

# Manufacturing Cost Models for Aerospace

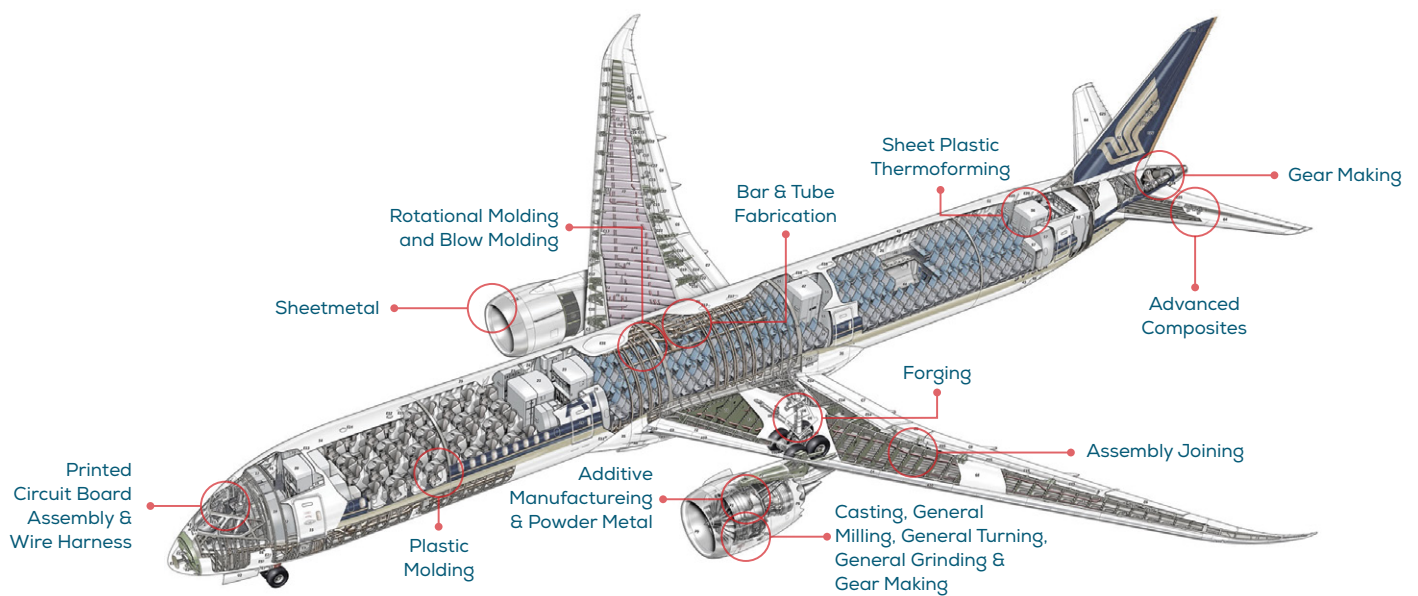
## Physics-Based Mechanistic Cost Models









DATA SHEET








aPriori's physics-based cost models address common manufacturing processes including sheet metal forming, bar & tube fabrication, welded or mechanical assemblies, plastic molding, sand and die casting, forging, turning and multi-axis machining, and a wide variety of heat treatments and surface treatment or finishing operations.


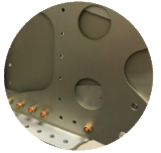

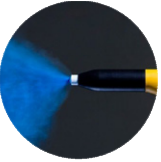
Deterministic routings generate the lowest cost production method and evaluate the manufacturability of all routings defined in the digital factory. This allows engineering, manufacturing and purchasing professionals to explore cost saving production alternatives down to the machine level.



Manufacturing Process Group	Supported Sub Processes and Operations	Aerospace Application and Example Components
<p>Sheetmetal</p> 	<ul style="list-style-type: none"> <li>• Stretch Forming</li> <li>• Hydroforming</li> <li>• Roll Bending (2, 3, 4 Rollers)</li> <li>• Soft Toolled Processes</li> <li>• Basic Stamping</li> <li>• Elesto-Forming*</li> </ul>	<p>Airframe Substructure Frames, Clips, Shear Ties, Skins, Fairings, Leading and Trailing Edges</p>
<p>Chemical Milling</p> 	<p>Cleaning, Identing, Masking Operations (Spraying, Curing, Scribing, Line Sealing, Spark Testing, Removal), Etch Cycle Operations (Mask Peeling, Etching, Rinsing, Depth Inspection), Final Inspection</p>	<p>Fuselage Panels, Wing Skins, Horizontal and Vertical Stabilizer Skins</p>

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<p><b>Machining: General Milling</b></p> 	<ul style="list-style-type: none"> <li>• 3-4-5 Axis CNC Milling</li> <li>• Sawing/Cut-to-Length</li> <li>• Gun Drilling</li> <li>• Wire EDM</li> <li>• Drill Press</li> <li>• Deburring</li> <li>• Jig Boring</li> <li>• Assembly Milling (User-Guided)</li> </ul>	<p>Wing Ribs and Spars, Fuselage Frames, Bulkheads, Fittings, Brackets, Seat Tracks, Landing Gear Components, Gearboxes, Transmissions</p>
<p><b>Machining: General Turning</b></p> 	<ul style="list-style-type: none"> <li>• 2-3-Axis CNC Conventional Lathes</li> <li>• 2-3-axis Bar Feed lathes</li> <li>• Mill-Turn</li> <li>• Deep Bore/Trepanning</li> <li>• Lathe Roughing (on castings)</li> <li>• Lathe Finishing</li> <li>• Single Point Threading</li> <li>• Single Plunge Grooving</li> <li>• Multi-Plunge Grooving</li> </ul>	<p>Engine Components, Fluid Handling Systems, Actuation Systems, Couplings, Valves, Sensors</p>
<p><b>Machining: General Grinding</b></p> 	<ul style="list-style-type: none"> <li>• OD Grinding</li> <li>• ID Grinding</li> <li>• Surface Grinding</li> <li>• Rotor Grinding</li> <li>• Jig Grinding</li> <li>• Cylindrical Grinding</li> </ul>	<p>Close Tolerance Engine Components, Landing Gear Components, Fluid Handling Systems, Couplings, Valves, Sensors</p>
<p><b>Casting</b></p> 	<ul style="list-style-type: none"> <li>• Sand Casting</li> <li>• High Pressure Die Casting</li> <li>• Gravity Die Casting</li> <li>• Investment Casting</li> </ul>	<p>Engine Components, Interior Components, Exterior and Interior Sensors, Motion Control and Actuation Systems, Hydraulic Fluid System Components, Cargo Systems, Landing and Braking Components</p>
<p><b>Bar &amp; Tube Fabrication</b></p> 	<ul style="list-style-type: none"> <li>• Bar Forming</li> <li>• Expansion</li> <li>• Flanging</li> <li>• Flaring</li> <li>• Flattening</li> <li>• Knurling</li> <li>• Notching</li> <li>• Reduction</li> <li>• Slotting</li> </ul>	<p>Hydraulic and Pneumatic Systems, Fuel Lines, Structural Tubing</p>
<p><b>Aluminum Extrusion Fabrication</b></p> 	<ul style="list-style-type: none"> <li>• Die and Billet Preheating</li> <li>• Release Agent Application</li> <li>• Cooling</li> <li>• Rough Cutoff</li> <li>• Straightening</li> <li>• Racking</li> <li>• Aging</li> <li>• Secondary Material Removal</li> </ul>	<p>Structural Components in Wings and Fuselages, Trim Pieces Inside Fuselage</p>
<p><b>Forging</b></p> 	<ul style="list-style-type: none"> <li>• Closed Die Hammer Forging</li> <li>• Ring Rolled Forging</li> </ul>	<p>Pylons, Landing Gear Axles, Structural Frames, Bulkheads, Turbine Cases, Transmission Components</p>
<p><b>Gear Making</b></p> 	<ul style="list-style-type: none"> <li>• Die and Billet Preheating</li> <li>• Release Agent Application</li> <li>• Cooling</li> <li>• Rough Cutoff</li> <li>• Straightening</li> <li>• Racking</li> <li>• Aging</li> <li>• Secondary Material Removal</li> </ul>	<p>Structural Components in Wings and Fuselages, Trim Pieces Inside Fuselage</p>

Manufacturing Process Group	Supported Sub Processes and Operations	Aerospace Application and Example Components
<b>Advanced Composites</b> 	<ul style="list-style-type: none"> <li>• Hand Layout</li> <li>• Automated Tape Layout</li> <li>• Automated Fiber Placement</li> </ul>	Fairings, Wing Ribs, Stringers, Shear Ties, Frames, Door Panels, Skin Panels, Control Surfaces
<b>Additive Manufacturing</b> 	<ul style="list-style-type: none"> <li>• SLA</li> <li>• SLS</li> <li>• DMLS</li> <li>• Material Jetting</li> <li>• SLM*</li> </ul>	Engine Components, Nozzles, Mounting Brackets, Jigs and Fixtures, Prototypes
<b>Powder Metal</b> 	Compaction Pressing, Furnace Sintering	Aircraft Engine Components
<b>Plastic Molding</b> 	<ul style="list-style-type: none"> <li>• Single Shot Injection Molding</li> <li>• Over-Molding</li> <li>• Insert Molding</li> <li>• Structural Foam Molding</li> <li>• Reaction Injection Molding</li> <li>• Rubber Molding (Small Plugs for Holes, Grommets, O-Rings, Seals)*</li> </ul>	Housings, Lenses, Panels, Enclosures and Containers, Seat Components, Galley Equipment
<b>Rotational Molding and Blow Molding</b> 	<ul style="list-style-type: none"> <li>• Extrusion Blow Molding</li> <li>• Material Grinding/Pulverizing</li> <li>• Trimming/Routing</li> </ul>	Ducting/Ventilation Systems, Ram Air Inlets, Avionics Cooling Systems
<b>Sheet Plastic Thermoforming</b> 	<ul style="list-style-type: none"> <li>• Vacuum Forming</li> <li>• Drape Molding</li> </ul>	Interior Panels, Seat Shells, Tray Tables, Armrests
<b>Printed Circuit Board Assembly</b> 	<ul style="list-style-type: none"> <li>• Component Preparation</li> <li>• Kitting</li> <li>• Surface Mount Assembly</li> <li>• Plated through Hole Assembly</li> <li>• Depanelization</li> <li>• Testing</li> <li>• Conformal Coating</li> </ul>	Cockpit Instrumentation, Navigation Systems, In-flight Entertainment Systems, Avionics, Power Management Systems, Control Systems, Lighting

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<b>Wire Harness</b> 	<ul style="list-style-type: none"> <li>• Wire/Bundle/Conduit Prep</li> <li>• Wire Termination</li> <li>• Connector Assembly</li> <li>• Splice</li> <li>• Branch Covering</li> <li>• Braid</li> <li>• Harness Layout</li> <li>• Labeling</li> <li>• Testing</li> </ul>	Cockpit instrumentation, Navigation systems, In-Flight Entertainment, Power Management Systems, Control Systems, Lighting
<b>Assembly Joining</b> 	<ul style="list-style-type: none"> <li>• Riveting</li> <li>• Lock Bolts</li> <li>• Nutplate Installation</li> <li>• Adhesive Bonding</li> <li>• Manual MIG Welding</li> <li>• Manual Spot Welding</li> <li>• Robotic MIG Welding</li> <li>• Robotic Spot Welding</li> <li>• TIG Welding, Laser Welding</li> <li>• Electro-Beam Welding</li> <li>• Resistance*</li> <li>• Ultrasonic and Friction Welding*</li> <li>• Brazing*</li> <li>• Soldering*</li> </ul>	Fastened Substructure and Skin Assemblies, Turbine Component Welding, Airframe Structure
<b>Heat Treatment</b> 	<ul style="list-style-type: none"> <li>• Aging</li> <li>• Annealing (3 types)</li> <li>• Cryogenic Freezing</li> <li>• Solutioning</li> <li>• Stress Relieving</li> <li>• Surface Hardening (3 types)</li> <li>• Tempering (2 types)</li> <li>• Through Hardening (4 types)</li> <li>• Hot Isostatic Pressing</li> <li>• Normalization*</li> <li>• Chromizing*</li> <li>• Borizing*</li> <li>• Most Heat Treatments—both whole part and localized*</li> </ul>	Engine components, Airframe Structure
<b>Surface Treatment</b> 	<ul style="list-style-type: none"> <li>• Shot Blast</li> <li>• Degreasing</li> <li>• Basic Painting</li> <li>• Anodizing</li> <li>• Powder-Coat Cart Painting</li> <li>• Wet-Coat Line Painting</li> <li>• One-Sided Fraction Painting</li> <li>• Plating (4 types)</li> <li>• Silk Screening</li> <li>• Passivation</li> <li>• Vibratory Deburr</li> <li>• Chem Film*</li> <li>• Booth Painting*</li> <li>• Protective Coat*</li> <li>• Most Surface Treatments—both whole part and localized*</li> </ul>	Structural components, Skins, Interior, Propulsion Systems
<b>User-Guided Processes (for costing without CAD)</b>	<ul style="list-style-type: none"> <li>• Turret Press</li> <li>• Bend Brake</li> <li>• Stage Tooling</li> <li>• Progressive Die</li> <li>• Injection Molding</li> </ul>	Early Costing with Minimal CAD Definition

\* Additional cost required to develop and deliver the processes listed with an asterisk. The aPriori Applied Services team may also be able to deliver processes not in this list after evaluating the requested processes and confirming the capability to develop a solution.



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