

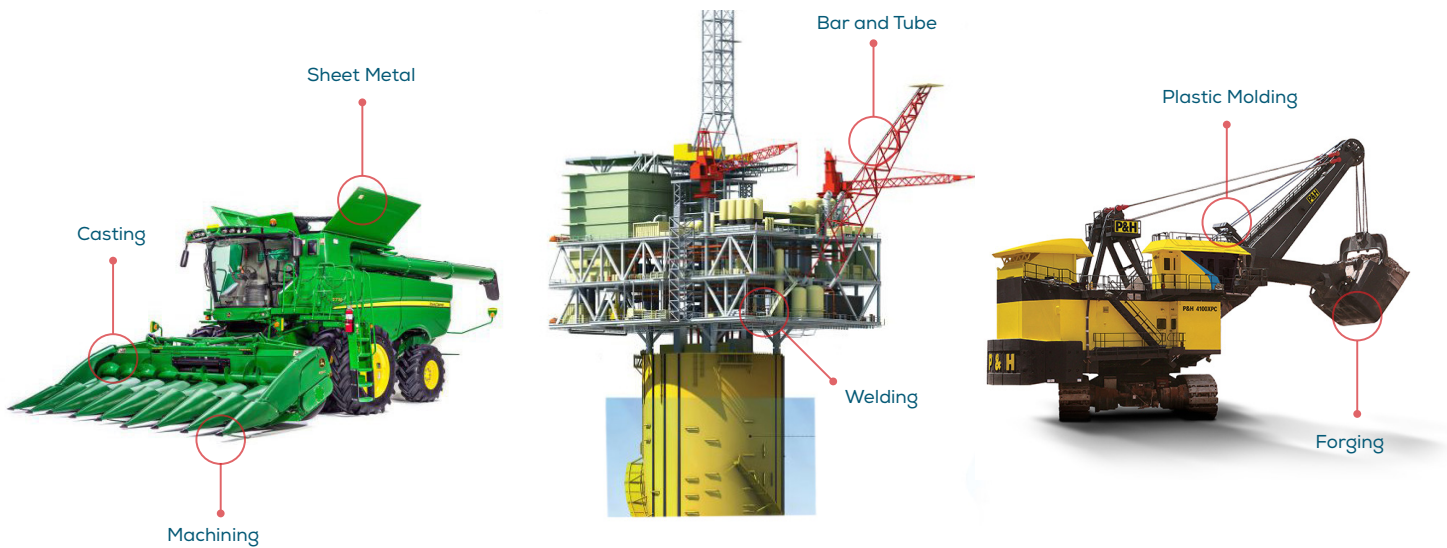
Manufacturing Cost Models for Heavy Industry



Physics-Based Mechanistic Cost Models






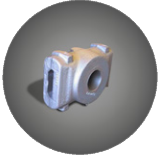
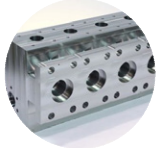
DATA SHEET






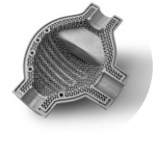
aPriori's physics-based cost models address common manufacturing processes including sheet metal fabrication, bar & tube fabrication, welded or mechanical assemblies, plastic molding, sand and die casting, forging, turning and multi-axis machining, and a wide variety of heat treatments and surface treatment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



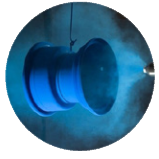
Deterministic routings generate the lowest cost production method and evaluate the manufacturability of all routings defined in the **digital factory**. This allows engineering, manufacturing and purchasing professionals to explore cost saving production alternatives down to the machine level.



Manufacturing Process Group	Supported Sub Processes and Operations	Heavy Industry Application and Example Components
<p>Sheet Metal</p> 	<ul style="list-style-type: none"> • Basic Stamping • Progressive Die Stamping • Transfer Die Stamping • Soft Toolled Processes • Hydroforming • Stretch Forming 	<p>Body, Chassis, Box, Structural Plating, Bucket, Smaller stampings in Engine Bay and in Auxillary Agro Assemblies, Corrosion Resistant Brackets & Washers, Oil Rig Structure, Clamps</p>
<p>Bar & Tube Fabrication</p> 	<ul style="list-style-type: none"> • Bar Forming • Expansion • Flanging • Flaring • Flattening • Knurling • Notching • Reduction • Slotting 	<p>Fluid Lines (Brake, Fuel, Hydraulics, Oil), Structure, Cage, Ladders, Cabs/Roll-Over-Protective-Structure, Oil Rig Structure</p>

Manufacturing Process Group	Supported Sub Processes and Operations	Heavy Industry Application and Example Components
<p>Aluminum Extrusion Fabrication</p> 	<ul style="list-style-type: none"> • Die and Billet Preheating • Release Agent Application • Cooling • Rough Cutoff • Straightening • Racking • Aging • Secondary Material Removal 	<p>Structural framing systems for mining, farming, and civil engineering equipment and vehicles; solar, wind, and alternative energy components; railings, support structures, side sills, A-pillars, B-pillars and other body and closure components for heavy duty tractors and trailers.</p>
<p>Casting</p> 	<ul style="list-style-type: none"> • Sand Casting • High Pressure Die Casting • Gravity Die Casting • Permanent Mold • Investment Casting 	<p>Engine Blocks, Transmission Housing, Transfer Cases, Oil Rig Structures, Pump Cases and Housings</p>
<p>Plastic Molding</p> 	<ul style="list-style-type: none"> • Single Shot Injection Molding • Over-Molding • Insert Molding • Structural Foam Molding • Reaction Injection Molding • Rubber Molding (Small Plugs for Body Holes, Grommets, O-Rings, Seals)* 	<p>Agro Equipment Exterior Panels, Cabin Interior Components, Windshields, Door Panels and Screens</p>
<p>Rotational Molding and Blow Molding</p> 	<ul style="list-style-type: none"> • Extrusion Blow Molding • Material Grinding/Pulverizing • Trimming/Routing 	<p>Gas Tanks, Ducting/Ventilation</p>
<p>Sheet Plastic Thermoforming</p> 	<ul style="list-style-type: none"> • Vacuum Forming • Drape Molding 	<p>Body Panels & Door Panels for Agro</p>
<p>Forging</p> 	<ul style="list-style-type: none"> • Closed Die Hammer Forging • Ring Rolled Forging 	<p>Steering Arms, Gears, Drive Components, Linkages</p>
<p>Machining: General Milling</p> 	<ul style="list-style-type: none"> • 3-4-5 Axis CNC Milling • Sawing/Cut-to-Length • Gun Drilling • Wire EDM • Drill Press • Deburring • Jig Boring • Assembly Milling (User-Guided) 	<p>Engine and Drive Train Components, Hydraulic Cylinders for Arms/Buckets & Stabilizers, All Members at Interfacing/Inflection Points, Down-hole Tools, Valves & Valve blocks. Directional Drilling Collars, Subs and Mandrels Artificial Lift Components such as Pockets, Mandrels, Bodies. Drill Rig Components, such as Top Drives, Links, Quills, Mandrels, Yokes, Pins</p> <p>Plastic Machining - Insulators, Fittings, Bushings, Valve Components, Gears, Bearings, Spacers</p>

Manufacturing Process Group	Supported Sub Processes and Operations	Heavy Industry Application and Example Components
<p>Machining: General Turning</p> 	<ul style="list-style-type: none"> • 2-3-Axis CNC Conventional Lathes • 2-3-Axis Bar Feed Lathes • Mill-Turn • Deep Bore/Trepanning • Lathe Roughing (on castings) • Lathe Finishing • Single Point Threading • Single Plunge Grooving • Multi-Plunge Grooving 	<p>Engine and Drive Train Components, Hydraulic Cylinders for Arms/ Buckets & Stabilizers, All Members at Interfacing/ Inflection Points, Down-hole Tools, Pipes, Valves & Valve Blocks. Directional Drilling Collars, Subs and Mandrels</p> <p>Artificial Lift Components Such as Pockets, Mandrels, Bodies. Drill Rig Components, such as Top Drives, Links, Quills, Mandrels, Yokes, Pins</p> <p>Plastic Machining - Insulators, Fittings, Bushings, Valve Components, Gears, Bearings, Spacers</p>
<p>Machining: General Grinding</p> 	<ul style="list-style-type: none"> • OD Grinding • ID Grinding • Surface Grinding • Rotor Grinding • Jig Grinding • Cylindrical Grinding 	<p>Engine and Drive Train Components, Hydraulic Cylinders for Arms/ Buckets & Stabilizers, All Members at Interfacing/ Inflection Points, Down-Hole Tools, Valves & Valve blocks</p>
<p>Gear Making</p> 	<ul style="list-style-type: none"> • Hobbing • Shaping • Broaching • Rolling • Bevel Gear Cutting • Shaving • Profile Grinding • Threaded Wheel Grinding • Spline Rolling 	<p>Transmission Components, Steering Systems, Axle Shafts</p>
<p>Printed Circuit Board Assembly</p> 	<ul style="list-style-type: none"> • Component Preparation • Kitting • Surface Mount • Assembly • Plated through Hole Assembly • Depanelization • Testing • Conformal Coating 	<p>Control Modules, ECU</p>
<p>Wire Harness</p> 	<ul style="list-style-type: none"> • Wire/Bundle/Conduit Prep • Wire Termination • Connector • Assembly • Splice • Branch Covering • Braid • Harness Layout • Labeling • Testing 	<p>Engine and Powertrain Control, Lighting, Radio, HVAC</p>
<p>Additive Manufacturing</p> 	<ul style="list-style-type: none"> • SLA • SLS • DMLS • Material Jetting • SLM* 	<p>Prototypes, R&D Assembly, Service Components, JIT Oil and Gas Components of all Kinds</p>

Manufacturing Process Group	Supported Sub Processes and Operations	Heavy Industry Application and Example Components
<p>Assembly Welding and Joining</p> 	<ul style="list-style-type: none"> • Riveting • Lock Bolts • Nutplate Installation • Adhesive Bonding • Manual MIG Welding • Manual Spot Welding • Robotic MIG Welding • Robotic Spot Welding • TIG Welding • Laser Welding • Electro-Beam Welding • Resistance* • Ultrasonic and Friction Welding* • Brazing* • Soldering* 	<p>Large Body, Frame, Bucket, Box, Arms, & Stabilizer Assemblies, Oil Rig Structures</p>
<p>Heat Treatment</p> 	<ul style="list-style-type: none"> • Aging • Annealing (3 types) • Cryogenic Freezing • Solutioning • Stress Relieving • Surface Hardening (3 types) • Tempering (2 types) • Through Hardening (4 types) • Hot Isostatic Pressing • Normalization* • Chromizing* • Borizing* • Most Heat Treatments—both whole part and localized* 	<p>Engine Components, Drive Components, Pump Components, High Pressure Components</p>
<p>Surface Treatment</p> 	<ul style="list-style-type: none"> • Shot Blast • Degreasing • Basic Painting • Anodizing • Powder-Coat Cart Painting • Wet-Coat Line Painting • One-Sided Fraction Painting • Plating (4 types) • Silk Screening • Passivation • Vibratory Deburr • Chem Film* • Booth Painting* • Protective Coat* • Most Surface Treatments—both whole part and localized* 	<p>Exterior Painted Components, Under Water or Below-ground Components and Systems</p>
<p>User-Guided Processes (for costing without CAD)</p>	<ul style="list-style-type: none"> • Turret Press • Bend Brake • Stage Tooling • Progressive Die • Injection Molding 	<p>Early Costing with Minimal CAD Definition</p>

**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.*



CORPORATE HEADQUARTERS USA, Concord, MA productcost@apriori.com | **APAC**, Tokyo, Japan apac@apriori.com

EMEA, Belfast, Northern Ireland emea@apriori.com | **DACH**, Munich, Germany dach@apriori.com