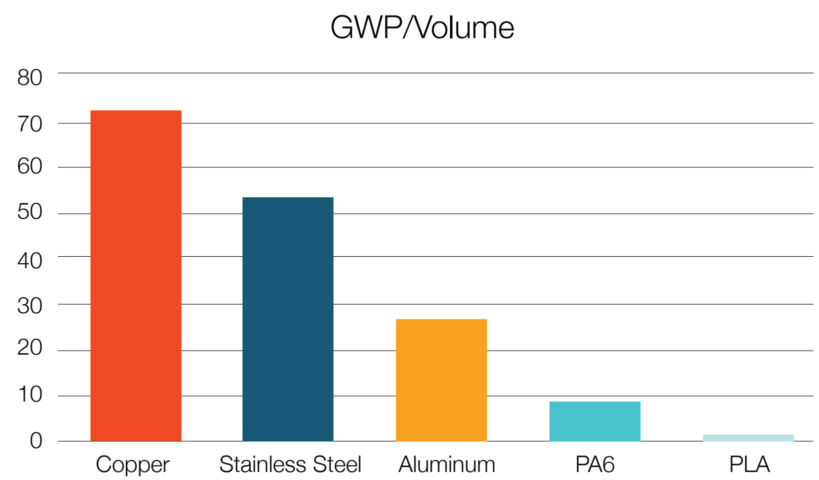

Figure 1: Plastics offer significant GWP reduction benefits vs. metal.

Designing with plastics gives designers the freedom to reduce material use. However, owing to public misconception, the need remains to prove the sustainability of plastics to industry. Proper design goals help do this, which include having reliable material data and material models; employing simulation and optimization; and something new: The ability to reduce CO_2 in material choices and therefore the final product.

This can be proven with verifiable data today. Trends point to a future in which plastic producers measure and provide proprietary CO_2 data manufacturing processes as a matter of course. (See sidebar, "A Plastics Industry First," page 14.)

Some very important truths illustrate how material selection can become a complicated affair when designing with plastics:

- Reliable material data, models, and simulation software are very important. Together, they →

allow designers to use as little material as possible to avoid over-engineering. Industry manufacturers are increasingly reporting more, and more detailed data, which bodes well for reliability.

- Changes in the three key aspects of a design – material shaping; part dimensioning/calculations (e.g., wall thickness); or material selection – the others will also change. Also, never forget that processing's influence is considerable. It is often necessary to revisit and optimize materials and designs.

And just like simulation and optimization, material selection is not one single step but should be reconsidered and revisited at any and every product development step. And these practices must always use the same set of material data throughout the process (as discussed in the previous article).

Influence of processing

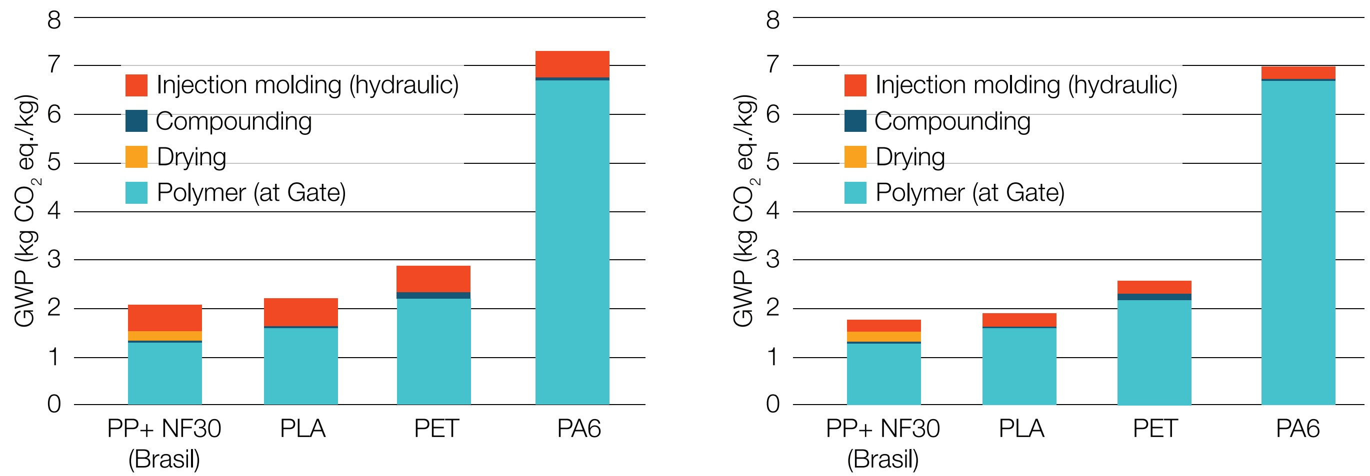

Figure 2: Process steps add GWP to the raw material to varying extents, and can vary even between two different injection molding machines as shown.

Understanding what Influences GWP

More and more plastic producers and sources are now reporting CO_2 footprint data, which allows generic data for testing. For instance, when many or most producers of PA66-GF30 or PP-T20 provide thermal and mechanical data; and minimums and maximum average stress/strain, it enables us to define GWP averages or ranges for investigating material options. This information, where provided by plastics producers, is included in the CAMPUS database as well as in the AMDC.

There is more to calculating reliable GWP for a material used in a new product design, because process influences affect GWP as these add CO_2. Every sophisticated producer and designer of plastic parts has or should use GWP data on their materials.

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Plastics and other material producers should consider providing more: A certificate with each shipment that includes information such as the specific day or batch, processing/energy details, and the machinery the material was produced on. These factors are relevant; even the GWP of two different injection molding machines can make a difference. (See **Figure 2**.)

Designers who have this information gain greater assurance of their data reliability. This may sound futuristic, but some major automakers are already asking for this because sustainability is so important in this sector.

Today, data is available for many materials and can be used to compare materials for optimal cost, GWP, and performance variables such as material stiffness/strength under tension, bending, compression, and viscosity. This is still early days, but the trend towards ever greater sustainability is likely to drive better data availability over time.

Designing for Sustainability

Moving beyond materials, other design factors can be considered to optimize cost and CO_2 savings such as dimensioning, shaping, and ongoing material reductions. The same techniques can also be used to optimize the use and quantity of recycled materials, which typically offer greater flow but also reduced mechanical properties. Even without GWP data from producers, designers can consider cost and performance to optimize the appropriate level of recycled content.

These worthy pursuits follow well-established design wisdom: The more you can trust your material data and material reduction approach, the greater trust you can have in your design. Also, the greater savings you may find long-term by avoiding unnecessarily high safety margins that require adding-back material to your design.

A further consideration is to ensure that sustainability does not adversely affect performance or the cost of the part. By comparing the results of the price of a material relative to its tensile strength and the cost of rising global warming potential benefits, provides a measure of "price per CO_2 saved" at various loadings. (See **Figure 3**.)

Comparison Between Indicators

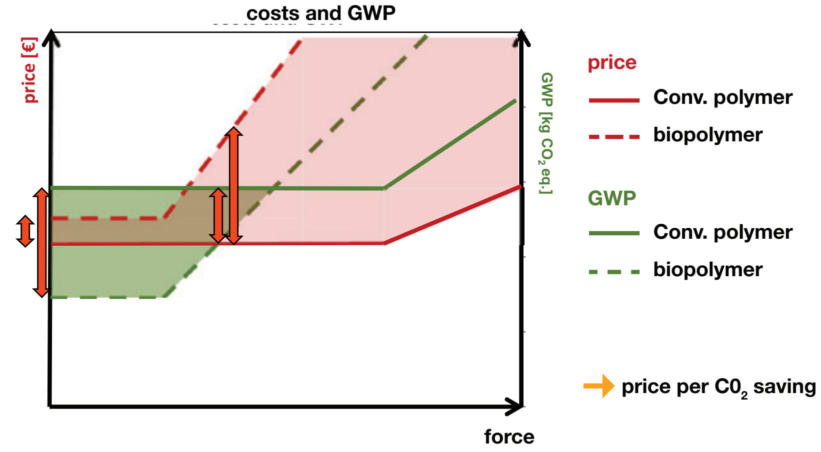


Figure 3: Evaluating "price per CO_2 saved" by comparing a material's price relative to its tensile strength and the cost at different GWP levels.

Sustainability goes beyond material selection but carries through design lifecycle. From material selection to reducing the material – along with costs and carbon footprint – additional tools →

become critical for dimensioning, and shaping. For example, using topology optimization to modify part geometries and improve rib structures provides additional material savings and lightweighting benefits. The design of sophisticated, sustainable parts and end-products should always employ these practices. (See next article in this e-book, "A More Efficient Approach to Lightweighting.") ■

A Plastics Industry First: CO_2 Tracking of Proprietary Processes

With the software tools available today, carbon footprint can be calculated to aid in product development. But what if you could validate that information based on real-time manufacturing data? In an industry first, this was proven to be possible in a 2022 demonstration in conjunction with the K Show in Düsseldorf, Germany.

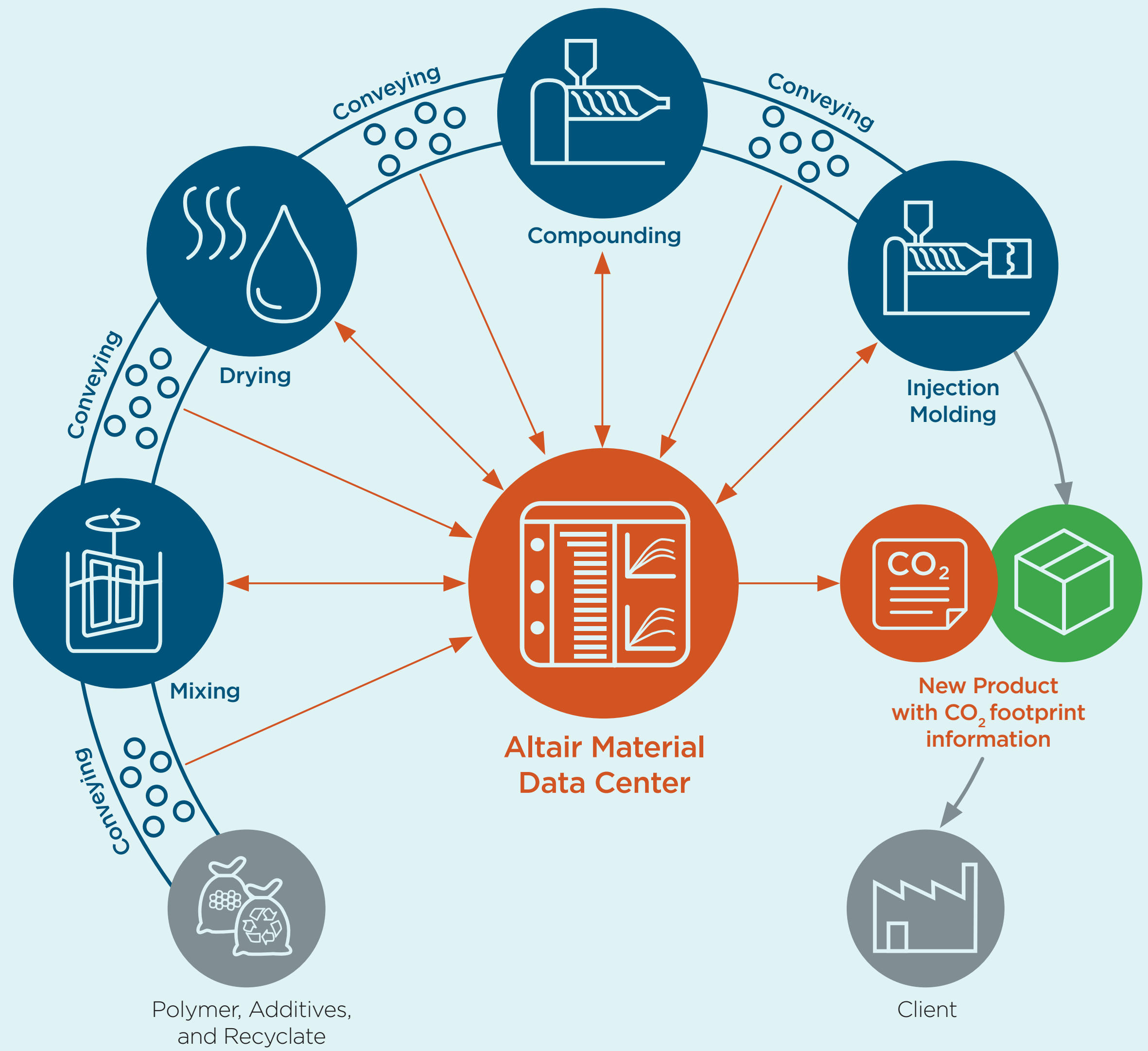
At the event, equipment supplier Motan Group, in partnership with Altair, demonstrated such a carbon footprint tracking system. It included a standalone version of the Altair Material Data →

Center (AMDC) which was connected to processing, compounding, and grinding systems. Based on material and real-time process data, the AMDC collected and tracked carbon footprint based on material properties and processing characteristics – in real time as the equipment was running batches.

The event proved that today's technology can provide:

- Accurate recommendations for optimal processing and reduction of material and energy waste
- Verifiable data to prove carbon footprint output from processes
- A unique solution for quantifying carbon footprint across the plastics value chain based – for the first time – on actual processing data

"The CO_2 Tracker project from Motan and Altair is the first integrated approach to map the complete production process and provides true material data transparency by capturing the actual processing data," said Motan Group's Sandra Füllsack, CEO. The demonstration system now resides in Motan's Technical Center, Isny, Germany. ■



Schematic view of the carbon footprint tracker.

A **More Efficient** Approach to **Lightweighting**

Radical improvements to workflows have significantly accelerated design space creation, exploration of variants, and successfully optimized lightweight plastic parts.

By Stuart Sampson, *Vice President of Product Management, Altair*

Image: shutterstock/ChunnapaStudio

Following initial material selection, simulation using topology optimization can further ease the creation of designs optimized for sustainability in common tasks such as material reduction and lightweighting.

Topology optimization helps balance structural performance, cost, and weight. It has become the poster child of generative design, due to its decades of use and increasing importance for design modifications – particularly formaterial substitutions and changes in manufacturing methods. It is therefore a foundational tool for sustainable design in many industries including automotive where the lightweighting parts and subsystems is necessary but must not compromise overall performance and cost. In a traditional design engineering environment, however, many fail to realize its benefits due to hindrances in work processes and organizational issues. In particular, the definition of the available package space has been an obstacle in the past due to limitations in efficiently using data from 3D models to create a design space in which to optimize part designs.

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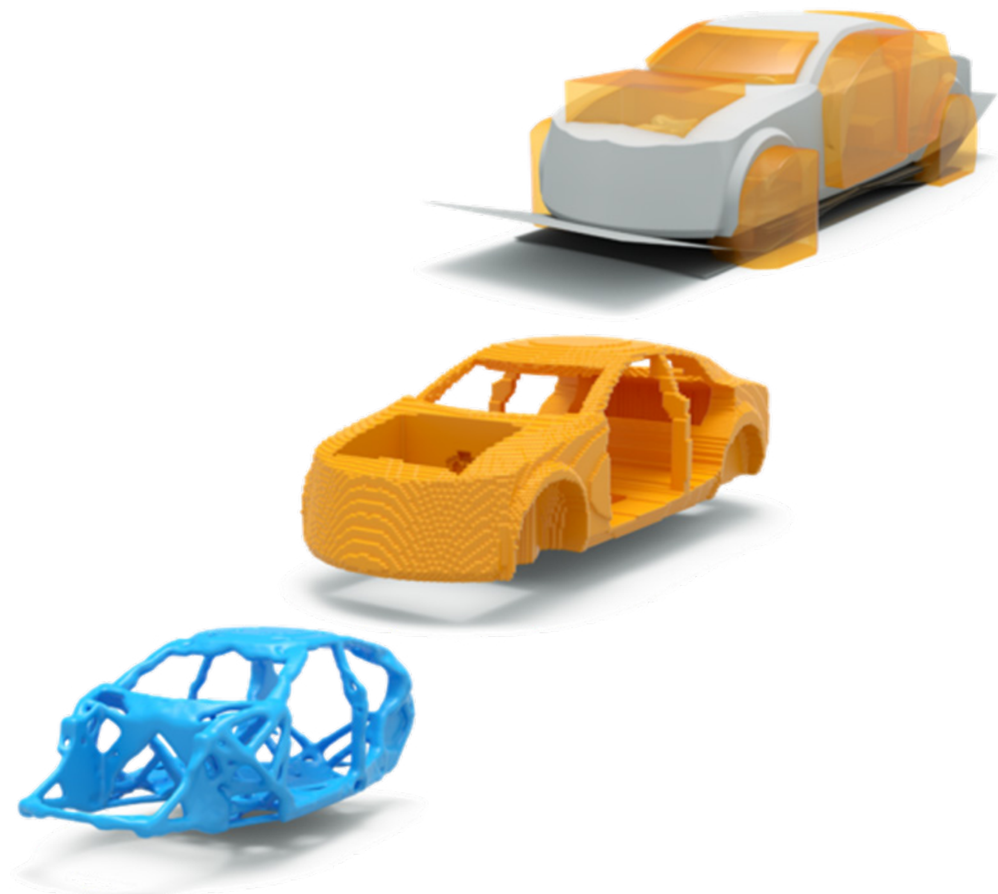

Photo courtesy: Altair

Solutions have evolved that include new process building engineering workflows that ease the preparation, creation, and management of design spaces for topology optimization while improving organizational efficiency. Full benefits are implemented using high-performance computing, coupling machine learning, digital twin with cloud technologies integrated with an advanced, standardized database environment. (See article, "Consistent Material Data: A Prerequisite to Sustainable Design," earlier in this e-book.)

3-Step Approach to Simulation-Driven Design

New simulation tools are in demand to efficiently support balancing of structural and acoustic performance – plus mass and cost constraints – in electric vehicle (EV) development and design. EVs not only represent a radical departure from internal combustion engine vehicles but from one another, because the industry is rapidly evolving. Vehicle architectures are diverse and continually require new ways of thinking about lightweighting.

Original Equipment Manufacturers (OEMs) are looking for new lightweight material solutions for structural reinforcements to provide low body mass while maintaining high stiffness. In addition, Noise, Vibration, Harshness (NVH) behavior is a requirement automotive engineers have long sought a solution to predict in the early concept phase.

Both these structural and acoustic requirements converge in engineering improvements such as improving NVH performance with optimized structural plastic inserts. This starts with analyses of the body-in-white (BiW, a vehicle's non-painted structural frame) and usually takes many iterations to develop the optimized design.

The goal is to achieve the optimal design as early as possible in the initial development phase because it later affects material and dimensioning design efforts. This is followed by the need for efficient concept development.

Overcoming Roadblocks: Easy as C123

For more than a decade, Altair's C123 approach has offered a more efficient path for design concept development, starting with the feasibility stage and carrying through the handover for designers to implement a finished design. It speeds preparation for topology by streamlining the massive volume of design explorations and trade-offs involved in vehicle development (i.e., body, platform, architecture).

The name C123 derives from a three-phase process that uses successively higher-fidelity models:

C1– *Load path development:* This step focuses on topology to identify the optimum structural layout using free-form modeling. It provides flexibility to analyze design ideas, cost of changes, feasibility studies to understand modular design, carry-over content, and general design balance limits.

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C2 – *Mature sections and joints:* This step focuses on parametric structures for rapid design exploration using low-fidelity models for design exploration. It includes what-if studies to choose and dimension cross-sections and structural joints.

C3 – *Verification and preparation for handover to mainstream development:* This step employs full, finite-element representation to finalize details in the product development phase using high-fidelity models for full-scale multi-disciplinary optimization of dimensions.

These phases focus more on how structures are represented as opposed to moving through three discrete steps executed one at a time; structures usually involve a mix of C1, C2 and C3 representations.

The C123 workflow provides a structure for shared responsibility and decision-making for design space creation and management. This results in **improved CAD-to-CAE communication** and **faster design space creation** for more efficient balancing of the many different and competing attributes that often "fight" for available space.

Topology optimization is a strategic enabler for mass reduction that leads to sustainable design alternatives, but only if there are no delays in securing feedback. Many departments must be involved in the design space creation of body concepts, which causes significant delays in traditional organizations. The C123 approach provides a solution with improved CAD-to-CAE communication, which removes organizational barriers, speeds generation of design feedback and, in turn, design space creation.

Faster design space creation

Design space creation is usually a tedious task because it is not addressed appropriately in the CAD environments used by design teams or in the CAE processes used by analysts. To accelerate this work, Altair created a dedicated workflow within HyperWorks' to prepare, create, and edit design spaces for topology optimization. This can be seen when examining traditional processes against the more modern, improved workflow employing the C123 workflow approach. (See **Figure 1**.)

In each scenario shown in Figure 1, two revisions are created.

The top workflow shows the process when CAD is involved in the package space definition. It can take many hours to retrieve the appropriate package space from CAD followed by additional CAE interpretation to generate a model. This traditional approach generates a CAD envelope represented with tetrahedral elements – a time-consuming representation rendered in high-fidelity, which does not yield any benefit regarding the final conceptual result.

The middle process flow highlights areas of the process that do not involve CAD. In this scenario, →

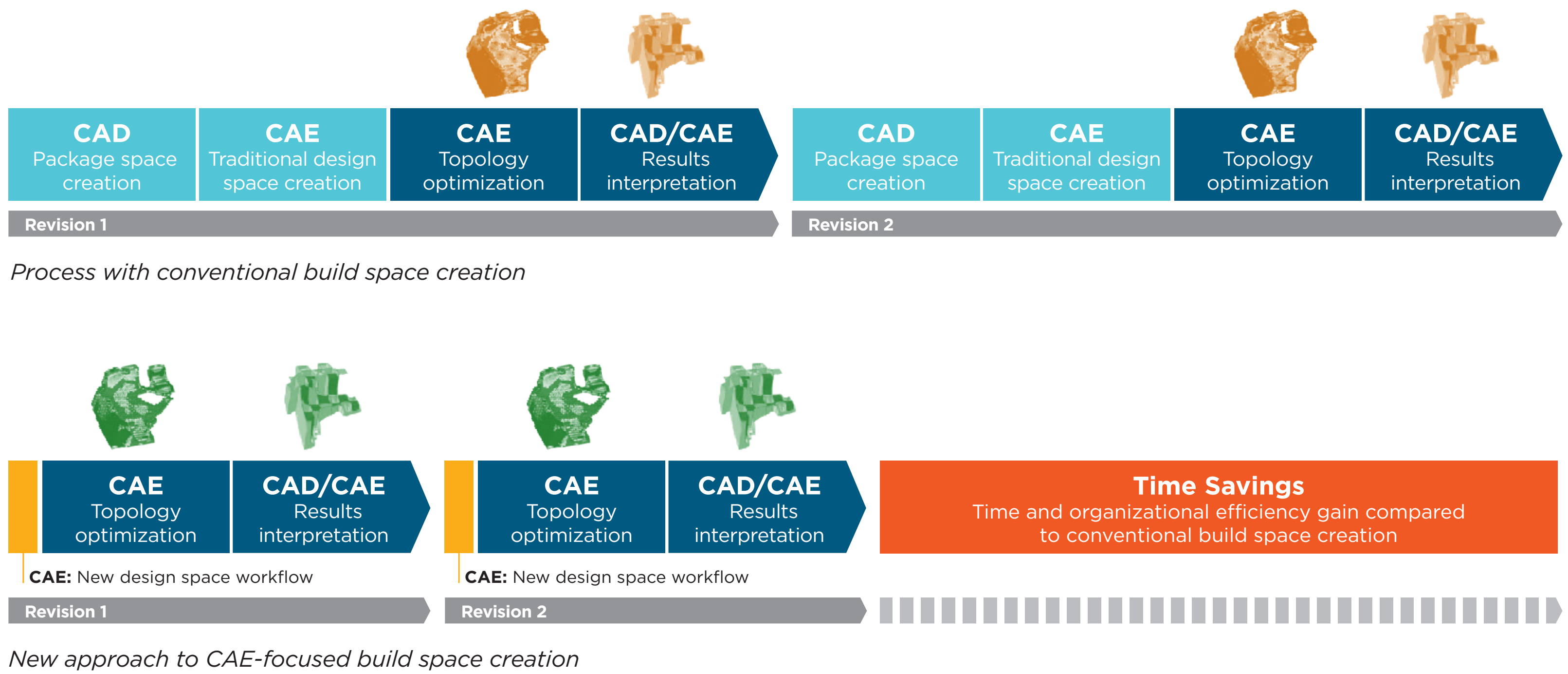


Figure 1: Applying HyperWorks design space workflows improves organizational efficiency and provides engineering lead time savings.

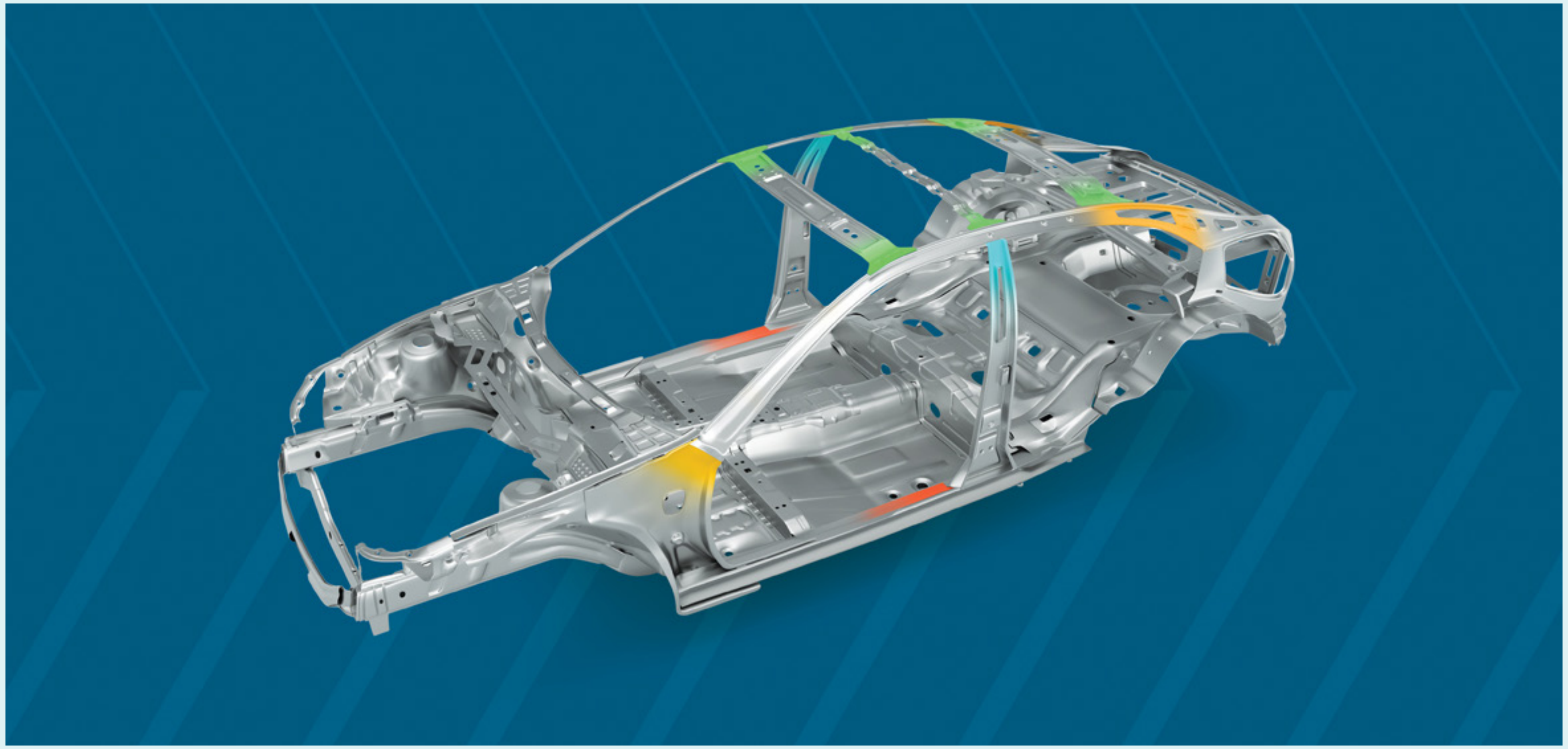
CAE needs to spend more time defining the package space correctly – again using the high-fidelity traditional approach using tetra elements.

The bottom process flow shows the time compression savings when the newer low fidelity design space process is used to generate the topology model. Up to 80 percent of the manual time spent building the model is saved, which provides more time for evaluating different designs and improving the engineered solution.

The C123 design space workflow improves package management and streamlines model building for topology optimization. Several tools can then be applied including a non-design space library, collision detection, and an innovative voxel Boolean mesh engine. With minimal preparation, a design space can now be created within a user-defined volume.

Exploration of design variants is now possible using models that can be re-generated in seconds; the model pedigree is saved enabling quick package space changes. The creation of the design space and the connection to the surrounding structure efficiently addresses the complexities found in a design's intersections and voids in various combinations. This approach can then be incorporated into an integrated engineering software environment.

L&L Products: 80% faster model setups



L&L Products reduced model setup times 80 percent with a completely CAE-driven workflow in serving automotive customers with structural foam adhesives used to reduce structural weight (and noise).

The company was running topology optimization models in OptiStruct but used a time-consuming three-step process to enable a model to be run: 1. Extracting surfaces from the initial CAE model; 2. Building an offset envelope of the part's surfaces in CAD; and 3. Creating a high-fidelity tetra mesh of the candidate design space. These steps took up to an hour – multiplied by the number of inserts (and repeated models) needed for a vehicle.

The solution came when engineers turned to HyperWorks local design space, which uses voxels instead of high-fidelity tetra elements, and reduced those steps to one with no compromise to performance. A single CAE engineer can now build models in five minutes instead of an hour. The engineer needs no CAD expertise to perform the single voxel-mesh step process, and the new process eliminates the traditional delays of requiring multiple teams for decision-making. (Read L&L case study for details.) ■

The Integrated CAE Software Environment

HyperWorks workflow provides an easy, integrated environment for rapid simulation and optimization of weight and performance. Home screen options provide an easy way to choose the desired function and to run simulations based on the models within each toolset.

Tools in the **Design Space** section of the software solution include selections for working in the type of design space to be created, such as local (e.g., BiW), local (e.g., structural insert), and/or adhesives. Below is a representation of these three scopes of work in an automotive design application involving structural inserts and baffles in a vehicle. These are used to control noise, vibration, and harshness (NVH) in an automotive body-in-white.

Additional **Package Management** tools are often needed for model treatment. These includes features for efficient stitching and filling holes to ensure parts are watertight, and for reducing model complexity to let users focus only on relevant detail. Additionally, **Connectivity** tools help you connect the design space to the surrounding structure via contact or physical elements. For example, a topology optimization design space can show a local reinforcement in the BiW structure – including voxel input and the connection to RBE, or rigid body elements.

Overall, streamlining the design space with this workflow creates an integrated engineering environment that can significantly reduce the time and cost of material substitution, lightweighting, and design. It also makes consistent, accurate information available to pertinent stakeholders in later steps to improve decision-making across the enterprise. ■

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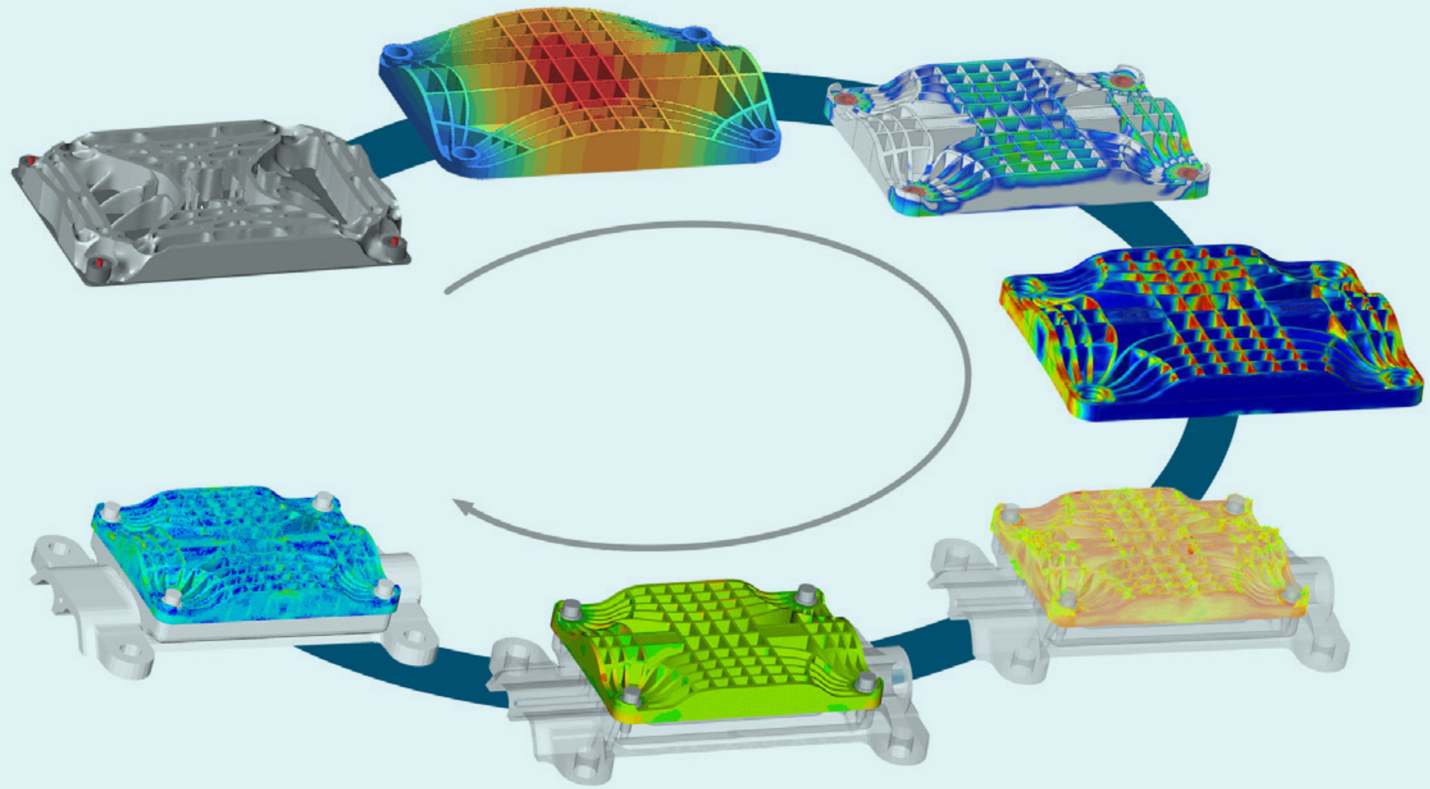
X-Plast: 25% Lighter Weight, 35% Lower Cost

Transportation industry supplier Knorr-Bremse turned to product development and molding firm X-Plast to evaluate lightweighting an existing metal component by plastic material substitution. It included a pneumatic braking system component.

The work employed Converse and S-Life Plastics software tools from PART Engineering, a member of the Altair Partner Alliance (APA); and Altair® Inspire™ Mold (all of which are addressed later in this e-book). Used as part of an integrated process, these tools facilitated finite element analysis and production of ready-to-use standalone model to predict fiber orientation and optimize the mold for optimal material use and part strength.



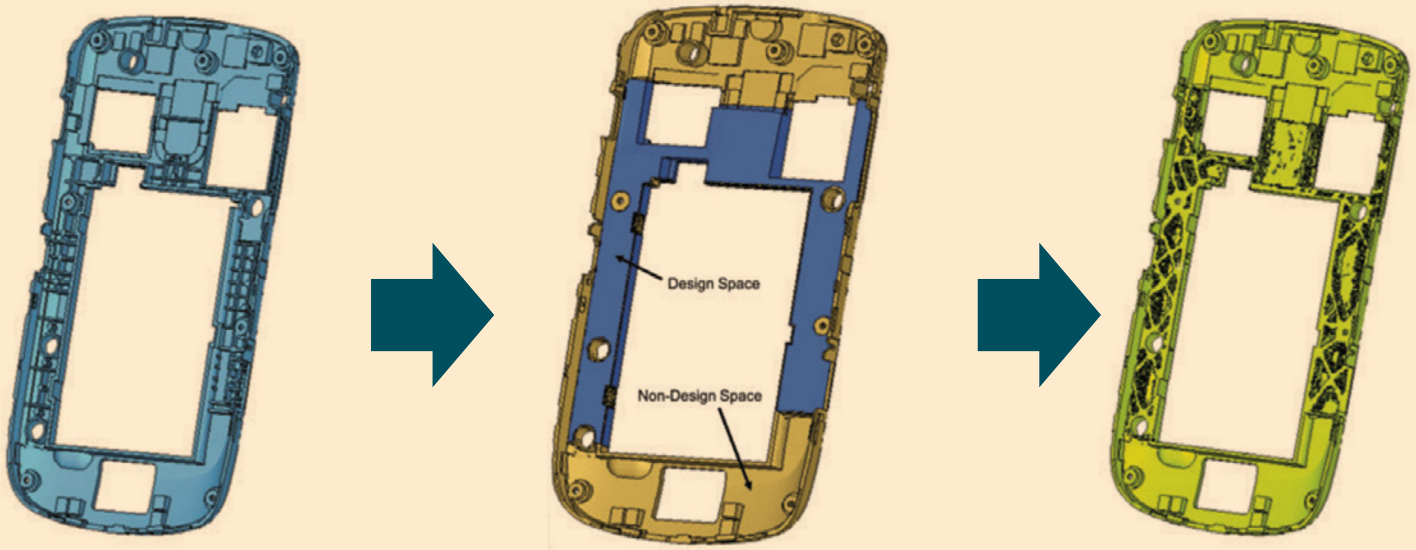
As a result, X-Plast reached the serial production within eight months, saved 35% of product costs, and reduced weight by 25% while ensuring the required 30 years of service life. These results illustrate how using the right tools can help improve ROI while meeting sustainability goals. (Read the case study for details.) ■

Beyond Automotive: Samsung Optimizes Consumer Goods

Samsung is an example of the ubiquitous application of topology optimization. More than a decade ago Samsung used topology optimization and iterative design for aluminum-to-nylon conversions in home appliances including a large washing machine belt pulley. This was done using Altair® OptiStruct®, a key component of Altair simulation. Benefits included reduced total volume and a 10% reduction in material usage. (Read the case study for details.)

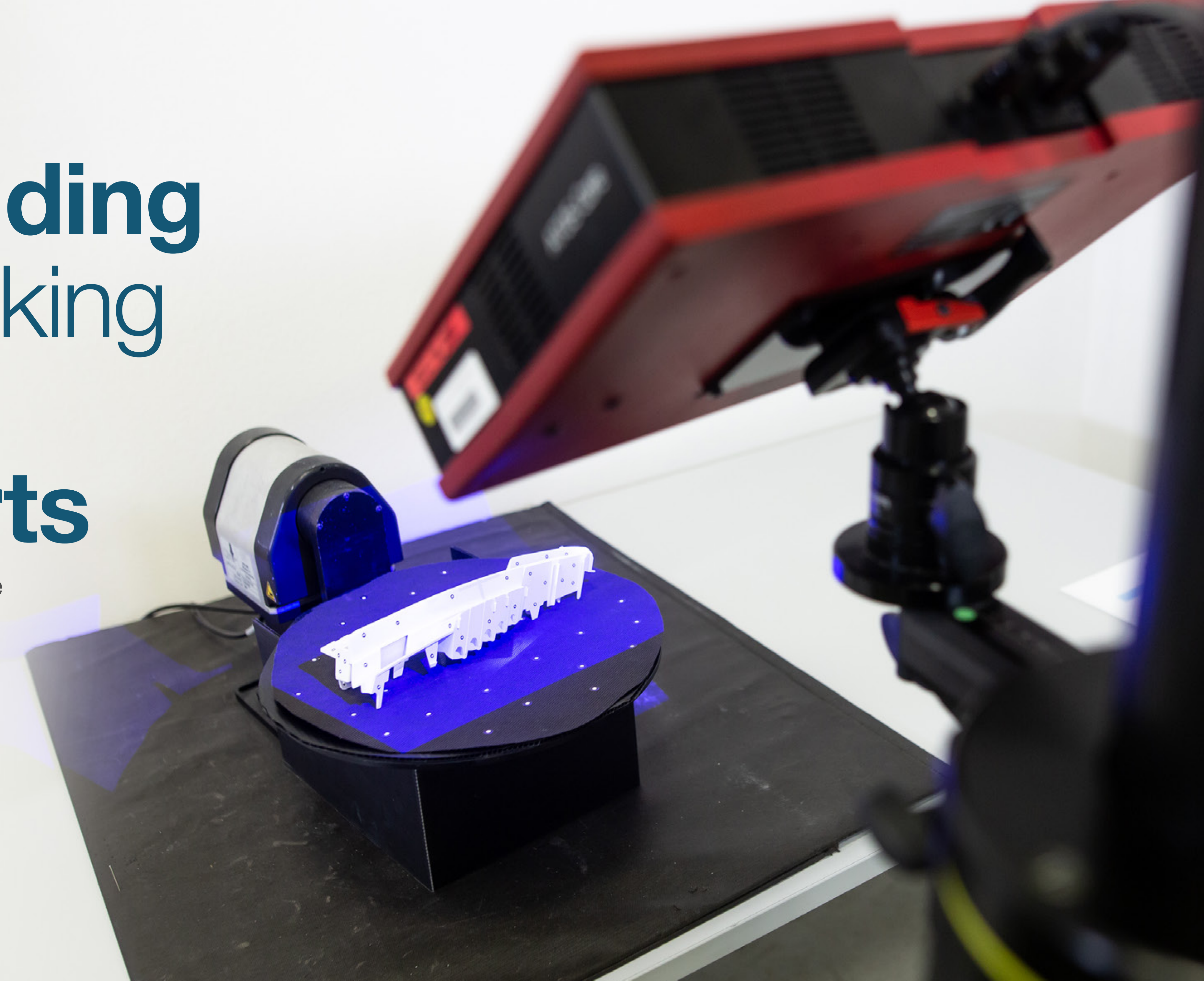
More recently, Samsung has been used to modify the rib structure of smartphones for increased stiffness with less material and, in turn, carbon footprint…while increasing stiffness 30 percent. ■

Case study smartphone - 30% increase in stiffness



Initial Design | **Design space model** | **Optimized rib structure**

Virtual Molding ways of working for **Better Plastic Parts**



If you want faster time to market and more first-time-right plastic injection molds, use simulation and rapid variant analysis to optimize your part, mold and parameters for manufacturing. The secret sauce is in the way of working.

By Dr. Bastiaan Oud, *Head of Strategy, SIMCON*

Image: shutterstock/Simon Kadula

Following topology optimization, product development teams must consider how a design will be affected by manufacturing. Here, we discuss best practices and the mistakes to be avoided when seeking to achieve better plastic parts when simulating the filling and molding processes. Using the right software is one part of the answer. But to get the full value, you may need to rethink your ways of working. Here's how.

Unfortunately, many injection molding engineers believe that "digitalization" means you install a piece of software, do a training, and, abracadabra, there's your value. The truth is: unfortunately, that's not enough. If you really want to realize the full value, you need to update the way you work. It's not just what tools you have, it's how you use them. The following discussion provides food for thought about what a modern, properly digitalized way of working looks like for part and mold design for plastic injection molding.

The Five Key Principles

Based on thousands of projects with the world's most demanding injection molding projects, Altair and SIMCON believe that the most successful part and mold engineering departments share a few distinctive features. They don't just use software, they redesign their way of working to harness the full power of their new digital capabilities. Here are some of the most important success factors.

1. **Front-load decision-making:** If the first time you are simulating is after you've designed your mold down to the last screw, you're doing it wrong. If you discover an issue, your hands will be tied, and it will be harder to fix. Instead, you should start simulating as soon as you've got your initial part geometry. Use these early insights to figure out what's wrong and fix it before you add more detail. Then add more and more aspects of your mold geometry (cooling channels, hot or cold runners, etc.), step by step. Your simulation will become more and more precise, as you add details, but that should not stop you from using the early insights to make those early directional design choices.

2. **Iterate smarter:** Once you've run your initial simulations, you'll know what issues you'll need to solve. Perhaps you've got weld lines in unfortunate places, perhaps there are filling issues, maybe you have discovered →

warpage issues, etc., the list goes on. So how should you go about finding better solutions? One way would be to change some of your settings, run another simulation, check whether that improves things, “rinse and repeat”. But that’s an old-fashioned and slow way of working because it’s essentially trial and error. It’s a sequential process because you’re running one simulation after another, which will take a long time. And you’re learning rate is slow, because you don’t yet know much about cause and effect before you set up that second round of simulations. A **smarter way of iterating** is to **parallelize** the exploration of alternatives. Using VARIMOS, which is available via Altar Partner Alliance (APA), you simply drag and drop in variables that tell the system what you can still change. For example, you could define wall thickness in ribs 1 and 3 as two variables and specify a range of +/- 10% for each. Your gate location (x- and y-coordinates) could be captured as a variable. You could treat injection parameters like pressures and temperatures as variables, and so on. Simply drag and drop in your variables, specify a range for each, and let the system set up, run, and analyze 20, 40 or more simulations for you, and run them in parallel. Thanks to the incredible performance of the VARIMOS solver, you will usually get same-day or next-day results for the full set of simulations and get an easy-to-understand summary of results across all of your simulations. You can do real-time “what-if” analysis and see changes if you modify your variables. And you get a first suggestion for optimized variable settings.

3. **Cross-functional product teams:** If at all possible, involve your downstream colleagues (machine operators and metrology personnel) upstream. Once you’ve run your simulation analysis, but before you commit to building the mold, show your intended injection parameters and predicted results to them, and get their feedback. If instead the first time they get involved is after you’ve built your mold, it will be impossible to reflect their feedback in a meaningful way, leading to costly mistakes.

4. **Consistent success criteria:** Unless you have a shared definition of what constitutes success, you’ll have a really hard time aligning the many departments involved in your project. They will pull in different directions, resulting in costly changes downstream. Write down a shared definition of how you will measure success for the project. Perhaps success means meeting a particular cycle time target, particular warpage goals, or a minimized energy footprint. Whatever it may be, unless everyone knows what you are working towards, trying to coordinate everyone is going to feel like herding cats. →

5. End-to-end digital integration: Enable

If you want colleagues to collaborate across departments, their software has to be compatible. Make sure you can seamlessly hand over your CAD files from part engineering to your rheology colleagues who do injection molding simulation. Make sure that your injection molding simulation is compatible with your structural solver (e.g., hand over fiber orientations, weld lines, etc.). And if possible, make sure you can digitally send your injection parameters to your injection molding machine, with paper printout in between. Unless handovers are digital, you will get tedious double work, frustrated colleagues, and costly mistakes. The unique Altair One licensing model provides a fantastic way to achieve this kind of seamless integration by giving access to all of the solutions you're going to need along that digital chain. CADMOULD and VARIMOS accept all leading CAD formats, so you can use your existing data. If you have →

Figure 1: These five shifts in the way of working make all the difference for plastic injection molding time to market, quality and cost.

enough units to run CADMOULD, you also have enough units to run PART Engineering's CONVERSE, which provides a convenient bridge to the many structural solvers that are available on Altair. And since CADMOULD and VARIMOS provide native digital compatibility with injection molding machines, you can send your parameters losslessly to e.g. your ARBURG or ENGEL injection molding machine on the shop floor.

To conclude, while it's great to learn from your mistakes, it's even better to learn from *other* people's mistakes. The principles outlined above capture hard-won learnings from thousands of part and mold design projects that SIMCON and Altair have seen over the years. If reading some of the above points made you stop and wonder why that's not what you're doing yet, reach out today! We'd be delighted to help you get started. ■

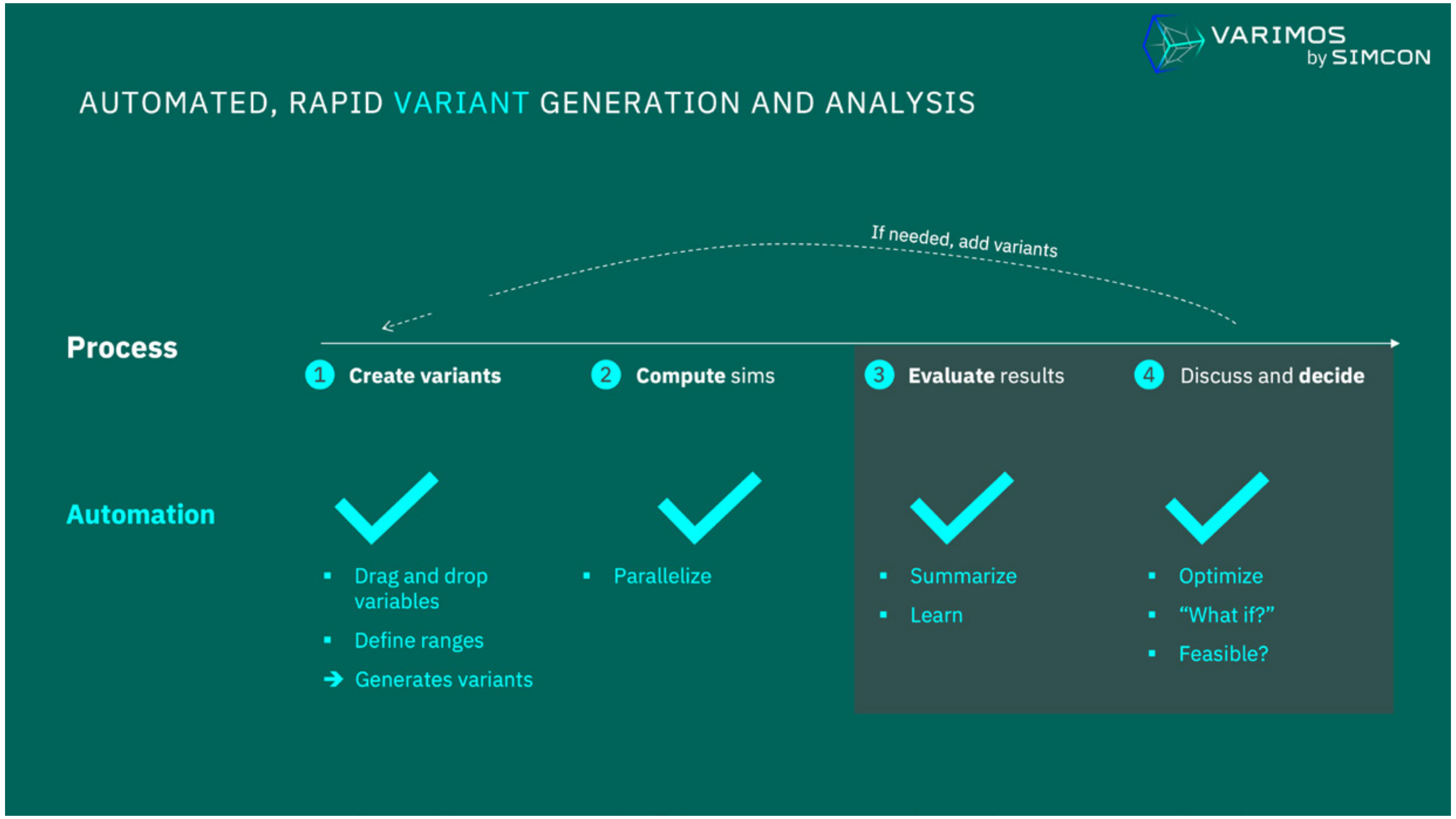


Figure 2: Iterate smarter: APA partner SIMCON provides a solution called VARIMOS, which automates all four steps of rapid variant analysis, from quickly setting up design variants, to simulating them in parallel, to inferring and modeling cause and effect across simulations, to making recommendations for optimized design.

FAQ:

The Business Case for Simulation for Successful Design and Injection Molding

How to evaluate the Global Warming Potential of materials alongside traditional performance and cost metrics.

By Martin Solina, *Vice President - Inspire Manufacturing Solutions, Altair*

Image: shutterstock/ Pixel B

Plastic injection molding is an established manufacturing technique used across numerous industries. Simulation is used by many product development organizations, but not everyone is familiar with the tools and techniques within organizations, and some industries are slower to catch-on to the need and reap the benefits. Here we answer some frequently asked questions about simulation technologies for the design and manufacturing of injection molded products.

Download the Injection Molding e-Guide from Altair for more details.

Why simulate injection molding?

The overall injection molding process is very complex and directly influences the quality of the molded part in many ways. For example, viscosity varies with shear rate and the density changes as a function of temperature and pressure. Additionally, the entire process is transient as the plastic goes from liquid to a solid state.

What competitive advantages do simulation technologies offer?

- **Better decision making:** Designers need to consider not only structural performance but also the manufacturability of the part. Applying simulation early in the design stage ensures products can be manufactured, which saves time and money.
- **Robust design with lower reject rates:** Component reject rates tend to be around 5% to 10% but can be even higher in some complex shaped parts. Using simulation technologies can significantly reduce rejected parts by identifying defective parts at an early stage. If these defects are found very late when they are already in production, it is very expensive to remedy. That's why reducing reject rates is so very important.
- **Faster products to market:** Using simulation to check a part can actually be manufactured before sending it to be produced saves a lot of time by significantly reducing the number of iteration loops between design and manufacturing teams. Any part that cannot be manufactured has to be redesigned and the analyses repeated, all of which cause delay.

What is the importance of Design for Manufacturing (DFM)?

Implementing a DFM approach early into the design stage puts powerful simulation technologies directly into the hands of the designers. It also gives insight into manufacturing processes and constraints to design and manufacture parts while reducing time and costs. "Think manufacturing" early in design adds in quality and part performance factors that can improve manufacturability. Click for details on injection molding solutions for manufacturability.

How does simulation reduce cost and drive better decisions?

Simulation enables a **virtual product design** approach using fully integrated tools across the whole design process. It enables concepts to be explored, problems to be resolved, design and process variables optimized together earlier, all within a single interoperable virtual product design ecosystem.

Faster time to market and reduced costs are attained by the need for fewer physical prototypes, with the physical testing needed for each, reduced reject rates, optimized material use, less waste, lower tooling costs, and less energy leading to confidence of fewer in-service failures.

Simulation-driven design is a powerful tool that brings together the different roles of designers, engineers, product development, manufacturers, process development, quality control, that all work together to deliver a reliable robust product first time.

How early in the design process should we perform simulation?

The earlier you can apply virtual product design, the more unexpected costs you are likely to avoid later in the process. The reason is simple: Making changes early during the design phase is much more effective in terms of quality, efficiency, and cost than at any later phase. (See **Figure 1**.)

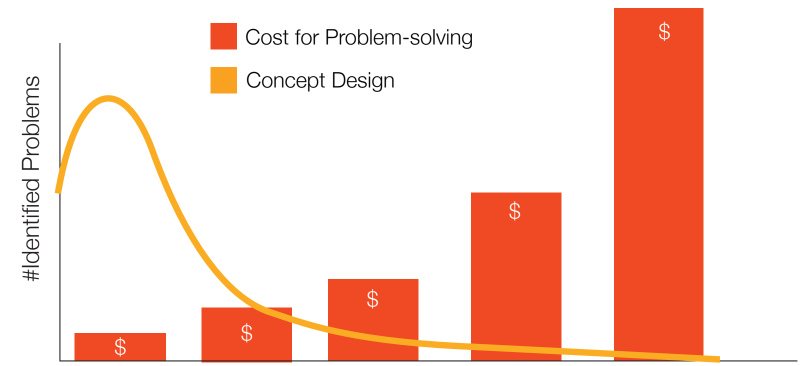


Figure 1: The earlier you use simulation in your project, the less risk of unexpected costs you will face later in the process.

Can simulation ensure defect-free production?

No amount of experience can guarantee a defect-free injection molding process. With complicated part geometries, molds are complex and expensive making it difficult and costly to remove defects through mold corrections. This is why employing simulation to identify and eliminate sources of defects in advance of mold manufacture and process setup is so important.

By "manufacturing" parts virtually, the sources of defects can be identified and eliminated reducing the need for physical prototypes. →

Injection molding simulation is commonly used to determine and improve filling pattern (i.e., sprue positioning, venting, weld lines); pressure and temperature distribution, i.e., cooling and cycle times, material damage; shrinkage and warpage (dimensional stability); and for reinforced plastics, fiber orientation distribution if a subsequent structural simulation is performed.

If not totally avoided, defects can be reduced to the point where the molded part remains within tolerance limits. By changing the part geometry and/or process parameters in the simulation model, the effect of changes can be readily evaluated virtually.

How can we establish standard workflows and data across organizations?

Increasingly over the last 10 to 15 years, experience across several industries has shown Altair that although designers and CAE analysts may have different goals, they share a need for easy-to-set-up and use simulation methods. By putting advanced simulation technologies in the hands of designers, Altair have created an easy workflow for users to easily define, set-up and run a “fast” simulation to address manufacturing defects (warping, sink marks, short shots, etc.) or a “detailed” simulation, which provides much more information from a more complex analysis, long before a mold is made.

Designers can make use now of real time simulation to try manufacturability and produce fast and early analysis to use this information to improve the part design. (See **Figure 2**.)

Integrating simulation in the end-to-end full workflow design process or within the entire life of the part, is very important for the future. Having the means to connect optimization, motion analysis, with manufacturing is already being applied in some forward-thinking industries to →

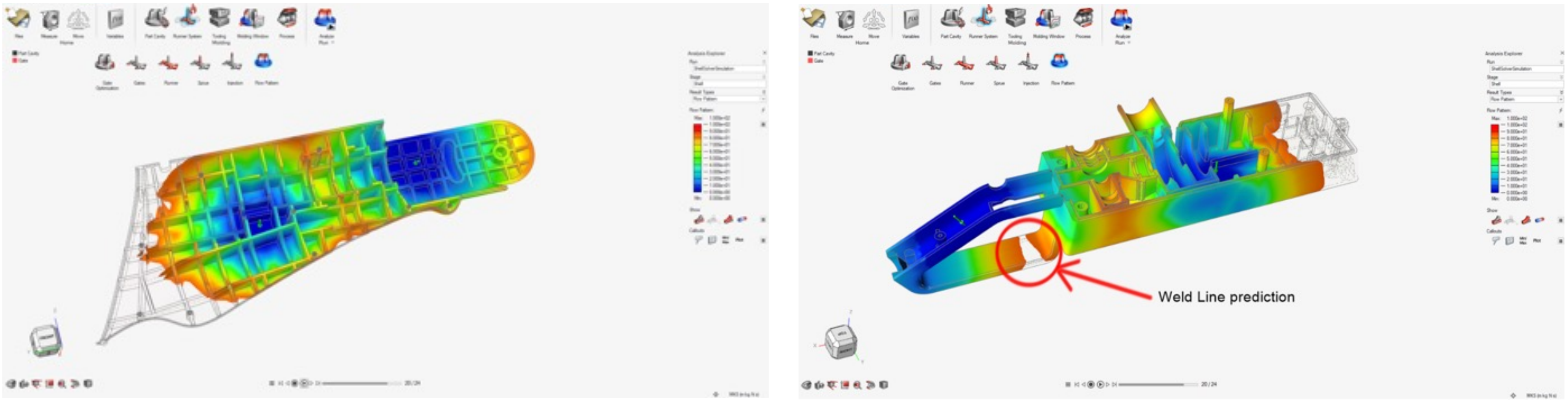


Figure 2: Real-time simulation reveals the plastic flow pattern (left) for the cover of a medical injector (left); and feasibility analysis and defect predictions (right) for a belt sander part. Details on both applications are discussed in sidebars accompanying this article.

create really robust, high-performance components. The same applies to sophisticated enterprises that seek the benefits of a fully integrated, holistic CAD/CAE platform with tools for design and simulation of injection molded plastic parts, such as Altair's injection molding solution. Download the Injection Molding e-Guide from Altair for more details..

Bringing together a multidisciplinary team of engineers all using the same virtual product design approach the "joined-up-thinking" needed to investigate, highlight problems and resolve them much earlier than in the traditional product design-development stage.

One final thought: Don't be afraid of simulation! Some people still have the idea that it's complex, hard to use, something that they don't know enough about, don't know how or lack the confidence to use. Today simulation can be used by anyone dealing with real parts, be they a designer, manufacturer, QA, structural analysts, estimators or sales teams.

If there is one overarching point to remember it's this: Everyone can make use of simulation because we have transformed simulation to be easy to use for everyone; don't be afraid of simulation…use it, and use it early.

→

What key points should we consider when approaching simulation?

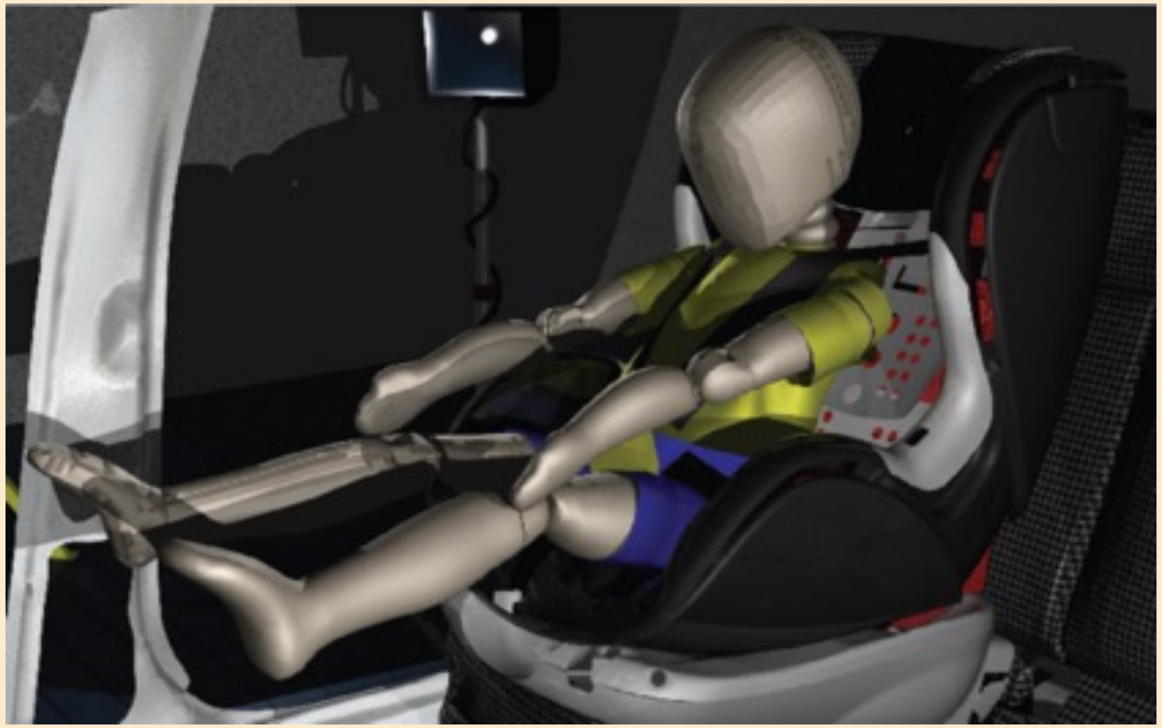
The first and foremost point to remember when embarking on a plastic injection simulation project is to use it as early as you can. Whereas in the past it was used only to virtual test or to validate, simulation has really become the new "workplace buddy" for sophisticated development teams. It's there to help when you have a design for a part and need to ask questions such as:

- Can my design be manufactured?
- Where do I put the gate so it fills properly?
- What and where will my part have a possible defect?
- How can I change my design to avoid these types of defects?
- How can I change my design to improve the manufacturability, reduce cost, etc.?

All of these questions can be addressed before physical assets make their way to the factory floor. But it bears repeating, with emphasis: Virtual product design avoids unexpected costs later in the process.

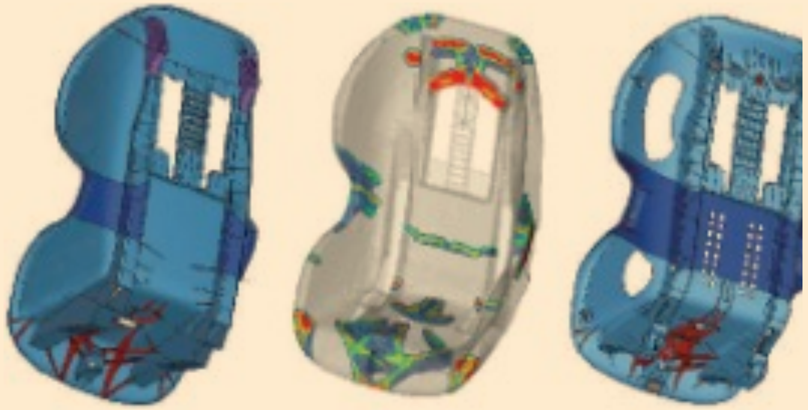
Britax-Römer: Reduced Weight, Improved Safety for Child Restraint Systems

Following the success using CAE tools in reducing the design and manufacturing of its award-winning Baby Safe Sleeper, Britax- Römer asked for Altair's support to develop its Trifix child car seat. This included topology optimization to create a weight-efficient structural layout and complex crash analyses to assure safety compliance. Altair scanned and meshed a model for the company, and the product design team modeled and analyzed performance in the virtual world, before physical testing which reduced the need for prototypes.



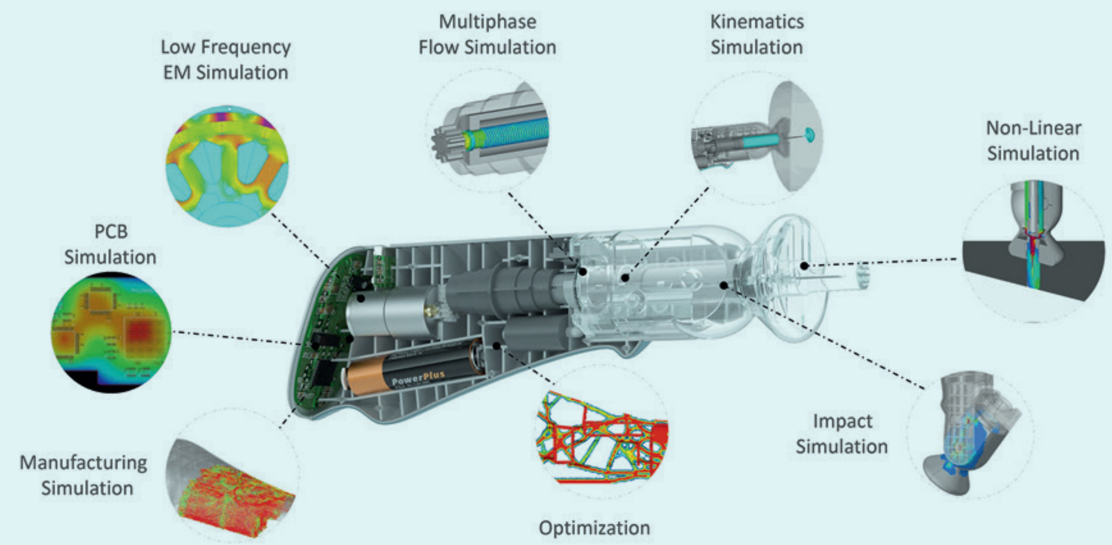
Results included a seat 1.8kg (3.97lbs) lighter than the original and a significant improvement in side impact protection performance. This and other successes have led to shorter development times.

"One of the innovations we have taken on board by using Altair is that we've shifted our engineering development from a later stage in the project to the start," said Iain Powell, Advanced Engineering Manager at Britax- Römer. (Read a case study here.)



Nolato: Virtual Design of a Medical Autoinjector

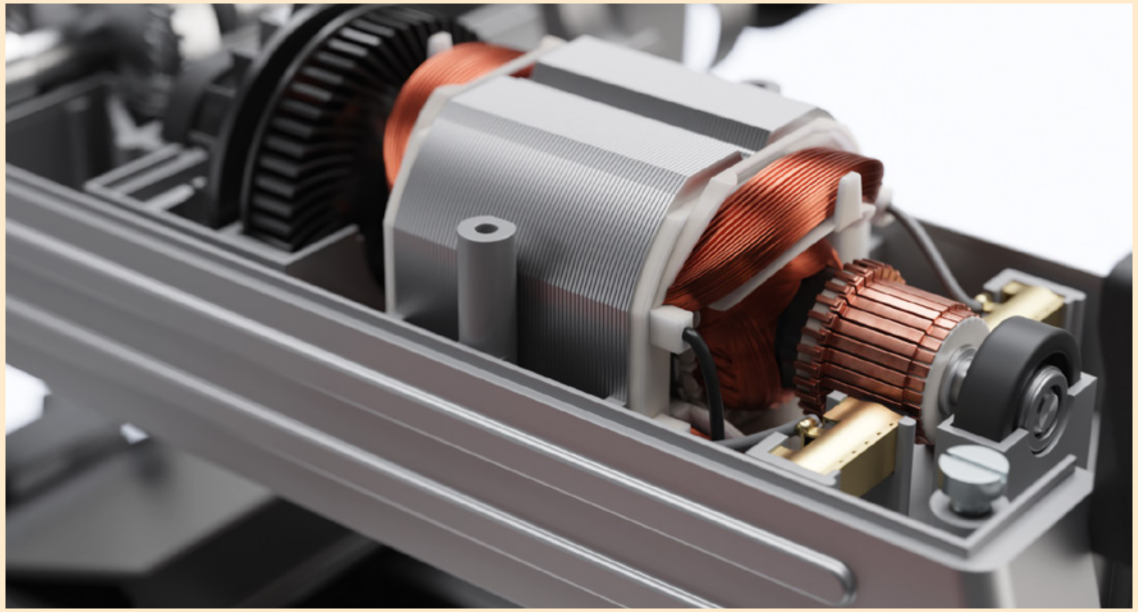
When developing its battery-powered Nolava medical auto injector, Nolato worked with Altair on a collaborative virtual design project. This life-saving device needed to be reliable especially because it delivers life-saving medication administered in the home by non-medically trained persons. A four-step virtual product development cycle allowed modifications prior to toolmaking, reducing manufacturing time and cost, from material, part, and assembly optimization though design for manufacturing (DFM) and successful production of thermoplastic parts.



Patrik Ingvarsson, Manager TDC EU, Nolato Medical Solutions attributes “a single, integrated environment” for the project’s success. This included streamlined design using material mapping of reinforced engineering polymers, efficient CAE analysis and optimization of structural and fatigue performance, injection molding models, and DFM. (Read a case study here.) ■

Belt Sander: Multiphysics Modeling with High-Performance Computing

Recently, Altair created a test concept to push the limits of virtual design analysis and optimization using a series of multiphysics benchmarks for performance testing of a belt sander power tool's external housing to improve stiffness and reduce weight. The model used multiple materials and approximately 280,000 elements. Using Altair® AcuSolve®, a computational fluid dynamics solver with massively parallel code, to simulate motor cooling via heat transfer to the external housing parts; and Altair® Radioss® to study the dynamic and transient-loading effects on the parts in thousands of simulated drop tests.



A significant objective: Push the limits of high-performance computing. Benchmarks were run on a dual-socket server with two 3rd Gen AMD EPYC processors, each with 64 cores and AMD 3D V-Cache technology. Results for each test were compared with a similarly configured prior-generation system and an 8-core workstation used as a reference to run the same simulations. (Read a details here or watch a full 60-minute video workshop here.)

The new processors showed computing results including up to 1.5x faster processing for thermal and CFD analysis; and 1.1x to 1.8x faster impact-test processing than earlier AMD EPYC processors. Additionally for drop testing, when running Radioss specifically, drop test simulations ran 23 times faster on a single-node running 3rd Gen AMD EPYC processors with AMD 3D V-Cache compared to the core workstation used as a reference. ■

How to **Improve** Manufacturability using **Multiscale Modeling**

Further analysis of material behavior and interactions with the molding process includes use of multiscale material modeling to accelerate product development.

By Jeff Wollschlager, *Vice President of Composites Technology, Altair*

Image: shutterstock/Chookiat K

Once a lightweight part design using reinforced engineering plastic is optimized for injection molding, the use of multiscale modeling can improve manufacturability by providing critical insights – and preventive actions – relating to material behavior inside the mold.

For those unfamiliar with multiscale material modeling, it is a powerful method to gain insights into advanced material behavior. Especially for composite materials, multiscale is an accepted, essential approach for predicting material properties accurately and efficiently for use in structural simulations. The tools used for this discussion use tools from Altair, which offers a full methodology to develop highly predictive and computationally efficient material models for structural simulation of anisotropic reinforced injection and compression molded materials.

While topology optimization (discussed in the prior article) does not consider local material effects arising in manufacturing, Altair's integrative simulation provides a seamless simulation-driven design process for injection molding plastic parts using closed design loops for the following:

- Structural optimization
- Part design
- Manufacturability assessment with injection molding simulation
- Process-dependent material assessment and structural validation

These integrated tools provide a holistic environment that uses consistent data across the product design lifecycle, and can potentially save hundreds of thousands of tons of material while designing more sustainable products in faster with a reduced development risk.

Multiscale modeling, an example of manufacturing assessment can help product developers improve material behavior, part geometry, and mold layout to achieve a part that withstands the rigors of manufacturing. This step is particularly beneficial to part quality and performance in the case of composite materials whose final properties are dependent on manufacturing. The example of short fiber-reinforced thermoplastic part – the lower structure of an automobile bumper encompasses how to calculate and model the molding process to ensure proper orientation of fibers for optimized manufacturability and part performance.

→

Integrative Simulation's Sustainable Evolution

Weight and cost considerations are critical to energy efficiency and overall sustainability in the automotive industry, the electrical/electronics sector, consumer goods and many other industries. The design of lightweight components can involve considerations of part replacement, material substitution, tooling, function integration, and determinations of manufacturing feasibility and costs.

During design evolution, replacing a portion of polymer with a fiber reinforcement is a common means of improving material performance, but proper simulation-driven design is critical to early evaluation of concept designs that involves several complex steps.

Integrative simulation has for two decades proven beneficial for exploring the behavior of fiber-reinforced thermoplastics, however, the application of simulation-driven design and integrative simulation technology was hindered by the complexity of the overall process and the significant investment in hardware, and software.

Today, software enables users to combine design for performance and manufacturability with more accessible means for material modeling and injection molding simulation. A comprehensive workflow can be applied for early determination of manufacturing alternatives for a typical composite part comprising short fiber reinforced polymer. It is designed to ensure identification of requirements; topology optimization including manufacturing design rules; automatic creation of geometry, part performance, and manufacturing feasibility checks.

Multiscale material modeling using actual fiber orientation test results is applied after concept design, feasibility of the injection molding process, evaluation of material properties (fiber orientation), and analyses of warpage and strength.

Balance Performance & Manufacturability

Assuring manufacturability early in the design process is important. Understanding how the modification of process parameters results in varying material behavior allows product quality control. An integrated, comprehensive, state-of-the-art injection molding simulation ensures parts are manufacturable during the design process. This opens a wide range of possibilities to balance performance and manufacturability to:

- Analyze and modify the part design at the same time you optimize for form, fit, and function.
- Analyze mold designs and feed system designs, single and multi-cavity family mold layouts.
- Improve sprue, runner, and gate position to influence fiber orientations and avoid weakening weld lines.

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In the following example, we will explore the use of short glass or carbon fibers in a car bumper design. (See **Figure 1**.)

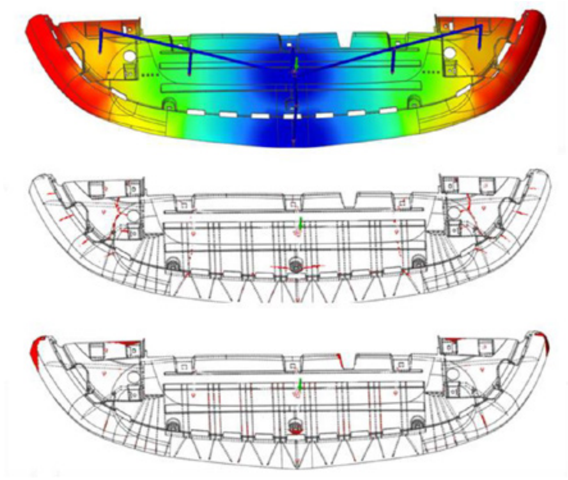

Figure 1: Injection molding simulation helps check manufacturability and identify potential problems such as air traps and weld lines.

Attacking Anisotropy – Fiber Direction

Plastics reinforced with short fibers are anisotropic which means their properties vary with direction and, for injection molding, also depend on how the fibers align during the process. Modern optimization methods support the part design and can improve it in every phase of its development. An appropriate numerical material description can consider the typical characteristics of the plastic in the simulation.

In the injection molding process, the molten flow orients the short fibers, in this case glass. However, the geometry of the component and molding process conditions typically create a three-layer distribution of the fibers which bears further investigation. The reason: Inside the mold, the fibers along the edge of the mold tend to lie in roughly the same direction as the melt flow whereas in the center the orientation is transverse, almost perpendicular. (See **Figure 2**.)

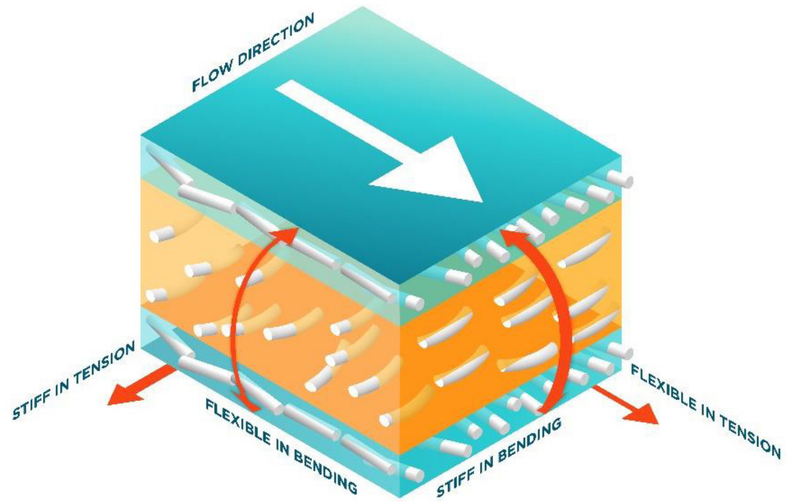

Figure 2: Typical distribution of short-fiber reinforcement during injection molding.

Fiber orientation largely depends on rheological properties: Different layer thickness distributions occur in the component, which depending on the flow geometry and the degree of structure viscosity. Additionally, anisotropic fiber distribution greatly influences the part's mechanical properties. Ultimately part quality and performance are at stake: Depending on both the fiber content and the direction of the fibers, the final part's stiffness and stress tolerances can vary by a factor of two.

Multiscale modeling is an example of how critical insights can be gained to better understand material behavior inside the mold to improve manufacturability. When used in an integrative simulation environment that includes the proper data access, simulation tools, and workflows, this practice is a key tool to help you improve both part geometries for better performance as well as mold layouts that can better withstand the complex manufacturing environment. ■

How to **Safeguard** Production Against **Mold Failures**

How to predict and prevent critical problems such as mold core fractures or failures to optimize production operations.

By Wolfgang Korte, *Managing Director, PART Engineering*

Image: shutterstock/Illus_man

Earlier, we spoke about defects in the parts being detected before the mold is made. Often, perhaps most times, these defects are not caused by the mold but by a part designer who may not fully understand how to design a mold. After simulation is used to evaluate a part design for manufacturability, which includes key aspects to include in mold design, one more step is important to ensure the required longevity of the mold tool itself. We call this "safeguarding."

Mold design is a multi-layered process in which both injection molding simulation and structural simulation can be used to safeguard against problems later in production. Now structural simulation can help with the mechanical design of the mold to avoid early mechanical failures or critical mold deformations that result in lost production, downtimes needed for mold repair and machine maintenance.

How can structural simulation avoid mold problems?

The correct design of the forming mold contour, the gating system and the cooling system all have great influence on the quality of the molded part. However, there remain many potential failures in the mechanical design of the injection mold itself.

Regularly occurring problems include breakage or excessive deformation of cores (core misalignment). Core shift leads to widened or narrowed flow cross-sections, which result from the difference in injection pressure between the upstream and downstream sides of the core – and consequently to dimensional deviations in the molded part. Core breakage usually occurs as a fatigue failure and only sets in after a critical number of injection cycles. Causes of core breakage are often excessive notch root stresses at the base of the core.

Core breakages naturally have serious consequences for the production process. They can cause production stoppages and extremely serious financial consequences because core replacements are typically not feasible in the short term.

Assessing the risk of core breakage is not technically trivial. To capture the load on the core during injection molding, knowledge of the injection pressure on the core is required. Since the pressure changes continuously during the →

injection molding process, the time history must be considered to determine the maximum pressure amplitude. This, in conjunction with the cyclic strength properties of the mold steel, determines the service life (cycle count) of the core.

Realistic calculation of a tolerable number of cycles can usually only be carried out efficiently with appropriate strength assessment software. For example, especially in the failure-critical notch areas, the influences of stress gradients must be captured. This can be done using tools from PART Engineering, as cited below as well as the online article, "Prediction and Prevention of Core Fractures in Injection Molds."

For this purpose, injection molding simulation is coupled with structural simulation to determine the pressure load on the core. The fatigue strength assessment is automated and standardized according to the German FKM guideline, which can be considered as state of the art when it comes to fatigue strength assessment of metals.

There are several tools used to carry out a fatigue strength assessment of injection molds and their cores. For example, Altair Partner Alliance member PART Engineering's Converse software helps users transfer e.g. melt pressure or temperature from injection molding simulation to structural simulation; and S-Life FKM) enables static, and fatigue strength assessments based on finite element analysis (FEA) results for components made out of steel, cast iron and aluminum materials. These tools integrate with Altair® Inspire™, which includes related tools including Altair® SimSolid® for rapid structural analysis, and Altair® SimLab® for multiple physics performance analyses.

The holistic solution for virtual manufacturing

When developing products, a holistic approach is required because of the considerable influence on the final performance of a component by the manufacturing processes used to make it.

The approaches discussed here for parts designed and manufactured for injection molding include software products from Altair and the Altair Partner Alliance. Together, they make it possible to first identify and eliminate potential problems in the early stages of development.

Owing to the integration, the resultingly seamless data exchange between software products means simulations do not use "idealized" material and component properties. Instead, the manufacturing influences on the end-product such as fiber orientations, shrinkage, and warpage are accurately predicted for actual conditions. Likewise, the injection molding process itself and the injection molding tool can be validated and optimized in terms of their suitability. The consistent use of the simulation tools presented can thus ensure the safe and economical production of plastic components. ■

Changing Together, for a **Better Tomorrow**

By Dr. Ming Zhou, *Altair Chief Engineer - Structures, CFD, Optimization*

Image: shutterstock/Pasuwan

Sustainability is transforming business practices across the globe, as companies today face a vital design imperative: quantifying and minimizing their carbon footprint through digital innovation. Thanks to Altair's world-class digital technologies and engineering expertise, we empower companies around the globe to make better material decisions, optimize product designs, and adopt organization-wide processes that add value and reduce costs at every stage of development.

Together, we can help organizations choose the right material, the right design, and the right process to develop solutions that minimize carbon emissions and bolster the bottom line.

The right material is the one that performs best in both the manufacturing process and the finished product while having the smallest possible carbon impact. Altair's material database helps purchasers, engineers and analysts across the organization collaborate and make decisions from a single data source. With it, they can understand global availability, supplier options and the environmental impact of material choices.

Additionally, our material database enables users to discover material behaviors for predictive modeling and can predict untested materials through integrated AI. Altair's connections with material producers are second-to-none, and our integration with

Image: shutterstock/Illus_man

M-Base means that our database is built upon the world's most comprehensive polymer database.

The right design is a delicate balance of performance, manufacturability and cost. Altair's industry-leading suite of simulation, machine learning and data analytics tools – combined with our decades of engineering expertise – empower product developers to achieve designs that maximize materials' potential while minimizing risk and reducing waste.

From optimization tools that drive minimum mass designs, to manufacturing simulation, multiscale modeling and more, Altair's solutions make material substitutions smarter.

The right process is one that maximizes cycle speeds and improves yields – all while safeguarding complex molds. Altair's digital twin software optimizes the manufacturing process at every step – from injection molding simulation, part, and tool interaction through structure and fatigue analysis for robust processes. Additionally, comprehensive workflows help manufacturers produce better products at a greater scale, with less machine downtime.

Together with our partners, we at Altair facilitate end-to-end strategic thinking and connect siloed data sources to streamlined decision-making, helping manufacturers keep sustainability at the forefront. Our material data, digital infrastructure and simulation-driven design tools improve products and safeguard tools and processes, transforming the plastics industry value chain for the challenges of today and tomorrow alike. ■

About

Altair is a global leader in computational science and artificial intelligence (AI) that provides software and cloud solutions in simulation, high-performance computing (HPC), data analytics, and AI. Altair enables organizations across all industries to compete more effectively and drive smarter decisions in an increasingly connected world – all while creating a greener, more sustainable future. For more information, visit https://www.altair.com/.

Ready to transform your plastics engineering value chain?

CONTACT ALTAIR