End-to-End CAD Process

A structured, multi-phase methodology for precision engineering and manufacturing-ready design

Our Six-Phase Methodology

A comprehensive framework designed to ensure precision, mitigate risk, and deliver manufacturing-ready products that align with your business objectives.

01

Strategic Project Initiation

Deep requirements gathering and scope definition

02

Conceptual Design & Feasibility

Creative exploration with data-driven validation

03

Advanced Modeling & Assembly

Creating the high-fidelity digital twin

04

Virtual Prototyping & Validation

Simulation-based performance testing

05

Manufacturing Readiness

Comprehensive documentation and GD&T

06

Quality Framework & Data Management

Standards adherence and version control

Phase 1: Strategic Project Initiation

This foundational phase focuses on deep understanding and clear definition to prevent costly downstream errors.

Professional Consultation

We engage as expert partners, providing holistic guidance on constructability, cost-effectiveness, and strategic alignment with your business goals.

Deep-Dive Requirements Gathering

Through collaborative workshops and techniques like the "5 Whys," we uncover core business, user, and system requirements that define the true project goal.

Scope Definition

We formalize project boundaries in a comprehensive Project Scope Statement, explicitly listing goals, deliverables, tasks, constraints, and exclusions to prevent scope creep.

Requirements Analysis: The Foundation

We start by establishing the fundamental problem parameters and constraints that will guide all subsequent design decisions.

Functional Requirements

What must the product do? Load capacity, speed, temperature range, duty cycle.

Physical Constraints

Size limitations, weight restrictions, material preferences, environmental conditions.

Manufacturing Considerations

Production volume, available processes, assembly complexity, cost targets.

Phase 2: Conceptual Design & Feasibility

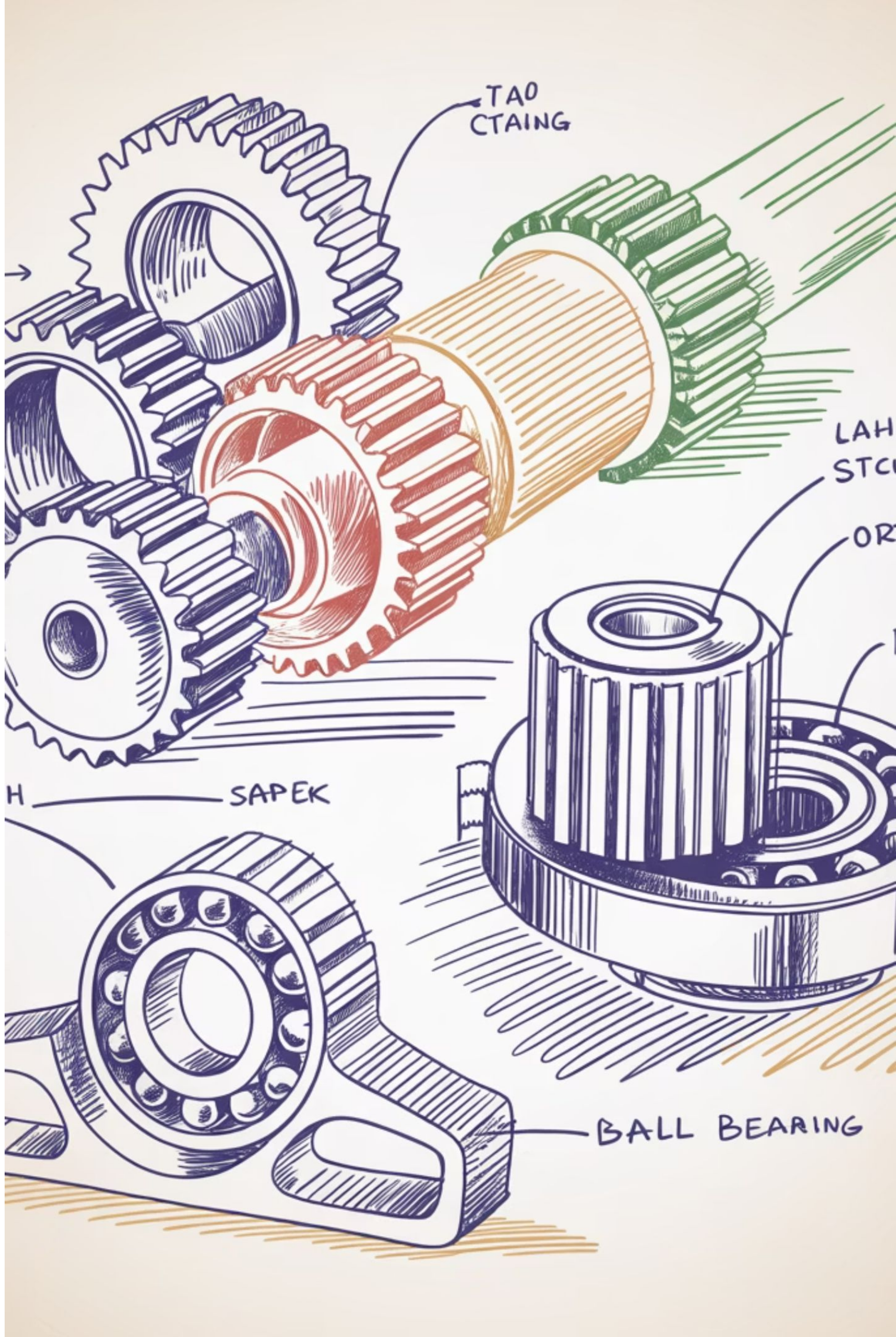
This phase balances creative exploration with rigorous, data-driven analysis to ensure the chosen design is both innovative and viable.

Conceptual Design

We generate multiple distinct design concepts using sketches and basic models to explore different strategic directions and establish a consistent design language.

Engineering Feasibility Study

The selected concept undergoes comprehensive evaluation of technical, economic, environmental, regulatory, and social viability to make an informed go/no-go decision.



Mathematical Modeling: The Starting Point

Before diving into CAD, we establish the theoretical foundation. Depending on the problem type, we prepare appropriate mathematical models to predict behavior and validate simulation results.

Dynamic Problems

Kane's Method

For complex multi-body dynamics like robotic arms or suspension systems, we use Kane's equations to model motion and forces efficiently.

Thermal Problems

Heat Transfer Calculations

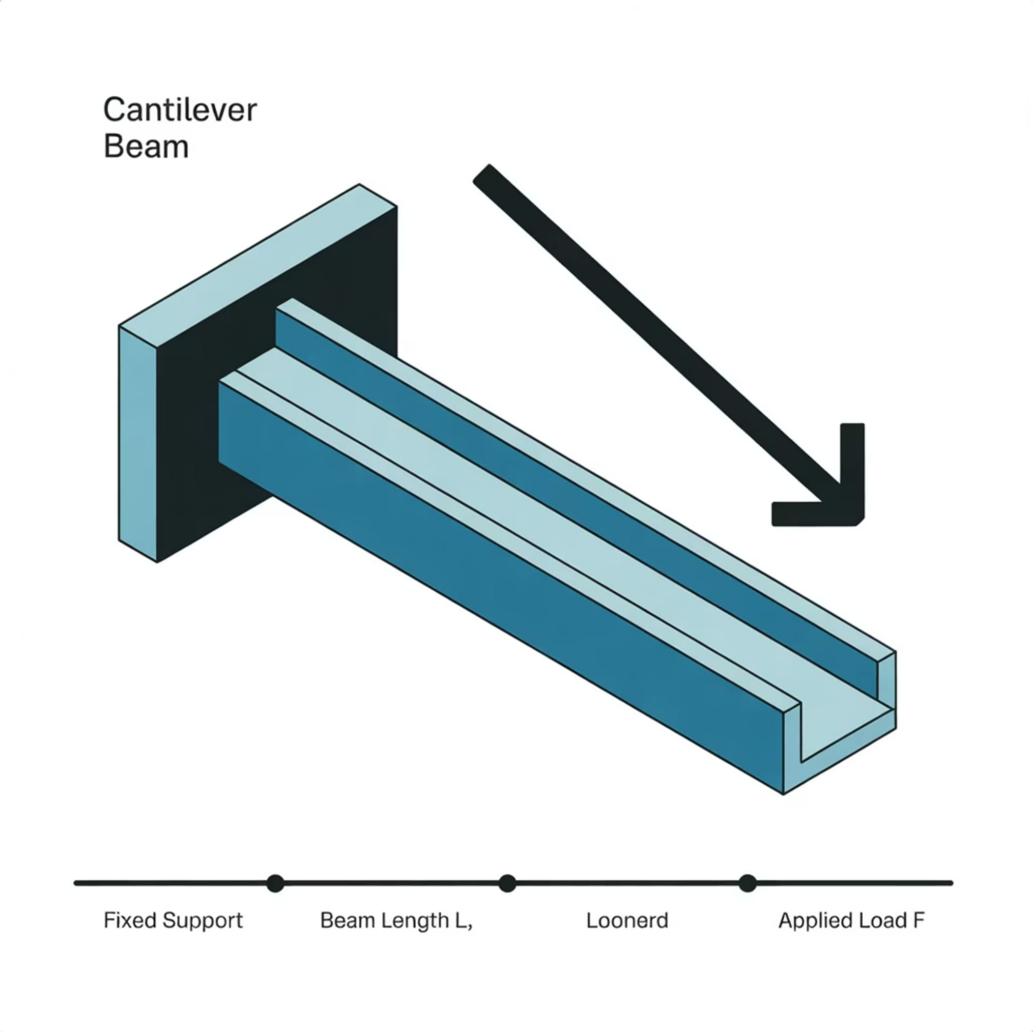
For heat sinks or electronic cooling, we apply conduction, convection, and radiation equations to predict temperature distributions.

Structural Problems

Beam Theory & Stress Analysis

For frames and brackets, we use classical mechanics to estimate deflection and stress under load conditions.

We go down to fundamentals, simplify the problem, and create the mathematical model. This gives us ballpark numbers where we expect simulation results to be.



Example: Cantilever Beam Analysis

Problem: Design a cantilever beam to support a 500 N load at its free end, with maximum deflection under 5 mm.

Hand Calculations

Maximum deflection formula:

$$\delta = \frac{FL^3}{3EI}$$

For a 1-meter steel beam (E = 200 GPa), we calculate required moment of inertia and select an appropriate cross-section before CAD modeling.

Validation Approach

These calculations provide expected values (e.g., δ ≈ 4.2 mm, σ ≈ 150 MPa). When we run FEA simulations, results should align within 10-15% of these predictions.

Phase 3: Advanced Modeling & Assembly

We create a high-fidelity 3D "digital twin" that serves as the single source of truth for the design, architected for performance and complexity.

Strategic Modeling

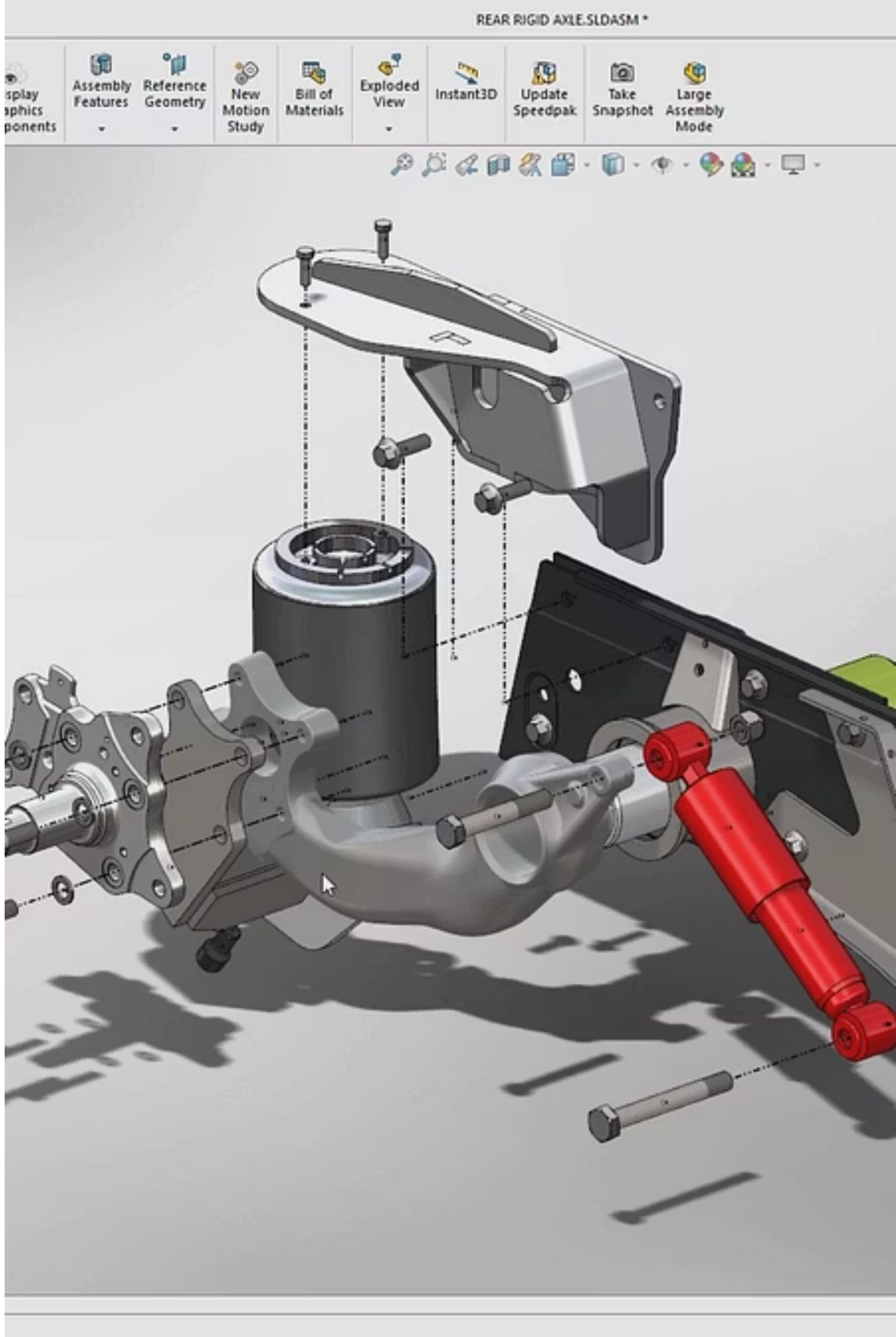
We apply both parametric (history-based) and direct (geometry-based) techniques where most effective—direct for rapid ideation, parametric for precise manufacturing-driven design.

Multi-Body Modeling

For complex assemblies and weldments, we use multi-body part modeling to design multiple solid bodies within a single part file, enabling efficient design of frames, chassis, and integrated systems.

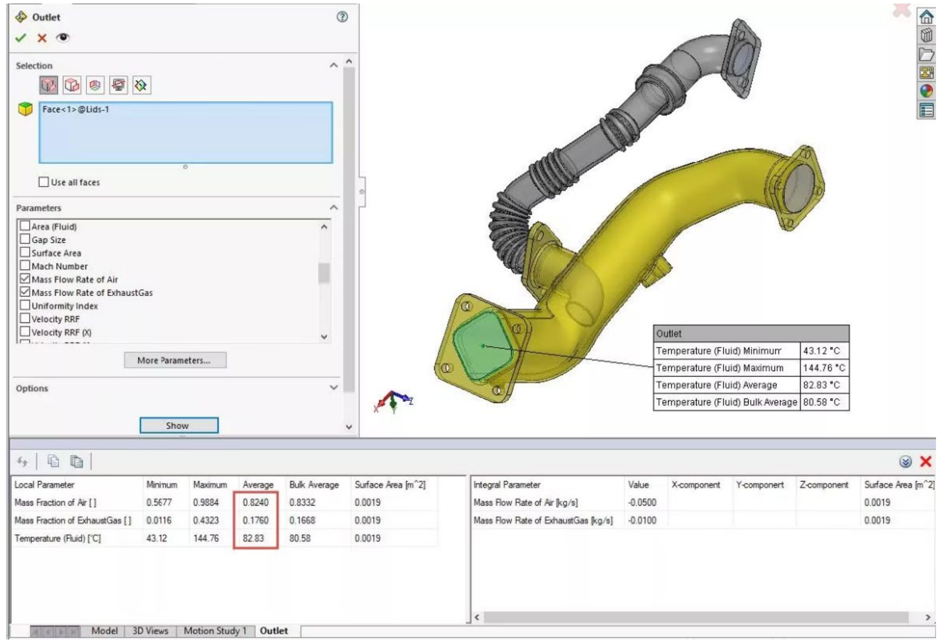
Large Assembly Management

We manage thousands of parts using logical sub-assemblies, component simplification, and performance-tuned settings to maintain speed and stability.



Parametric vs. Direct Modeling

Parametric Modeling



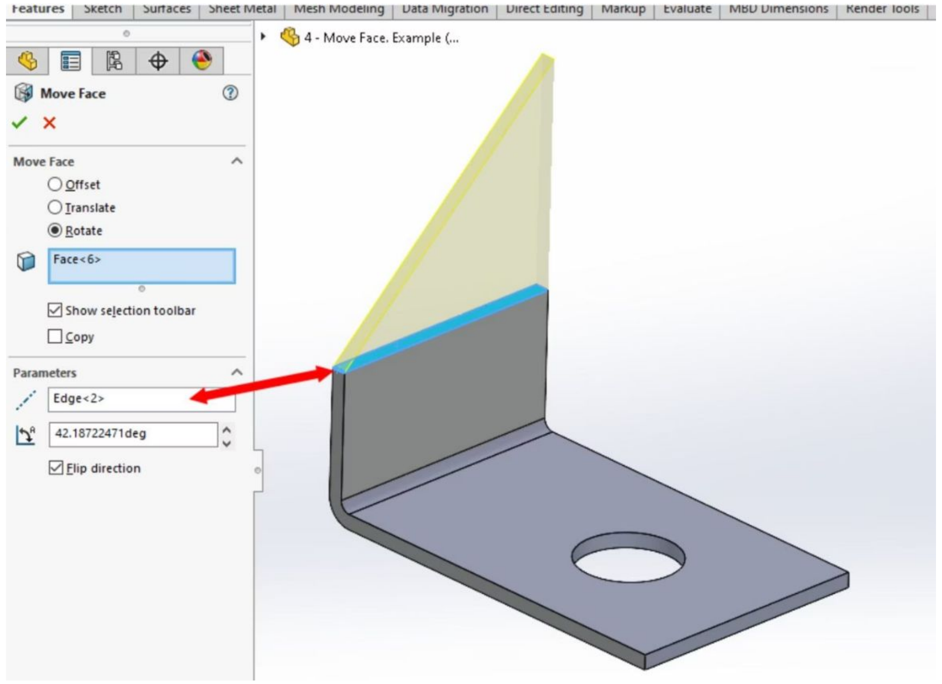
History-Based: Features are defined by parameters and relationships, building a chronological design history.

Design Intent: Captures precise design intent through constraints, dimensions, and equations.

Iterative Changes: Ideal for complex, evolving designs requiring controlled modifications.

Production Focus: Best for manufacturing-driven parts needing high precision and control.

Direct Modeling



Geometry-Based: Directly manipulate faces, edges, and vertices without relying on a feature history.

Intuitive Editing: Enables fast, flexible concept exploration and rapid changes.

Imported Models: Excellent for modifying models from various sources or without known history.

Quick Iteration: Perfect for rapid mockups and early-stage design exploration.

Example: Gearbox Housing Design

Challenge: Design a compact gearbox housing for a 10:1 reduction ratio, integrating mounting features, bearing seats, and oil seals.

Layout Sketch

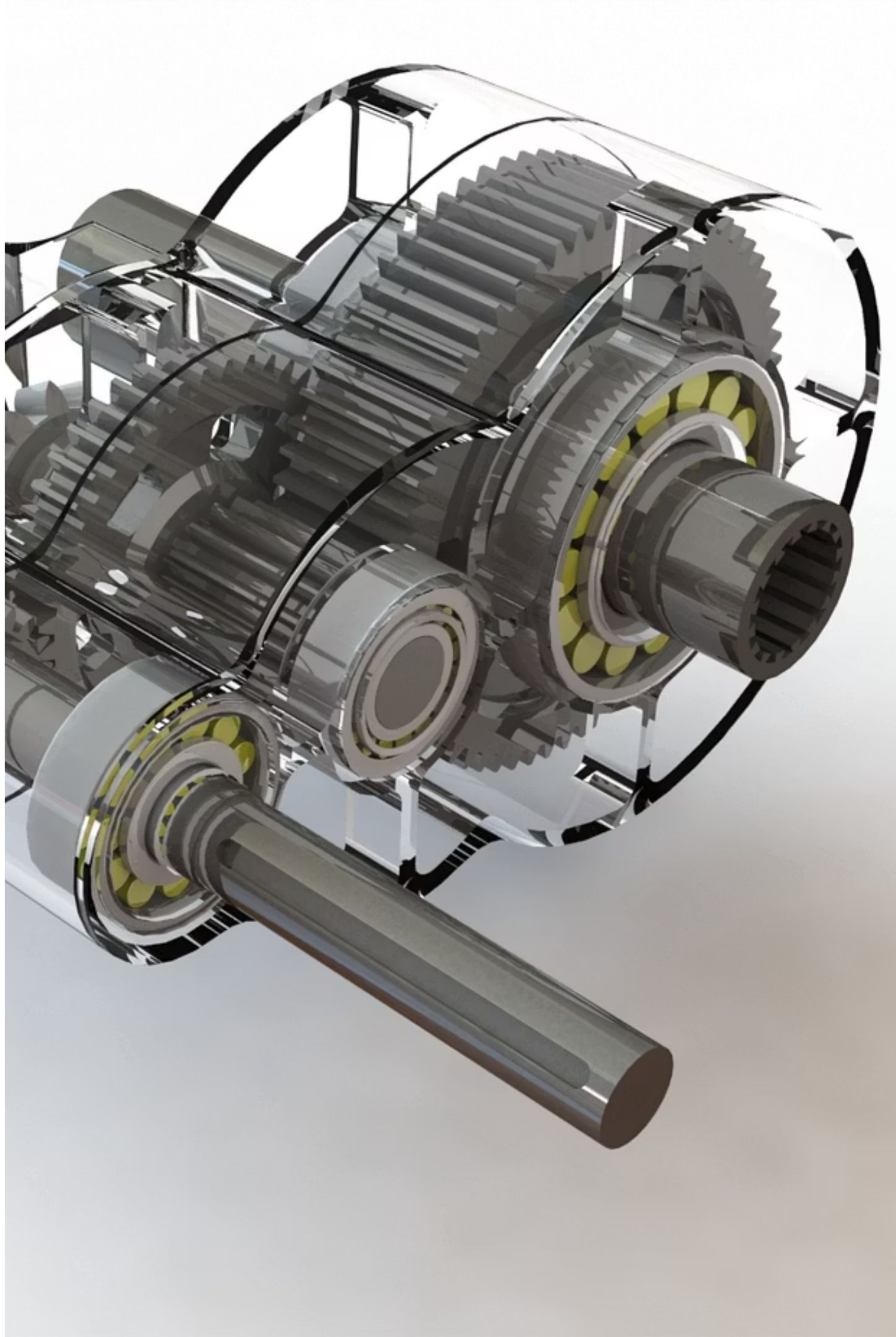
Create 2D layout defining gear centers, shaft spacing, and overall envelope based on gear calculations (center distance = (D1 + D2)/2).

Parametric Features

Build housing using extrusions, ribs, and shells. Link dimensions to gear parameters so housing updates automatically with gear size changes.

Assembly Validation

Insert gears, shafts, and bearings. Check clearances (minimum 2 mm), validate bearing fit (H7/k6), and verify assembly sequence.



Advanced SOLIDWORKS Modeling Techniques

Beyond basic part modeling, SOLIDWORKS offers specialized tools to tackle diverse engineering challenges, enabling efficient design for complex forms, structural frameworks, and fabricated parts.

Boundary Surfaces

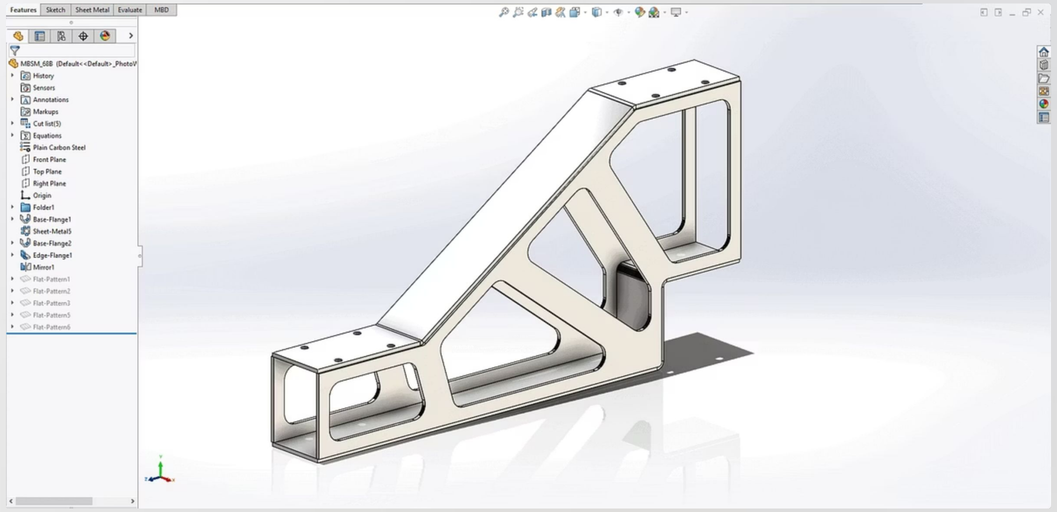
For complex multi-patch surfaces, Boundary Surfaces offer precise control over edges, curvature, and tangency, ideal for intricate transitions and smooth blends.

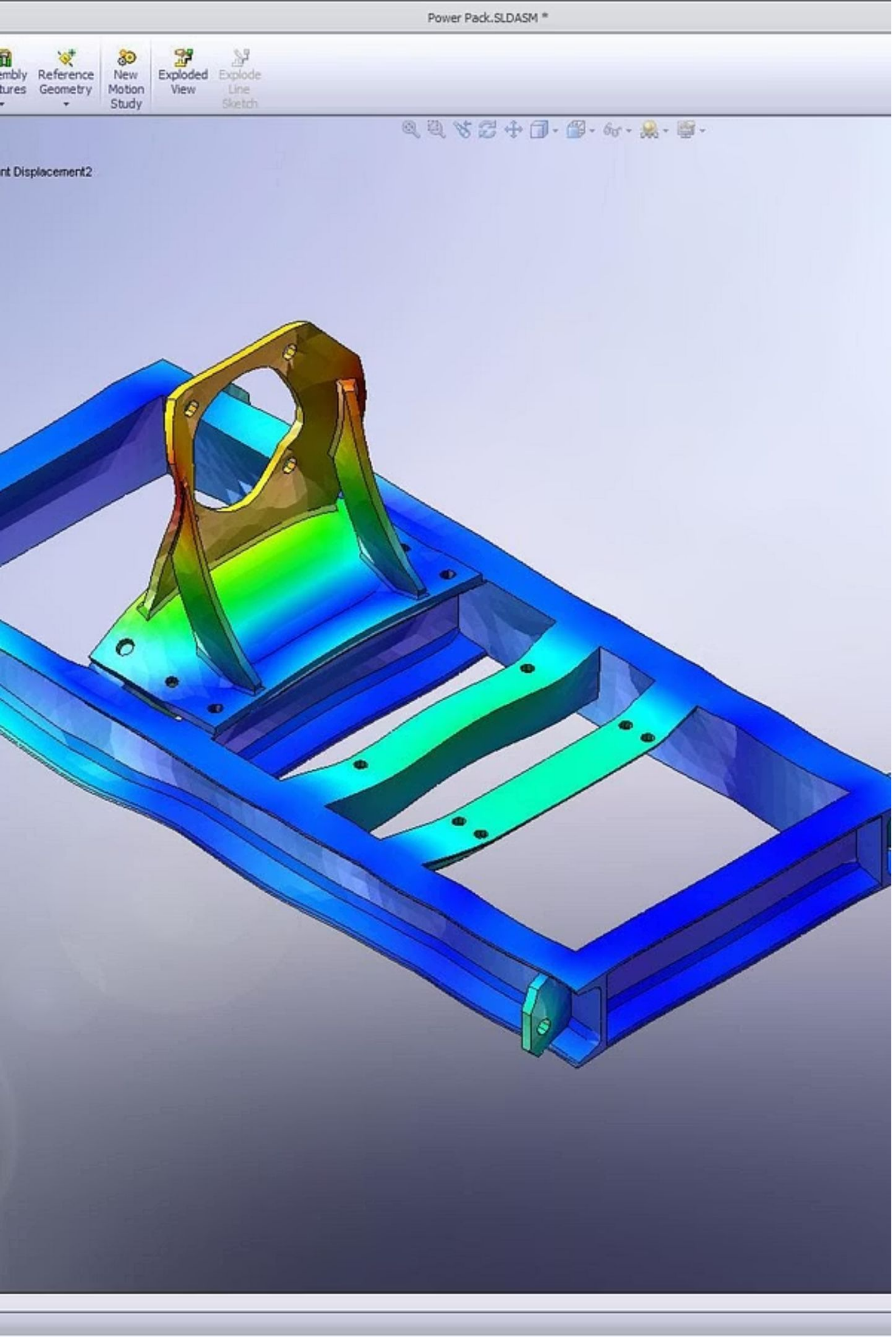
Weldments

Streamline structural frame design with Weldments, utilizing standard profiles and generating automatic cut lists, saving time in fabrication.

Sheet Metal

Design fabricated parts efficiently with Sheet Metal tools, incorporating bend allowances and automatically generating flat patterns for manufacturing.



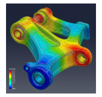


Phase 4: Virtual Prototyping & Validation

Before committing to physical prototypes, we use advanced simulation to test and validate the design's real-world performance digitally.

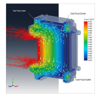
Engineering Calculations

We perform mathematical analysis and hand calculations to validate simulation results, including stress analysis, thermal calculations, and dynamic modeling.



Finite Element Analysis (FEA)

We simulate mechanical stress, vibration, and heat to identify potential structural failure points and ensure design integrity and reliability.



Computational Fluid Dynamics (CFD)

We analyze fluid flow and heat transfer to optimize aerodynamics, electronics cooling, and energy efficiency.

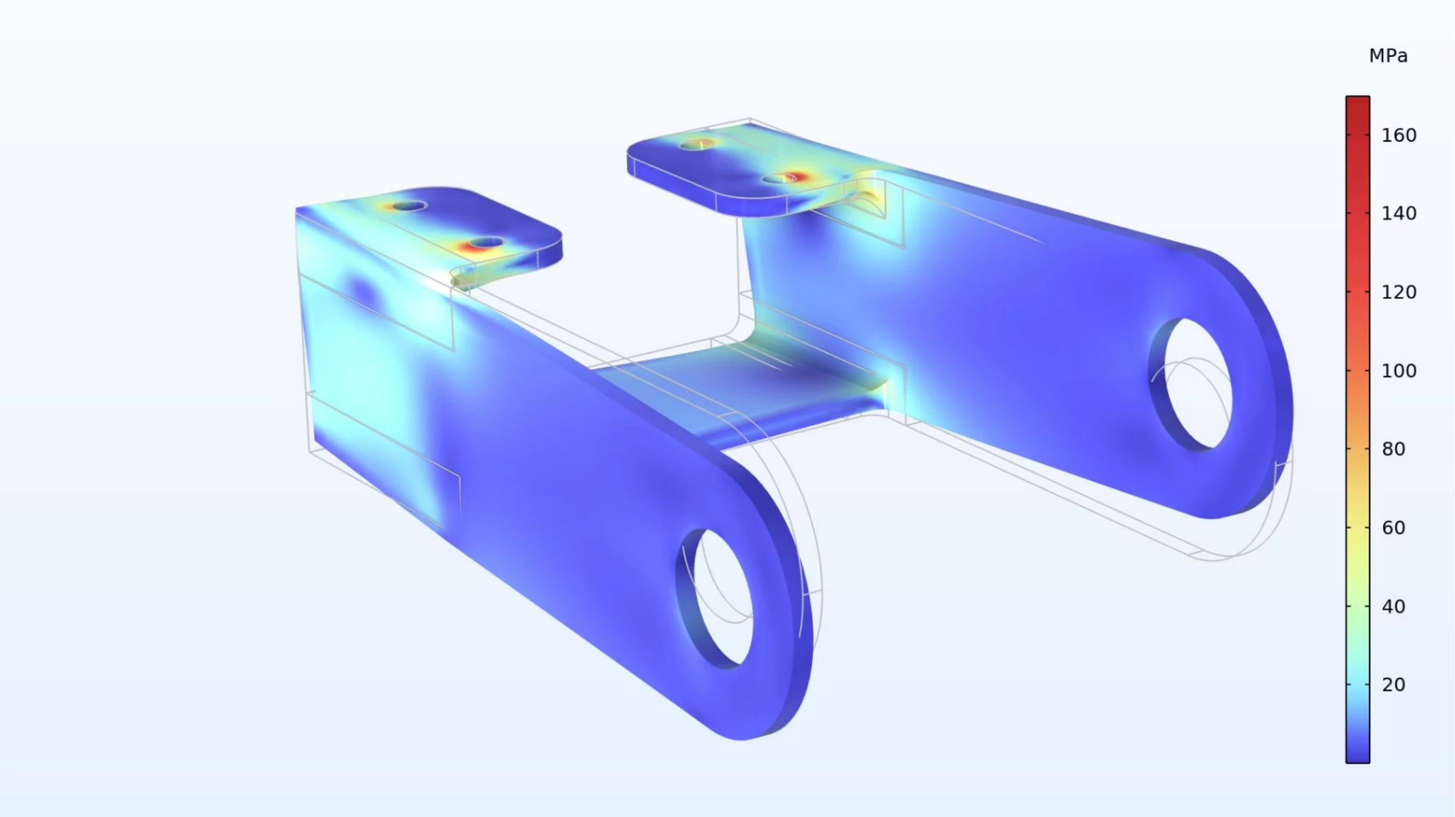
Example: FEA of Bracket Design

Setup & Validation

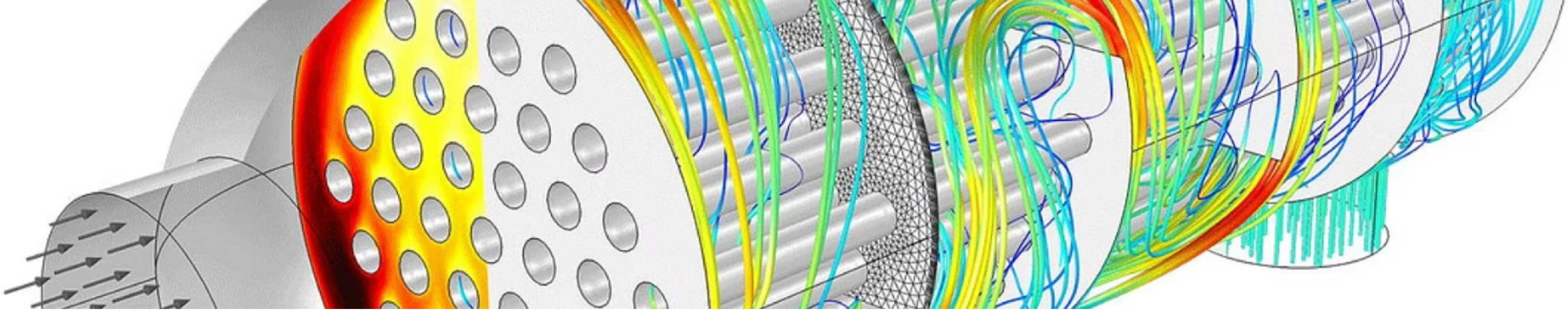
Design scenario: L-bracket supporting 2000 N vertical load, fixed at base.

Hand calculation: Using bending stress formula $\sigma = Mc/I$, we predict maximum stress ≈ 180 MPa at the fillet.

FEA mesh: 10 mm element size with 0.5 mm refinement at stress concentrations.



Results: FEA shows σ_max = 195 MPa (8% higher due to stress concentration factor). Hand calculation validates FEA magnitude. Safety factor of 1.28 against yield (250 MPa) confirms design adequacy.



Example: CFD for Heat Exchanger Design

Problem: Design a shell-and-tube heat exchanger to cool process fluid from 120°C to 80°C with 500 kW heat duty.

Analytical Foundation

Using heat exchanger equations:

$$Q = UA\Delta T_{lm}$$

We determine the required heat transfer area and overall heat transfer coefficient, based on LMTD calculations, guiding the preliminary design.

CFD Validation

CFD simulation reveals detailed temperature profiles, pressure drops, and local heat transfer coefficients. This validates our analytical estimates and helps identify potential areas for design optimization to meet performance targets.

Phase 5: Manufacturing Readiness

We create comprehensive and unambiguous documentation that serves as the official blueprint for production, bridging the gap between the digital model and the physical product.

1

Geometric Dimensioning & Tolerancing (GD&T)

We use the standardized language of GD&T to precisely communicate allowable variations in part geometry, ensuring function and interchangeability across production runs.

2

Tolerance Stack-Up Analysis

We mathematically verify that individual part tolerances will not accumulate to cause assembly failure, using both worst-case and statistical (RSS) methods.

3

2D Drawing Generation

We generate comprehensive 2D technical drawings for all parts and assemblies, including detailed views, sections, and callouts to ensure clarity and precision for manufacturing.

4

Final Documentation

We produce a complete package including detailed assembly drawings and comprehensive Bill of Materials (BOM) listing every component required for production.

Example: Tolerance Stack-Up Analysis

Assembly requirement: Ball bearing must have 0.02-0.08 mm radial clearance in housing bore for proper operation.

Worst-Case Method

Chain: Housing bore Ø25 H7 (+0.021/0), Bearing OD Ø25 f6 (-0.013/-0.034 mm)

Max clearance = 25.021 - 24.966 = 0.055 mm

Min clearance = 25.000 - 24.987 = 0.013 mm

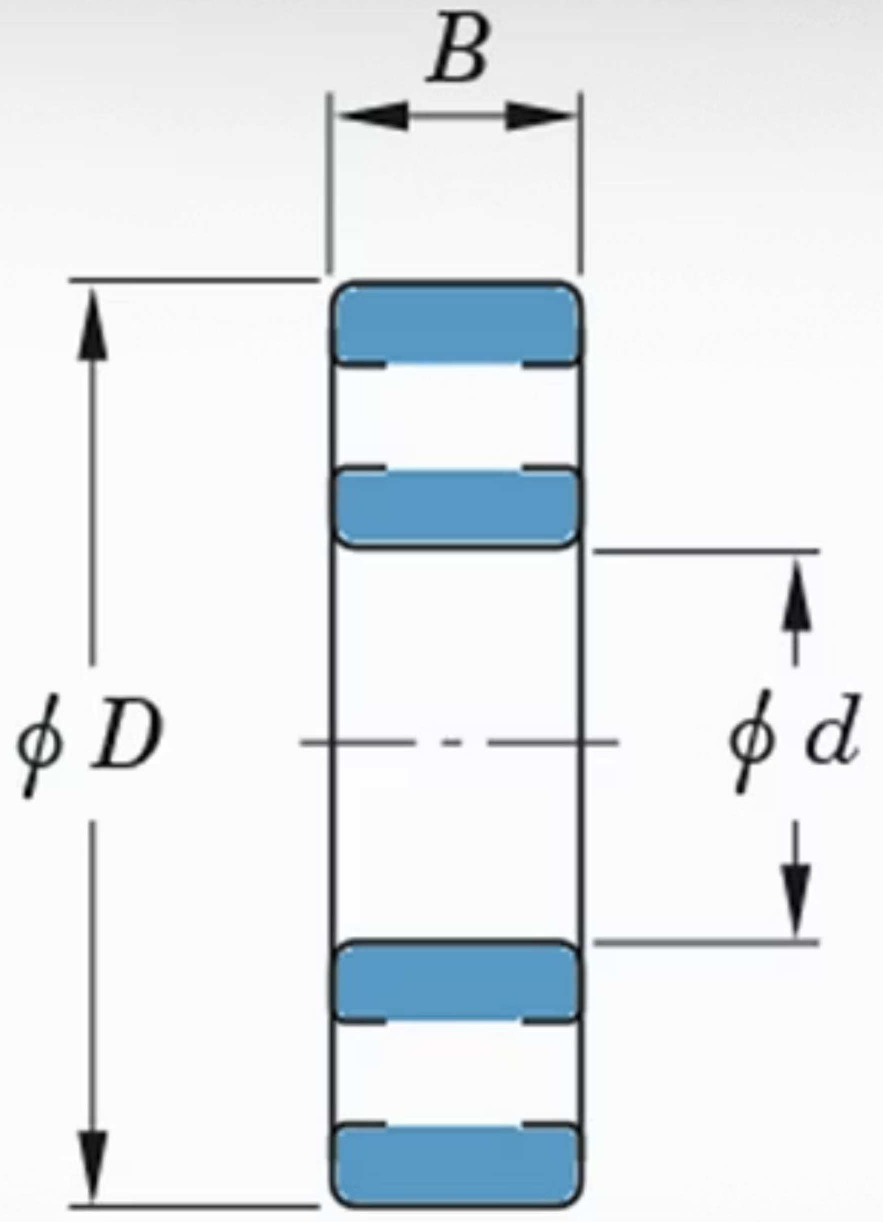
Meets requirements!

Statistical Method (RSS)

For high-volume production, RSS method accounts for probability:

$$\sigma_{total} = \sqrt{\sigma_1^2 + \sigma_2^2}$$

Provides more economical tolerances while maintaining quality at acceptable defect rates (typically 3σ = 99.7% yield).



Cylindrical bore

GD&T: The Language of Manufacturing

Geometric Dimensioning and Tolerancing provides unambiguous communication of design intent, specifying not just sizes but also form, orientation, and location tolerances.

Form Controls

Flatness, straightness, circularity, and cylindricity define feature shape independent of other features.

Orientation Controls

Perpendicularity, parallelism, and angularity relate features to datums, ensuring proper mating and function.

Location Controls

Position, concentricity, and symmetry precisely define feature locations for assembly and interchangeability.

Phase 6: Quality Framework & Data Management

Our entire process is governed by a robust quality management system to ensure consistency, data integrity, and the highest standards of professionalism.

Adherence to Standards

We strictly follow international standards (ASME Y14.5, ISO 1101, ISO 2768) for all drawings and documentation to ensure universal clarity and reduce manufacturing errors.

Internal Design Reviews

We conduct formal, multi-stage design reviews at critical milestones. These "quality gates" involve cross-functional teams to identify issues early and ensure continuous alignment with goals.

Product Data Management (PDM)

All project data is managed in a secure, centralized PDM system, providing strict revision control, preventing errors from outdated files, and creating a fully traceable audit history.

Design Review Gates: Quality Checkpoints

Formal reviews at critical milestones ensure design quality and stakeholder alignment throughout the project lifecycle.

1. **Conceptual Design Review**

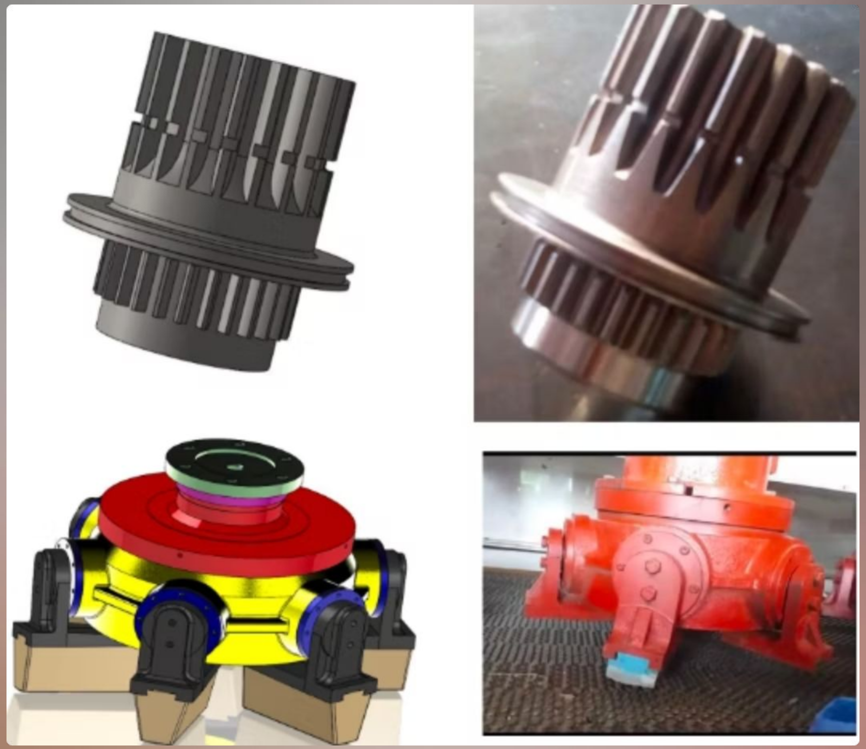
   Evaluate feasibility, cost estimates, and alignment with requirements. Go/no-go decision point.

2. **Preliminary Design Review**

   Assess detailed design approach, initial analysis results, and manufacturing considerations.

3. **Critical Design Review**

   Validate final design, simulation results, and complete documentation before release to manufacturing.



Your Path to Manufacturing Success

Our systematic six-phase process delivers precision-engineered, manufacturing-ready designs backed by rigorous analysis and quality assurance.

6	100%	3
Comprehensive Phases	**Documentation Complete**	**Validation Methods**
From strategic initiation through quality management	GD&T, drawings, BOM, and simulation reports	Engineering Calculations, FEA and CFD for confidence

Ready to transform your concepts into reality? Our proven methodology ensures your project's success from initial requirements through final production.