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Seven ways to improve your sheet metal design

Tips for creating sheet metal parts faster and easier

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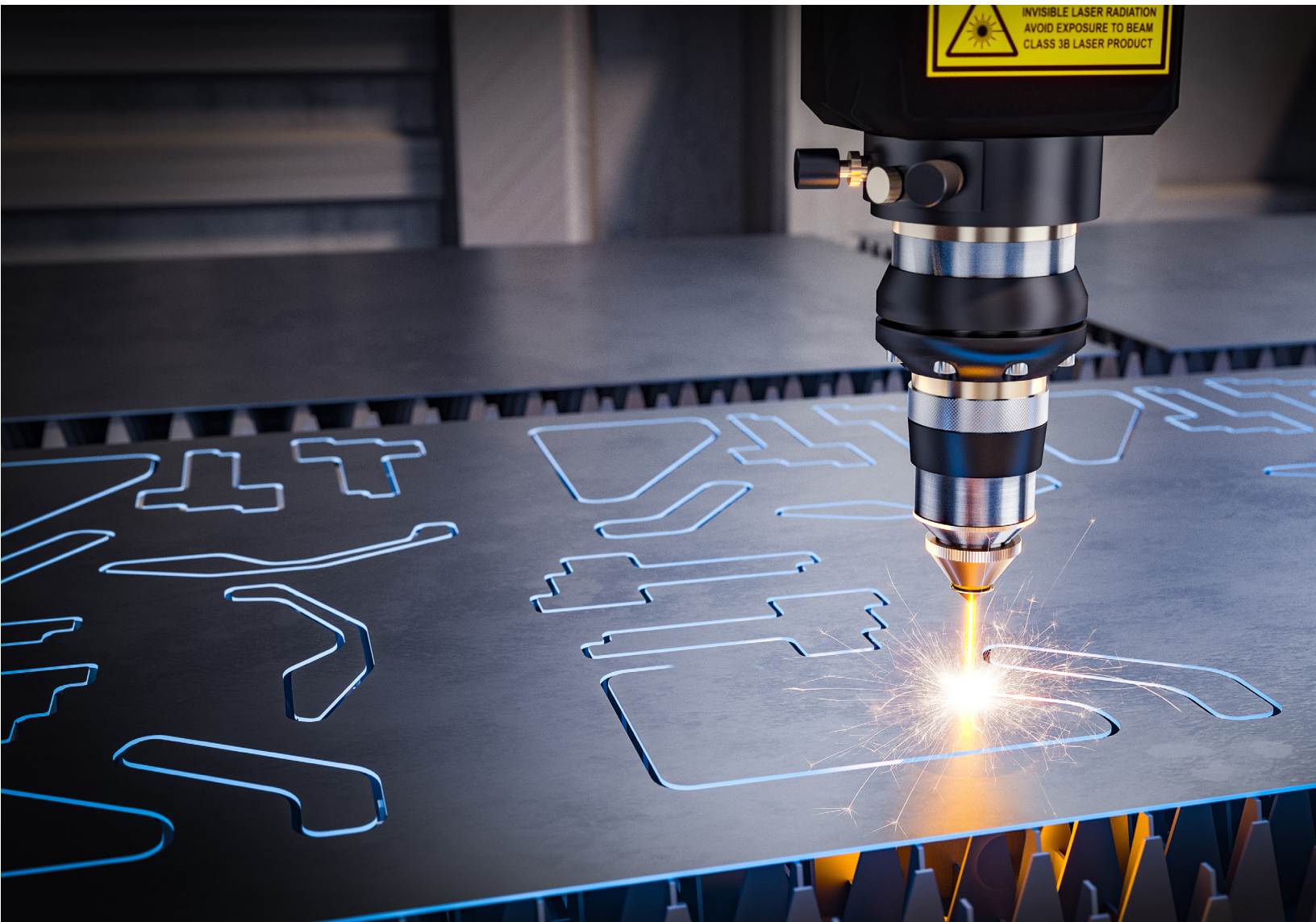
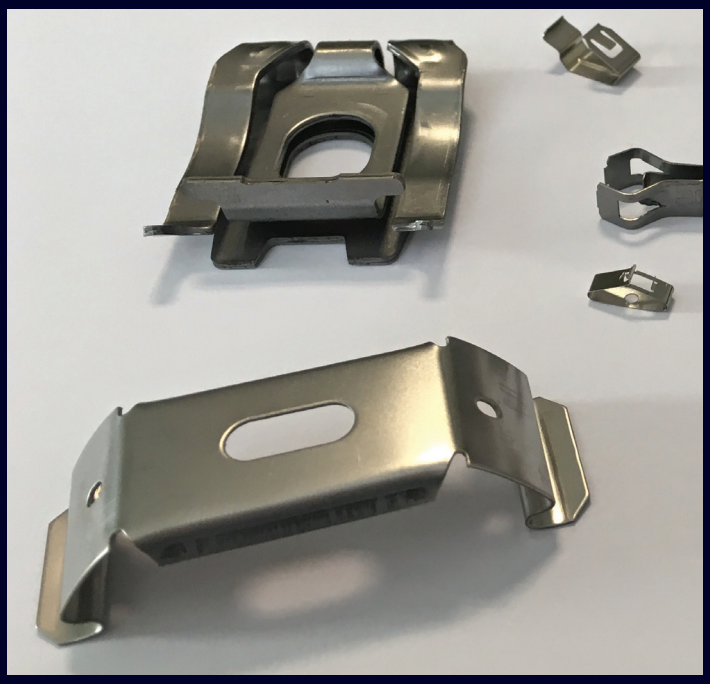


When you design sheet metal parts, you face a **series of unique challenges**

Although parts are typically designed in their formed state, they begin as a flat plate or sheet. As a result, manufacturability becomes a critical aspect of every feature making up the finished part. Add to this the need to account for material thickness, along with bend and corner relief, miter deformation features and critical dimensions (inside or outside), it is easy to see where challenges can arise.

This e-book outlines seven best practices for sheet metal design, focusing on improving speed, accuracy and manufacturability. These practices emphasize early validation, simplified feature structures, flexible modeling approaches and clear communication with manufacturing.

Although the principles in this e-book are broadly applicable, regardless of software, engineering teams using modern computer-aided design (CAD) systems are better positioned to reduce rework, respond to late-stage changes and maintain a reliable digital thread from design through fabrication.



TIP 1

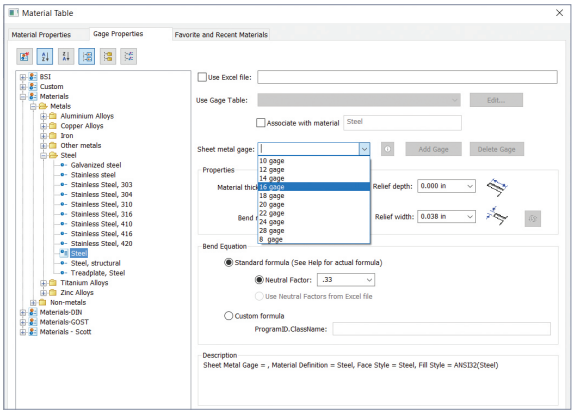
Define sheet metal parameters before starting your design

Establishing correct sheet metal parameters, including defining the material type (for example, stainless steel, aluminum, copper) and its precise thickness (gage), at the beginning of your sheet metal design process is not just a good habit – it is a fundamental requirement for successful manufacturing. These properties directly govern critical aspects like bend calculations, K-factors, forming limits and the overall manufacturability of your part. By addressing this early, you prevent costly redesigns, ensure accurate flat pattern generation and lay the groundwork for efficient fabrication.

Depending on your machinery and/or dies, K-factor calculations may not suit your needs. For example, if your dies bend at a sharper radius than the stock material thickness, you need to account for that. Spreadsheet-based gage tables allow you to standardize bend data across designs.

Key considerations

- **Standardization is key:** Wherever possible, leverage industry-standard material libraries and gage tables. This ensures consistency and compatibility across your projects and with your suppliers
- **K-factor precision:** K-factors, which determine bend allowance, can vary significantly based on material properties, thickness and the specific tooling and machinery used. Be prepared to account for these nuances, as custom adjustments may be necessary for truly precise bend calculations
- **Downstream impact:** Early material assignment is not just for bending. It profoundly impacts downstream processes like stress analysis (finite element analysis (FEA)), weight calculations and cost estimations, providing a more accurate digital representation of your final product from the beginning



Designcenter Solid Edge software has a vast database of gage thicknesses available.

Did you know?

You can configure Designcenter™ Solid Edge® software to automatically prompt you for material and gage assignment upon creating a new document, ensuring you never overlook this critical step. Designcenter Solid Edge also supports bend allowance (BA) and bend deduction (BD) for sheet metal, allowing precise flat pattern calculation based on material and tool-specific spreadsheet tables. These methods allow designers to choose between using the neutral factor, direct bend deduction or bend allowance at the feature level.

Designcenter Solid Edge is part of the Siemens Xcelerator business platform of software, hardware and services.

TIP 2

Use dedicated sheet metal features for efficiency and accuracy

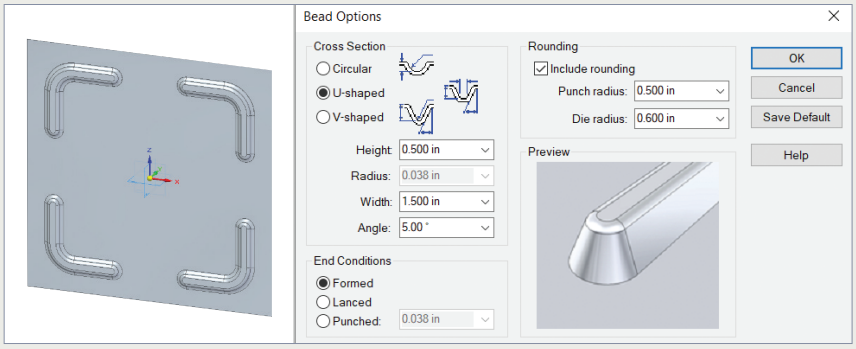
Modern CAD software offers a rich array of specialized sheet metal features, such as dimples, louvers, beads, gussets, hems, jogs and drawn cutouts. These are specifically engineered to behave correctly within the sheet metal environment, automatically accounting for material deformation and bend allowances. Using these intelligent features, rather than attempting to create complex forms with generic modeling tools, is paramount for ensuring proper flat pattern generation, validating manufacturability and maintaining your design intent.

Key considerations

- **Embedded design intent:** Specialized features inherently embed manufacturing knowledge. They simplify creating complex geometries into intelligent, modifiable elements that understand how sheet metal bends and forms
- **Automated validation:** Many built-in features include inherent checks for manufacturability, providing early warnings for potential issues and significantly reducing errors before they ever reach the shop floor
- **Parameter-driven agility:** These features are typically parameter-driven, allowing for quick modifications and iterations. You can adjust dimensions, angles or depths with ease, without needing to painstakingly rebuild geometry from scratch

Did you know?

Unlike general-purpose CAD tools, the sheet metal environment of Designcenter Solid Edge is purpose-built. Features like contour flange, tab and lofted flange for base geometry, and bead, dimple and drawn cutout for formed parts embed manufacturing intelligence directly into the model, ensuring flat patterns, bend calculations and downstream outputs remain accurate.



With a simple sketch and some property parameters, you can take the guesswork out of otherwise complex shapes.

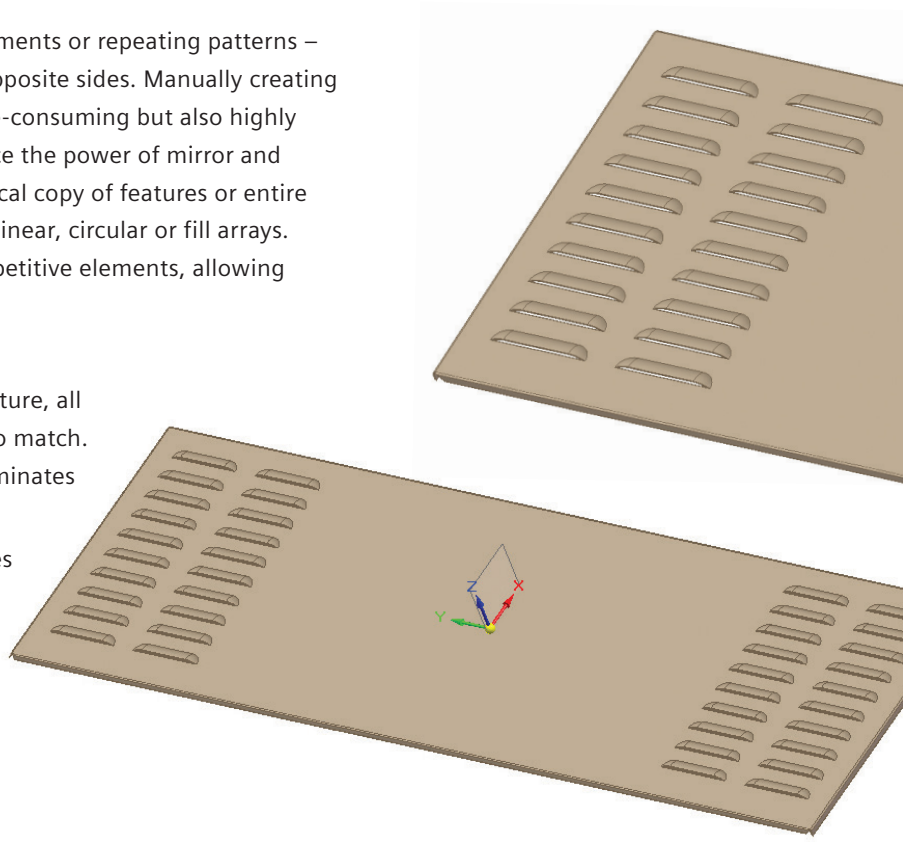
TIP 3

Use mirror and pattern features for repetitive geometry

Sheet metal parts frequently incorporate symmetrical elements or repeating patterns – arrays of holes, louvers, cutouts or identical flanges on opposite sides. Manually creating each instance of these features is not only incredibly time-consuming but also highly susceptible to inconsistencies and errors. Instead, embrace the power of mirror and pattern commands. Mirroring creates a precise, symmetrical copy of features or entire bodies, while patterning efficiently replicates features in linear, circular or fill arrays. These commands drastically reduce modeling time for repetitive elements, allowing engineers to focus on more complex design challenges.

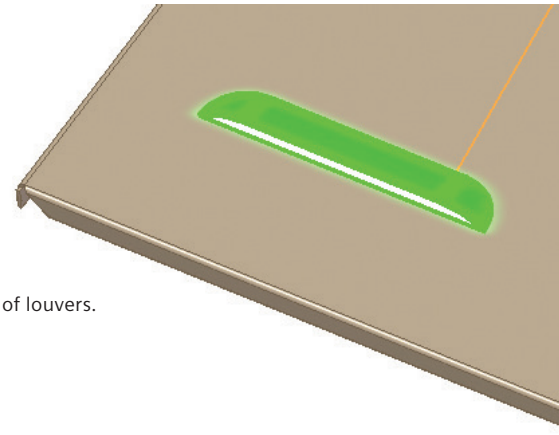
Key considerations

- **Ensured consistency:** When you modify the parent feature, all mirrored or patterned instances automatically update to match. This guarantees consistency across your design and eliminates the need for tedious manual adjustments
- **Centralized design control:** Mirror and pattern features provide a single point of control for all instances. This simplifies design modifications and reduces the risk of errors when the design requires changes



Did you know?

The mirror and pattern features are tightly integrated with design automation tools in Designcenter Solid Edge. This allows engineers to automate creating complex sheet metal layouts and variations, freeing up time for innovation rather than repetition.



A mirrored 2 x 10 array of louvers.

TIP 4

Optimize geometry with contour flanges to streamline your feature tree

In sheet metal design, a common pitfall is creating parts by layering numerous individual tabs and flanges. Although effective, this approach often leads to an unnecessarily long and complex feature tree, riddled with parent/child dependencies. This not only consumes more time and clicks during creation but also significantly compromises productivity and makes future modifications a headache.

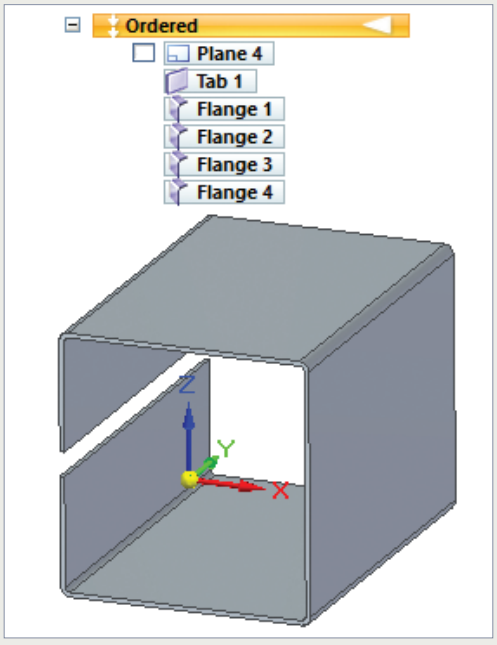
A more efficient approach is to utilize contour flanges. This powerful feature allows you to create complex profiles, including multiple bends and flanges, simultaneously from a single 2D sketch. The result is a dramatically simplified model, a cleaner feature tree and a much more agile design.

Key considerations

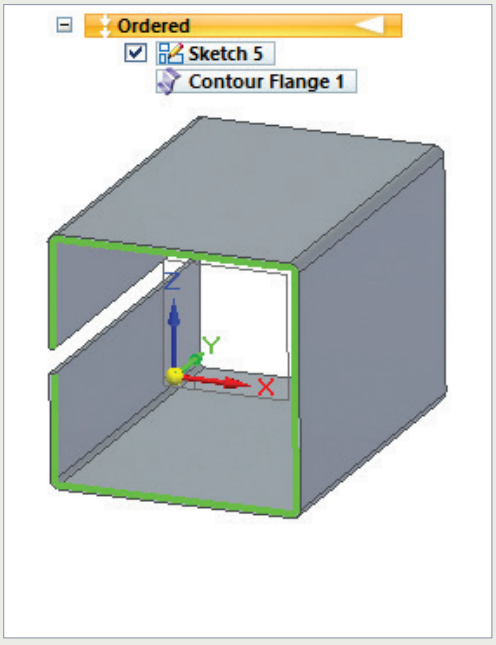
- **Reduced complexity:** A simpler, more concise feature tree is inherently easier to understand, navigate and manage, especially when collaborating with other engineers or revisiting a design months later
- **Accelerated design iteration:** Fewer features mean faster model regeneration times. This translates directly into quicker design iterations, allowing you to explore more options and respond to changes faster
- **Enhanced maintainability:** Changes made to a single contour flange feature are far less likely to cause cascading errors or unexpected geometry updates compared to modifying multiple individual tab and flange features, ensuring design integrity

Did you know?

Using contour flanges can reduce model complexity by up to 70 percent and significantly decrease regeneration times, directly impacting your productivity metrics. Designcenter Solid Edge includes intuitive controls and expanded capabilities for the contour flange command. This allows for creating intricate and complex profiles with ease and precision.



Using tab and flange features creates a much longer and complex feature tree.



Contour flange achieves the same result in a single feature.

TIP 5

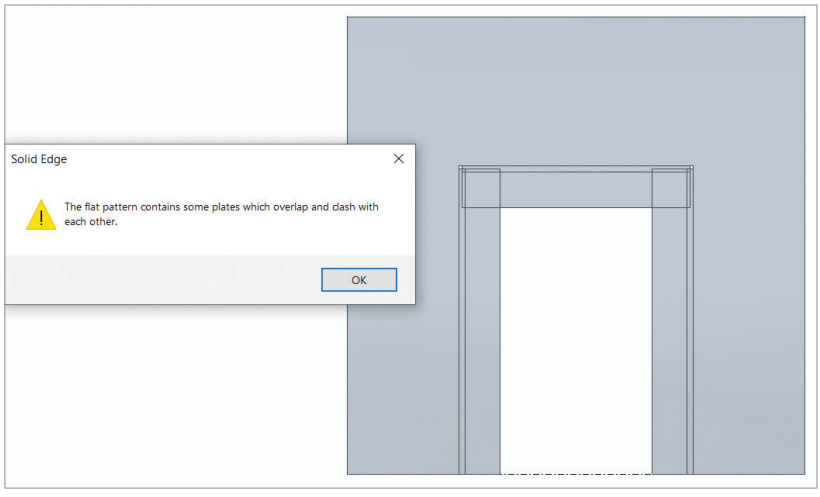
Design concurrently with the flat pattern for continual validation

A model might appear flawless in your CAD system, but that does not guarantee it is manufacturable. The true test of a sheet metal design lies in its flat pattern. Issues such as overlapping flanges, insufficient bend relief, material deformation or interference between features often only become apparent when unfolding the part. Flat pattern validation should occur continually throughout the modeling process. Regularly review the flat pattern during design, use fold and unfold to add features across bends correctly and ensure you have properly defined bend reliefs and corner conditions.

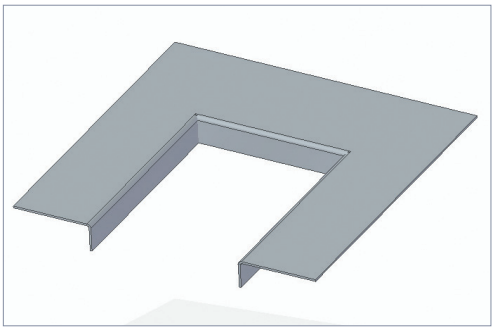
Thoroughly verifying the flat pattern is a nonnegotiable step to prevent costly production delays, minimize material waste and avoid extensive rework on the shop floor.

Key considerations

- **Proactive interference detection:** Always check for any self-intersections or overlaps that occur when the part is in its unfolded state. These are clear indicators of an unmanufacturable design
- **Tooling compatibility:** Ensure all bend radii, corner reliefs and feature clearances are compatible with your available manufacturing tooling and processes. What works in theory might not work in practice
- **Material behavior:** Account for how the material will stretch and compress during bending and forming, especially for complex geometries. Ignoring this can lead to unexpected deformations



On verification of the flat pattern, it becomes clear that the two front flanges will overlap the back flange, making this part unmanufacturable.



These three internal flanges look fine in the folded state.

Did you know?

Using Designcenter Solid Edge to create and display precise flat patterns allows users to visually verify manufacturability for various cutting technologies like computer numerical control (CNC) routers, waterjet and plasma cutting machines. After verification, it is as easy as saving a file "As Flat" to create a CNC code-ready file, ensuring a seamless transition to the shop floor.

TIP 6

Make late-stage changes easily with synchronous technology

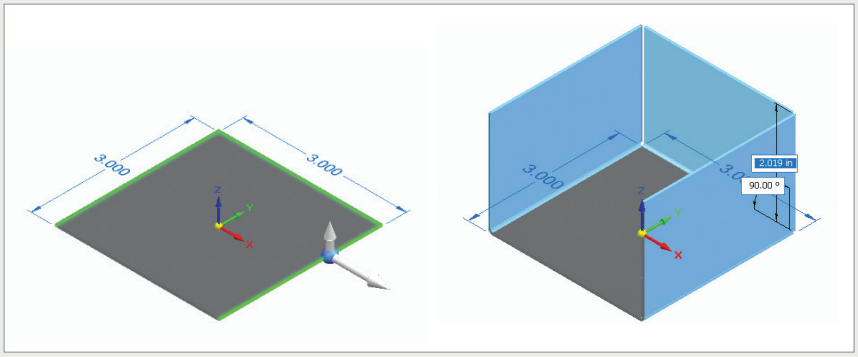
Design changes are inevitable. Sheet metal designs frequently evolve due to manufacturing feedback or changing requirements. Traditional, history-based CAD systems can often become rigid, making late-stage modifications cumbersome and time-consuming. This is where synchronous technology shines. It offers a revolutionary approach that combines the intuitive speed and simplicity of direct modeling with the precision and control of parametric design. This empowers engineers to make rapid, flexible edits to geometry without being constrained by the original feature tree, significantly accelerating design iterations and enhancing responsiveness to change requests.

Key considerations

- **Direct manipulation:** The ability to directly push, pull and move faces or features on a model is incredibly intuitive and fast, mimicking how you might interact with a physical object
- **Intelligent design intent recognition:** A robust direct modeling system should intelligently recognize and maintain design intent (for example, concentricity, parallelism, tangency) even when you are directly editing geometry, reducing the need for manual constraints
- **Multi-CAD agility:** The flexibility to work with imported models from various CAD systems as if they were native files is crucial for seamless collaboration with suppliers, partners and customers, regardless of their preferred software

Did you know?

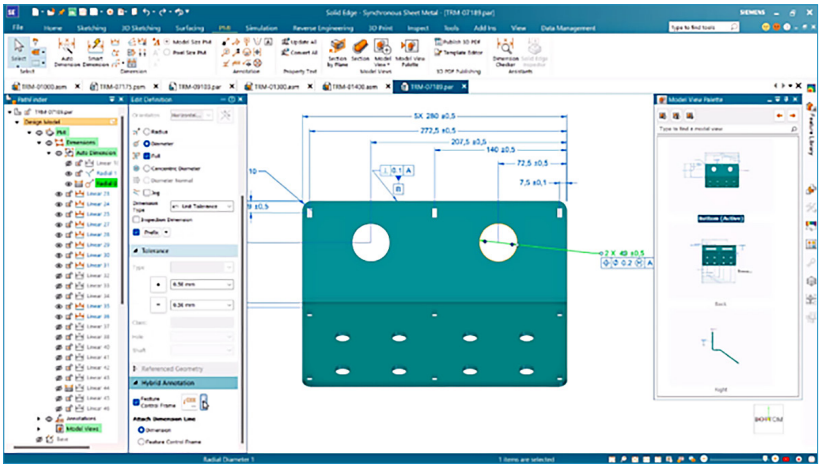
Synchronous technology in Designcenter Solid Edge allows you to create centered or offset flanges on the fly, directly manipulating the geometry without needing additional sketches or complex feature definitions. This exemplifies the speed and intuitive nature of this powerful technology.



Using synchronous technology, creating multiple flanges is as simple as clicking on an edge and pulling the steering wheel arrow up or down in the direction you want the flange to go.

TIP 7

Prioritize clear, accurate documentation



Although 3D models are the heart of modern design, manufacturing documentation – whether traditional 2D drawings or advanced model-based definition (MBD) – remains a critical communication bridge to the shop floor. Clear, accurate and comprehensively annotated documentation is essential to prevent misinterpretations, reduce errors during fabrication and ensure the final product precisely meets specifications. Treating documentation as an afterthought inevitably leads to costly rework, production delays and compromised quality.

Key considerations

- **Comprehensive annotation:** Ensure all necessary dimensions, tolerances, bend notes, material specifications and surface finishes are clearly and unambiguously communicated
- **Essential bend tables:** Provide clear and concise bend tables that detail bend angles, radii and the correct sequence of bends for manufacturing
- **Associative linkage:** Your documentation should be associatively linked to the 3D model. This means any changes made to the design automatically update the documentation, maintaining a single source of truth and eliminating manual errors
- **Flat pattern views:** Always include flat pattern drawing views with dimensions to locate bend lines and appropriate bend up/down labels, crucial for CNC programming and fabrication

Did you know?

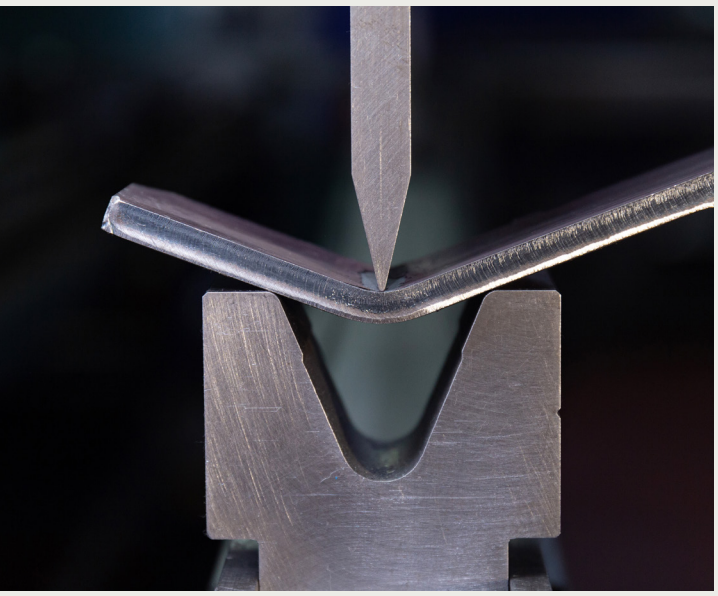
Leveraging Designcenter Solid Edge streamlines sheet metal drawing creation, including bend tables, with its industry-leading CAD drafting system. All information from your sheet metal file – including formed and flat geometry – is readily available in the draft environment, ensuring associative updates when your designs change.

Designcenter Solid Edge for sheet metal design

Create 3D models, generate flat patterns and perform simulation and analysis for sheet metal products such as enclosures, cabinets, brackets, panels and other parts with Designcenter Solid Edge sheet metal design software. Easily create designs and concepts that meet your requirements and validate designs at all stages, ensuring products meet your standards for strength, rigidity and durability.

Advanced bending via rich materials, precise calculations and custom k-factors

Designcenter Solid Edge comes preloaded with a broad range of industry-standard materials and metal gage tables, including advanced alloys and composites. This simplifies initial setup and ensures you are working with the most current data.



Sophisticated bend calculation algorithms offer increased precision, especially for complex bends or thicker materials. This minimizes common issues like springback and ensures your flat patterns are right the first time. BD and BA in bend length calculations for sheet metal allow you to control material conditions related to manufacturing and tooling. You can select the bend calculation method, edit it in the spreadsheet and customize the specific settings for bend equations. This ensures your designs translate seamlessly from the Digital Twin to the physical part, minimizing errors.

Designcenter Solid Edge moves beyond simple spreadsheet uploads, offering more robust tools for managing and applying custom K-factor tables tailored to your specific machinery, tooling and material combinations. This ensures unparalleled accuracy in your bend allowances.

Material properties assigned within Designcenter Solid Edge seamlessly integrate with built-in simulation tools (for example, FEA). This allows for earlier and more accurate performance predictions based on real-world material behavior, helping you validate designs before physical prototyping.

Smart design via feature recognition, versatile tools and instant DFM feedback
Designcenter Solid Edge takes the power of built-in features to the next level.

This solution boasts enhanced intelligence for recognizing and applying sheet metal features, even on imported models from other CAD systems. This makes working with multi-CAD data and legacy designs significantly easier and more efficient.

An extensive library of forming tools, including versatile dimple options, advanced louver patterns and handling of complex corner conditions, enables a wider range of design possibilities directly within the sheet metal environment.

Designcenter Solid Edge can leverage generative design principles to suggest optimal stiffening ribs, lightweighting cutouts or feature placements for sheet metal parts. This allows you to balance performance requirements with material efficiency, often leading to innovative and optimized designs you might not have conceived manually.

Using Designcenter Solid Edge provides sophisticated design for manufacturability (DFM) feedback directly within the design environment. It highlights potential issues with feature placement, bend radii or material deformation in real time, allowing for proactive adjustments and ensuring your designs are production ready.

Adaptive feature integration and enhanced parametric control
Contour flanges in Designcenter Solid Edge can intelligently adapt to surrounding geometry and subsequent design changes. This reduces the need for manual adjustments during modifications, saving valuable time and effort.

Parametric capabilities in Designcenter Solid Edge allow you to define and control contour flanges with unparalleled precision. This ensures your design intent is maintained even when significant changes are made, providing robust and predictable behavior.

Intelligent, flexible mirroring and patterning
Designcenter Solid Edge provides a variety of patterning options, including advanced patterns along a curve, pattern on a face and versatile fill patterns. This enables the creation of highly complex arrays with minimal

effort, adapting intelligently to underlying geometry. Additionally, the ability to mirror across nonplanar faces or complex geometries allows you to apply symmetrical design to intricate sheet metal components.

Patterning capabilities also extend seamlessly to the assembly level. You can efficiently pattern sheet metal components within larger product structures, ensuring alignment and consistency across your entire design.

Mirror and pattern features are tightly integrated with broader design automation tools in Designcenter Solid Edge. This allows engineers to automate creating complex sheet metal layouts and variations, freeing up time for innovation rather than repetition.

Unparalleled flexibility via synchronous technology

Synchronous technology, a cornerstone of Designcenter Solid Edge, delivers unparalleled flexibility for sheet metal design.

Intelligent recognition of sheet metal features within synchronous models allows for direct, history-free editing of bends, flanges, dimples and forming features with precision and control, even on complex imported geometry.

Push/pull operations provide intelligent suggestions and real-time previews for how geometry will behave. This is particularly powerful for complex sheet metal forms, allowing you to make significant changes with simple gestures.

Seamlessly switch between synchronous methods for conceptual design and rapid changes and ordered (history-based) methods for detailed, history-dependent features when precise control over design steps is paramount. This flexibility ensures you use the best tool for each stage of your design.

Synchronous technology in Designcenter Solid Edge drastically reduces the time you need to incorporate design changes from customers or manufacturing feedback. This leads to significantly shorter development cycles, faster time-to-market and greater responsiveness to market demands.

Work with multi-CAD data as if it were native, eliminating cumbersome preplanning, feature failures and time-consuming rework often associated with imported geometry. This fosters truly seamless collaboration with your entire supply chain.

Easily create precise manufacturing documentation

Designcenter Solid Edge offers industry-leading capabilities to streamline creating precise manufacturing documentation. Artificial intelligence (AI)-driven drawing creation, including intelligent placement of views, dimensions and annotations, significantly reduces manual effort and ensures consistency, allowing engineers to generate production-ready drawings quickly.

Flexible and highly customizable bend table options allow you to tailor the presented information to perfectly match your specific manufacturing processes and supplier requirements, improving clarity and reducing ambiguity.

Using Designcenter Solid Edge robustly supports MBD principles for sheet metal. By embedding product and manufacturing information (PMI) directly into the 3D model, you can potentially reduce reliance on traditional 2D drawings while improving clarity, reducing errors and accelerating downstream processes.

Designcenter Solid Edge offers enhanced collaboration tools that streamline the drawing review and approval processes. Easily share, mark up and manage feedback on your documentation, improving communication and accelerating sign-offs across your teams and with external partners.

Conclusion

Good techniques can help improve performance, but they are only half of the equation. When you take the potential complexity of sheet metal design into consideration, it becomes obvious you need a highly specialized set of tools if you want to realize real-world productivity and quality gains from design through manufacturing.

Designcenter Solid Edge provides the industry's best-in-class sheet metal design system, with support for the entire design-through-fabrication process. With capabilities to handle complex sheet metal design challenges, including manufacturability, using Designcenter Solid Edge streamlines the entire product development process, from sheet metal part design through flat pattern and drawing development.

To learn more about the sheet metal design capabilities of Designcenter Solid Edge, visit: www.siemens.com/sheet-metal-design

Or, try Designcenter Solid Edge for yourself: https://solidedge.siemens.com/en/try-now/

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