



Leveraging Digital Manufacturing to Accelerate Time to Market and to Reduce Risk

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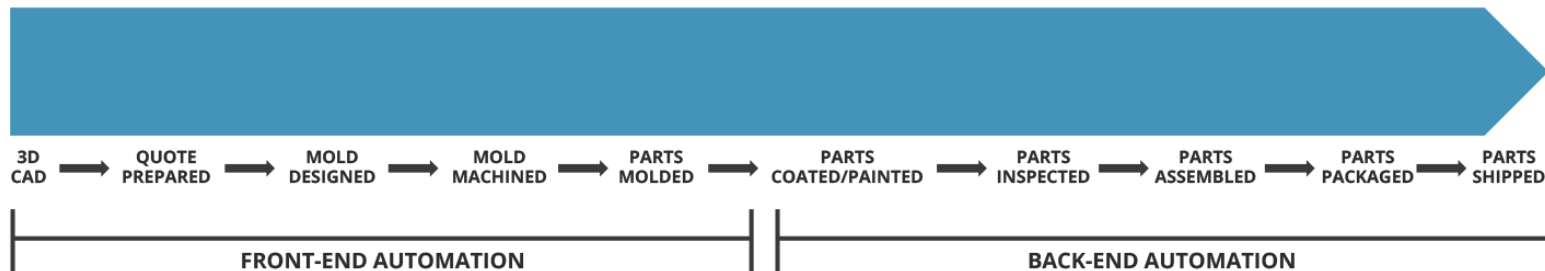
THESIS

- Recent advances in digital manufacturing technologies enable iterative design and development.
- Up-front investments and market risk are reduced through effective and frequent prototyping early in the development cycle.
- Quick-turn manufacturing options create a bridge between low- and high-volume production, resulting in getting to market faster.
- On-demand manufacturing helps manage the volatility of demand and reduce inventory costs.

DIGITAL (A.K.A. ADVANCED) MANUFACTURING

- Integration of modern software technology with physical manufacturing.
- This can happen throughout the manufacturing process. Where it happens matters.

INJECTION MOLDING EXAMPLE



FRONT-END AUTOMATION

- Automates the work that varies with each part design.
- Focus on design and manufacturability of the custom part:
 - Quoting
 - Design for Manufacturability (DFM)



Best Suited for Short-Run Production

BACK-END AUTOMATION

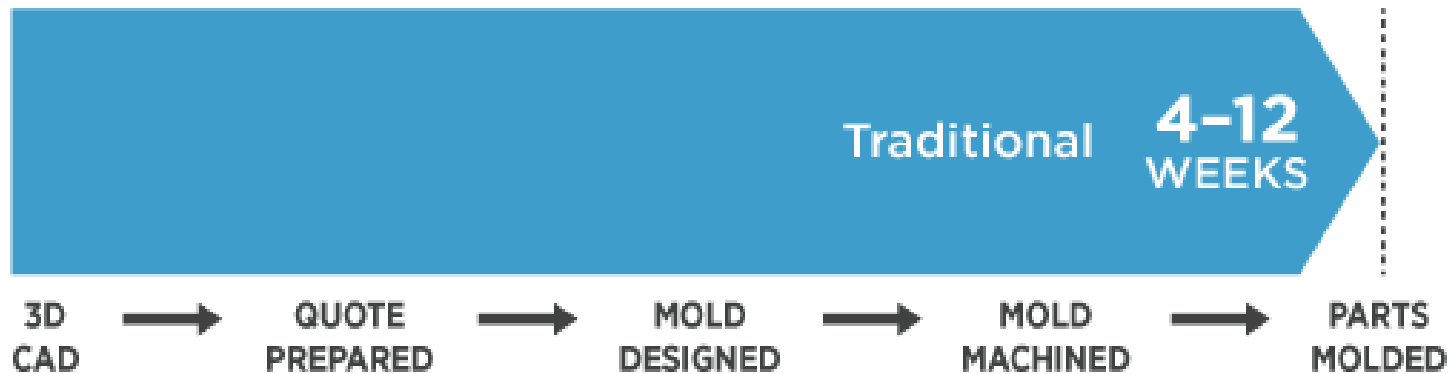
- Automates the work that is consistent for each part produced.
- High-volume manufacturers focus on optimization of manufacturing at scale:
 - Maximum capital equipment utilization.
 - Minimum wasted materials and time.



Best Suited for High-Volume Production

FOCUS ON FRONT-END AUTOMATION

INJECTION MOLDING EXAMPLE



- What can we unlock when we automate the key steps of this process?

DIGITAL MEETS PHYSICAL

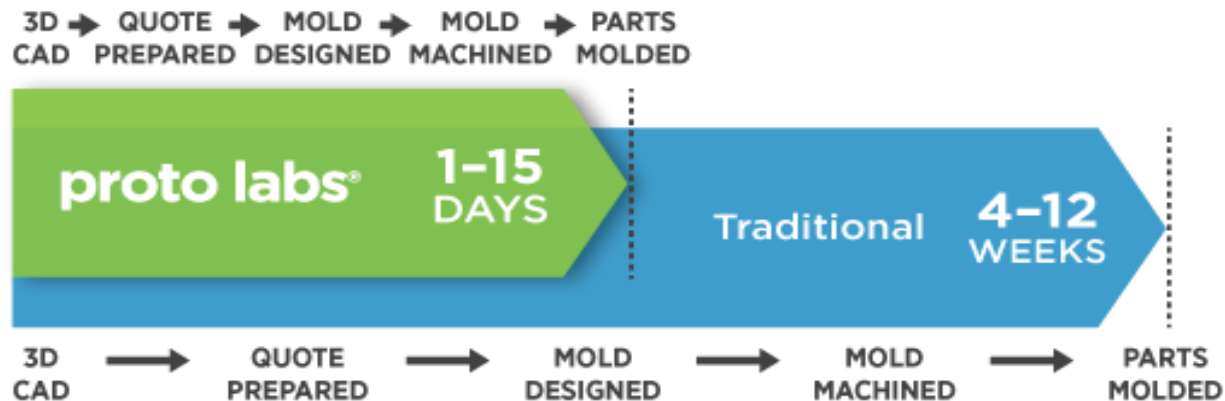
- Confluence of 3D CAD digital product design (defines the part) with physical manufacturing process (makes the part).



BENEFITS OF CONFLUENCE

- Increases speed to market - first parts can be made in days, not months.
- Reduces up-front investment - cost of first parts greatly reduced.
- Greater flexibility – ability to react quicker to market demands.

INJECTION MOLDING EXAMPLE



WHO IS PROTO LABS

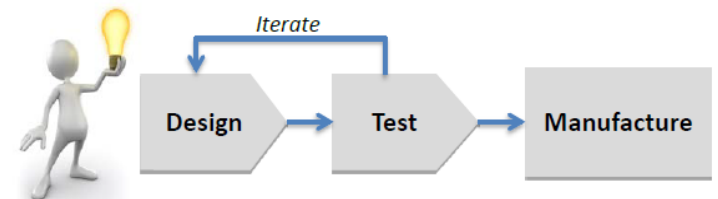
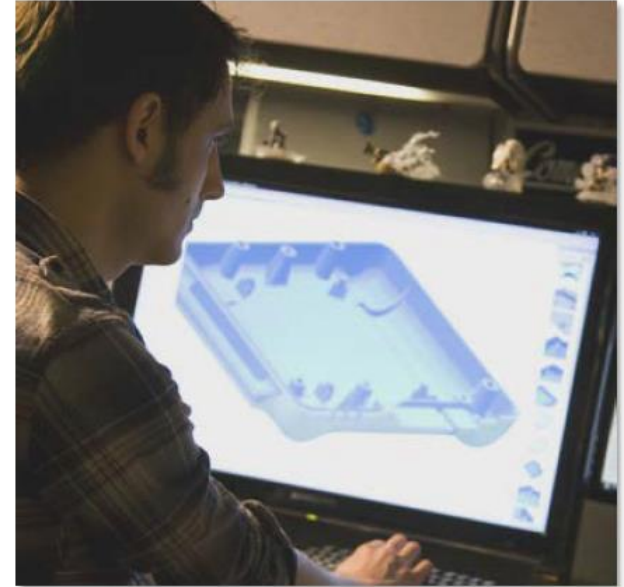
- Founded in 1999 by Larry Lukis.
- Headquartered near Minneapolis, MN.
- 7 manufacturing facilities (US, UK, Japan).
- Publicly-held corporation as of February 2012.
- ISO-9001:2008 Registered.

PRLB
LISTED
NYSE



WHO WE SERVE

- Product developers and engineers.
- Medical device development and other medical applications are a key customer segment.
- Our mission is to help product developers get to market sooner, through quick-turn prototyping and on-demand manufacturing.
- We manufacture parts in days, sometimes as fast as **same** day!



OUR SCALE...

300+
CNC Mills

170+
Molding Presses

50+
Industrial 3D Printers

U.S. PRODUCTION STATS

- Roughly new 250 injection molds/week.
- Roughly 500,000 production plastic parts/week of roughly 250 different part numbers.
- Roughly 1,200 injection molding and CNC machining quotes/day, including re-quotes.
- Roughly 8,000 CNC machined plastic and metal parts/day, of roughly 2,300 different part numbers.
- Roughly 7,500 3D printed parts/week of roughly 1,000 different part numbers.

SUITE OF MANUFACTURING SERVICES

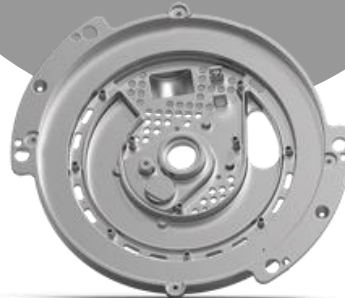
3D PRINTING

Stereolithography
Direct Metal Laser Sintering
Selective Laser Sintering



CNC MACHINING

Three-Axis Milling
Turning with Live Tooling



INJECTION MOLDING

Plastic Injection Molding
Liquid Silicone Rubber Molding
Metal Injection Molding
Magnesium Injection Molding



ADDITIVE MANUFACTURING

- Manufacturing the un-manufacturable.
- Choosing the right process and material for your application.
- Outsourcing versus investing in own equipment.
- Mass customization opportunities in orthopedics, prosthesis and dentistry.

3D PRINTING

Stereolithography
Direct Metal Laser Sintering
Selective Laser Sintering



1-50+ Parts in 1-7 Days.
Starting @ \$95.00

CNC MACHINING

- Accelerate development by prototyping multiple design iterations at once.
- Engineering-grade materials in plastics and metals.
- Get to clinical trials and regulatory approvals quicker by cutting design time in half.
- Automation, capacity, and capability to machine parts in quantities of 1 - 200 in as fast as 24 hours.

CNC MACHINING

Three-Axis Milling
Turning with Live Tooling



1-200+ Parts in 1-3
Days. Starting @ \$65.00

INJECTION MOLDING

- Prototype using the same process and materials used in production.
- Fast-track development by incorporating Design for Manufacturability (DFM) feedback into your product development process.
- Get to trials quicker by using soft tooling to make sample parts.
- Bridge tool, on-demand manufacturing and end-of-life planning.

INJECTION MOLDING

Plastic Injection Molding
Liquid Silicone Rubber Molding
Metal Injection Molding
Magnesium Injection Molding



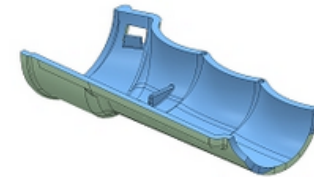
25-10,000+ Parts in 1-15 Days.
Molds starting @ \$1495.00

AUTOMATED ONLINE QUOTING

- Price estimates within hours.
- Interactive quotes with real time updates to price.

PROTOQUOTE®

Prepared for:
ABC Design Co
Quote Number: 173644 Quote Date: 6/23/2015
Part Name/Number: **Sample Part**
Extents: 2.987 in x 1.596 in x 0.733 in



[View in 3D](#)

① Confirm or Modify Specifications and Review Pricing

Cavities:	<input type="text" value="1 cavity"/>
A-side (green) finish:	<input checked="" type="checkbox"/> <input type="text" value="PM-F0 (Non-cosmetic - finish to Protomold discretion)"/>
B-side (blue) finish:	<input checked="" type="checkbox"/> <input type="text" value="PM-F0 (Non-cosmetic - finish to Protomold discretion)"/>
Tooling Price: \$1,925.00	
Sample Quantity:	<input type="text" value="25"/> <input type="button" value="Sample Parts 25 @ \$2.48:"/>
Material:	<input checked="" type="checkbox"/> <input type="text" value="ABS/PC, Black (Bayblend T85 XF-901510)"/> <input checked="" type="checkbox"/> <input type="button" value="Change Material Color"/>
<small>The selected material is not compatible with added colorants</small>	
Lead Time:	<input checked="" type="checkbox"/> <input type="text" value="Sample parts ship in 3 business days (expedite applies)"/>
Expedite Fee: \$1,925.00	

Molded parts can ship in 3 days in this example

Total USD: \$3,912.00

INTERACTIVE DFM ANALYSIS

- Design for Manufacturability (DFM) built into quote.
- Detailed feedback per each feature.
- Flow analysis.

Required Changes (3)

Moldability Advisory (7)

Other Info (3)

The following illustrations indicate changes to the model which are required for compatibility with the Protomold process.

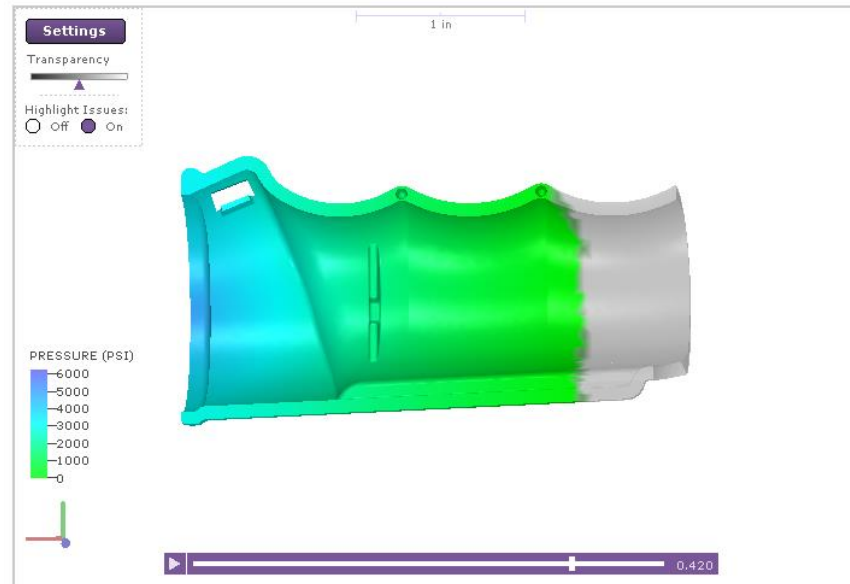
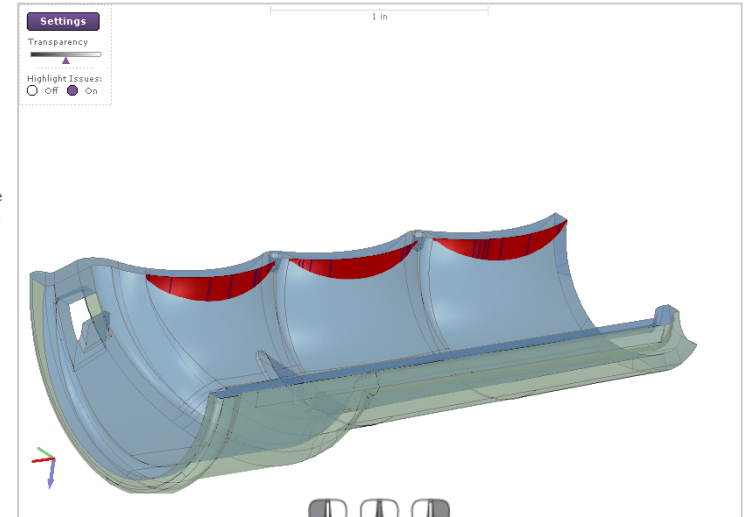
Required Changes:

1. Undercut
2. Minimum thickness
3. Minimum thickness

Undercut

Faces shown in red have undercut portions. Blue lines (if any) indicate undercut regions. We are unable to produce these undercuts with the current Protomold process. For details, clarification, options, or alternatives, please contact a Customer Service Engineer at customerservice@protolabs.com or 877.479.3680.

An updated file is needed to make this part.



[FAQ/Troubleshoot](#)

APPLICATIONS

- Prototyping / Iterative Design:
 - Significantly reduce design phase of produce development cycle by testing multiple designs at once.
- On-demand manufacturing
- Bridge to high-volume production
- End-of-life manufacturing



Economically Manages Volatility of Demand

PROTOTYPING EXAMPLE: Medical Device

Medical device manufacturer was building a surgical device. It needed to select the best design concept from multiple competing ideas for upcoming regulatory review.

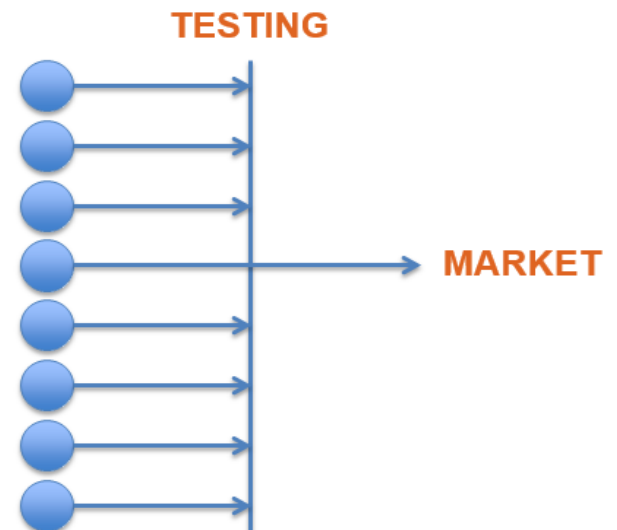
It needed all prototype parts molded, as that is how production parts would be made.

Submitted 8 designs for molded parts. Made 8 molds simultaneously. Made 300 parts off of each in just 10 days.

Was able to test functionality of all 8 designs and pick the best design in order to move forward quicker.

Prototyping Applications

- Concept
- Form/fit/function testing
- Design for manufacturability
- Iterative development



PROTOTYPING EXAMPLE: Consumer Electronics

Consumer electronics manufacturer was building wireless speakers. It needed plastic parts for the cosmetic external housing.

To validate the design early and place an order for production tooling, they needed to test:

- Form and fit
- Function
- Materials

Iterated their design several times, ordering 2,200 parts over 6 months in all.

Successfully launched and delivered to consumer electronics retailer in 9 months.

Prototyping Applications

- Concept
- Form/fit/function testing
- Design for manufacturability
- Iterative development



Not actual part. Image via hometheaterequipment.com

ON-DEMAND EXAMPLE: Industrial Machinery

Industrial manufacturer needed production parts for a machine that sold 3000-5000 units per year.

Annual demand volume was inconsistent on premium priced machines.

Difficulty finding traditional production tooling vendor to support low volume orders without the need to maintain large inventories of parts.

Made 4 tools and produced parts as needed for 7 years, in lots of 50-500 each.

On-demand Applications

- Unpredictable demand
- Lower annual volumes
- No inventory maintenance



Not actual customer machinery. Example courtesy of Wikipedia.org

BRIDGE TOOLING EXAMPLE: Automotive Lighting

Automotive manufacturer needed lenses for production assemblies.

3 molds, 4 cavity molds each made in 15 days. Tooling ordered with intent of bridge tooling lasting 6 months.

Production tooling was not available when expected and the program required parts for 12 months.

Each mold produced 100,000 – 200,000 parts.

Enabled early market entry and active supply chain for a full year while awaiting steel tooling.

Bridge Tooling Applications

- Early market entry
- Pilot runs
- Manage through disruptions in supply chain
- Affordability



Not actual part. Image via ptonline.com

END-OF-LIFE EXAMPLE: Telecommunications

Telecommunications manufacturer needed parts for warranty replacement on a sun-setting product.

Parts were needed immediately to begin field servicing of commercial customers.

Production tooling vendor did not want to support low quantities and had long lead times.

Molds and parts were produced in 10 days. Field service began within 2 weeks and met the demand of warranty schedule.

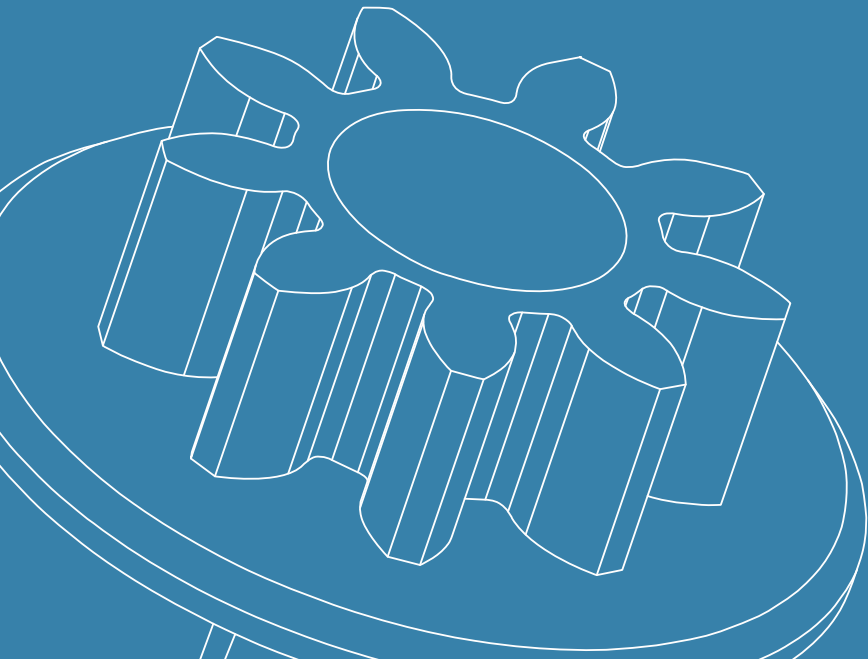
End-of-life Applications

- Unpredictable demand
- Lower annual volumes
- No inventory maintenance



Not actual part. Image via cyfordtechnologies.com

THANK YOU



proto labs[®]
Real Parts. Really Fast.™