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## **Prototyping Overview**

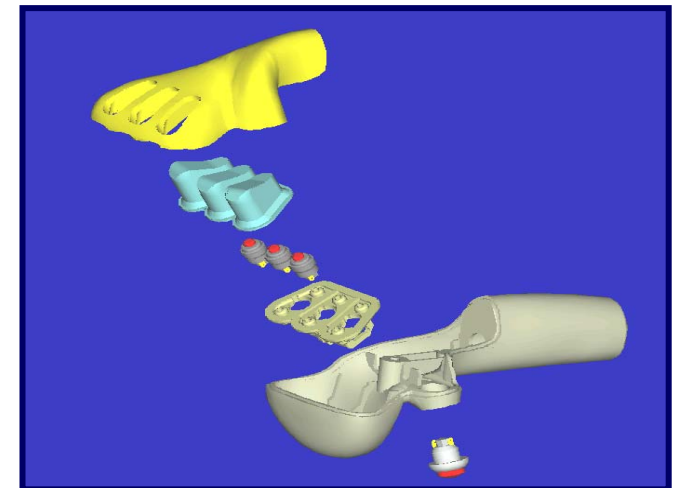
# Prototyping for Mechanical Parts



# Paramount Industries

Started as prototyping vendor,  
then added:

- Industrial Design
- Product Engineering
- Product verification
- Breadboard models
- Computer Animations
- Graphic Design



<b>Rapid Prototyping Chart-</b> 3D data required	Common uses	Material Description	Cost for Ball Tray	Delivery for Ball Tray	Tolerance	Layer height	Surface scale 1-4 fine to coarse
<b>SLA</b> Stereo Lithography Apparatus		liquid photopolymer				0.002- 0.005	
standard	appearance models, casting masters	rigid	\$300	2 days	+/- .002 +/- .005	0.005	1
flex resin	more durable appearance models	flexible	\$300	2 days	+/- .002 +/- .005	0.005	1
<b>SLS</b> Selective Laser Sintering		thermoplastic powder					
Nylon	living hinges, snap fits, functional models	nylon, polyamide	\$250	2 days	+/- .007	0.004	2
Glass Filled Nylon	extremely durable	33% glass filled	\$250	2 days	+/- .007	0.004	2
Somos, elastomeric	soft touch parts	like Santoprene	\$200	2 days	+/- .007	0.004	2
Castform	investment cast masters	styrene/wax	\$300	4 days	+/- .007	0.004	2
<b>FDM,</b> Fuse Deposition Modeling		modeling filament					
ABS	replicate ABS	thermoplastic	\$250	2days	+/- .005 +/- .010	0.005 - 0.016	4
Polycarbonate	replicate PolyCarb	thermoplastic	\$250	2 days	+/- .005 +/- .010	0.01	4
<b>ZCorp</b>	form study models, colors available	starch	\$150	2 days	+/- .005 +/- .010	0.003 - 0.010	3

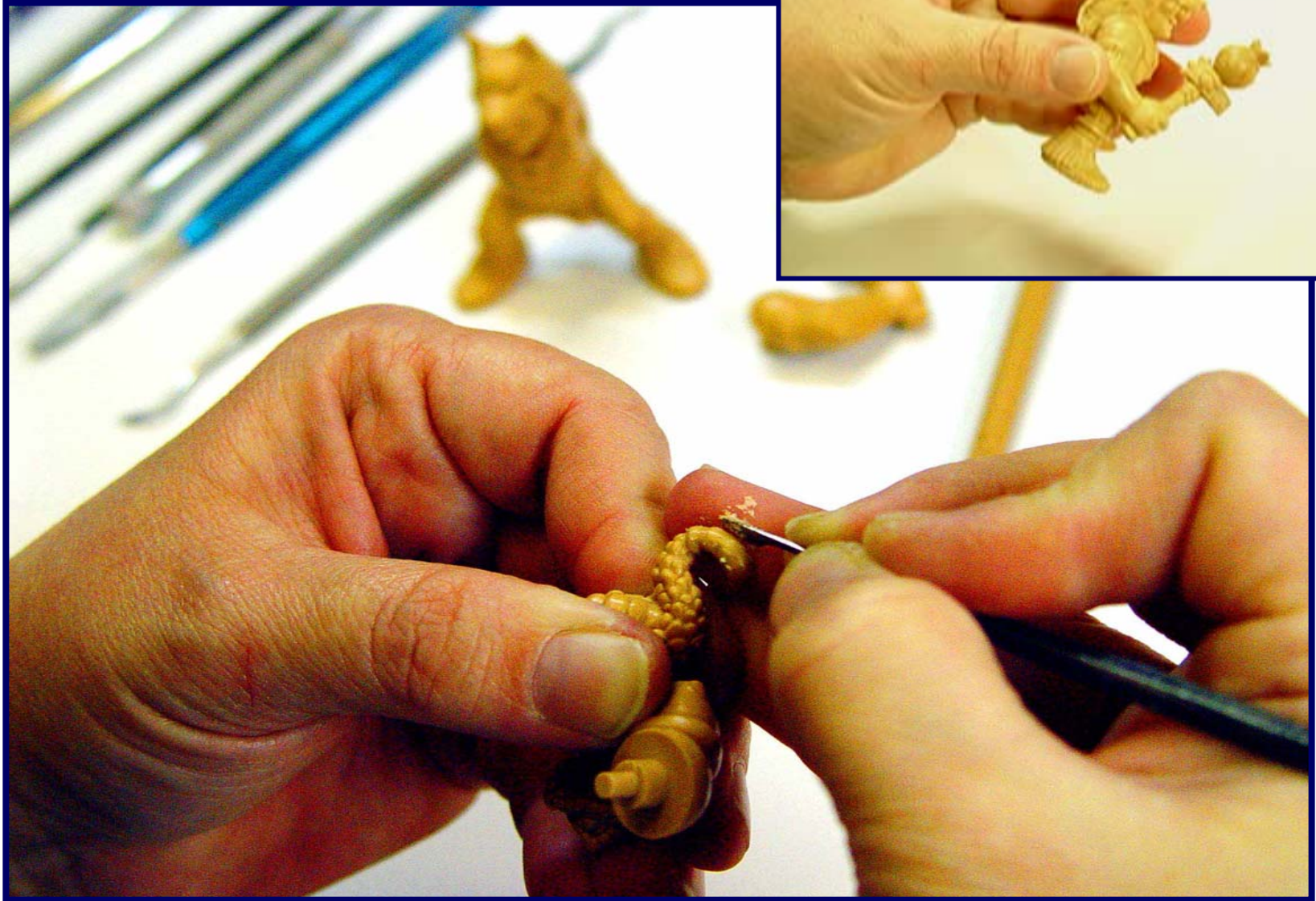


## Rapid Prototyping- SLS

<b>Other Prototyping Methods</b>	Common uses	Benefits	Input/ Process	Delivery	Tolerance	Material characteristics	Quantities
<b>Fabrication</b>							
hand made models	form study models, wax models, breadboard models, LooksLike/WorksLike models	achieve geometry too complex for 3D CAD, multiple materials	napkin sketch to part drawings	complexity dependant	as needed	limitless	1-5
<b>Urethane Castings</b>							
Silicone RTV Molds, cast urethane resins	sales samples, LL/WL models,	replicates production, fast, inexpensive, color	pattern/ cast silicone	1-2 weeks	+/- .001- .100 in/in	rigid, flexible, clear, hollow, insert and co-molding, production <i>like</i> materials	10 - <50
<b>Thermoforming</b>							
Sheet thermoplastics	wall thickness housings, blister packaging	quick, molds and produce many parts	pattern or mold	.5-2 weeks	+/- .010- .060	simple geometry, opaque and clear	prototype & production
<b>Investment Casting</b>							
metal cast process	engineering check models	production materials	pattern	2-4 weeks	material dependant	metals, zinc to titanium	prototype & production
<b>CNC Machining</b>							
Computer numeric controlled machining	engineering check models, strong parts	production materials	part drawings, 3D data	geometry dependant	limitless	all plastic and metals	prototype & production



# Wax Sculpting



# Fabricated Model





# Cast Urethane Samples



# Vacuum Forming



Pattern

Part

# Investment Casting

1. Wax Pattern is created (positive)
  2. Pattern is dipped in ceramic slurry and then fine sand
  3. Assembly is de-waxed by applying heat
  4. Molten metal is poured into shell
- Creates metal parts that are difficult or impossible to machine

# CNC Machining



<b>Prototype Tooling</b>							
	Uses	Benefits	Input/ Process	Delivery	Tolerance	Material characteristics	Quantities
Aluminum	test production materials and part geometry	faster and less expensive than production tooling	2D, 3D data, Pattern/ CNC EDM, pantograph	1-10 weeks	+/- .002 in/in	medium temp thermoplastics	25K- <50k
Pre-Hard Steel (P-20)	same as aluminum, longer tool life, more complex tools, wider range of materials	same as aluminum	2D, 3D data, Pattern/ CNC EDM, pantograph	1-10 weeks	production	all thermoplastics w/ glass	100K - <250K
<b>Production Tooling</b>							
	Uses	Benefits	Input/ Process	Delivery	Tolerance	Material characteristics	Quantities
Hardened Steel, Multi Cavity	all materials	large quantities, lower part cost	2D, 3D data, Pattern/ CNC, EDM, pantograph	complexity dependant	production	all thermoplastics w/ glass	1M +



# Prototype Tooling

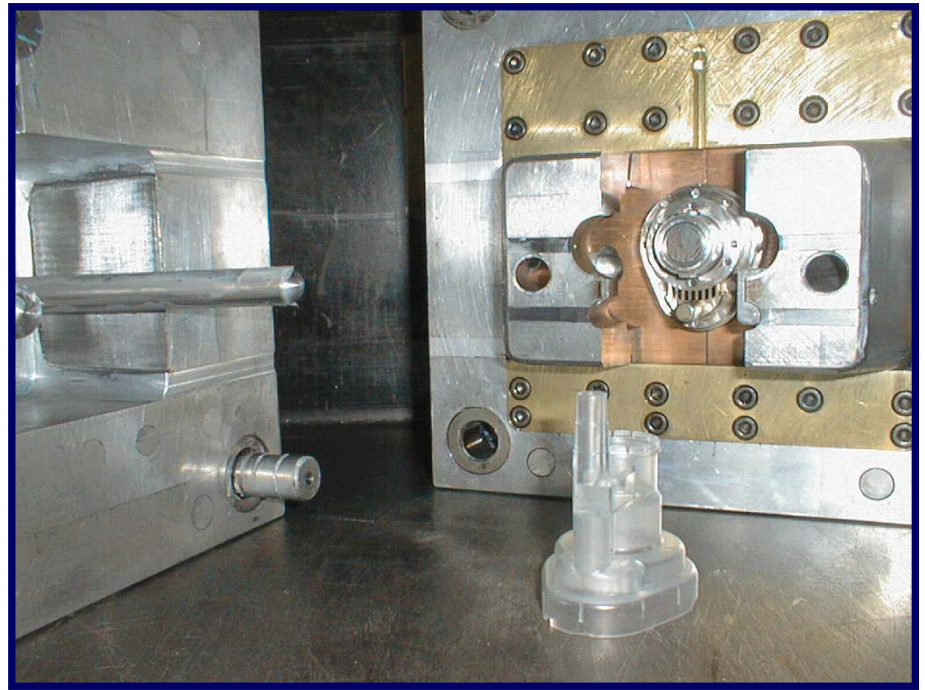




# Prototype Tooling

Aluminum or Pre-hardened Steel

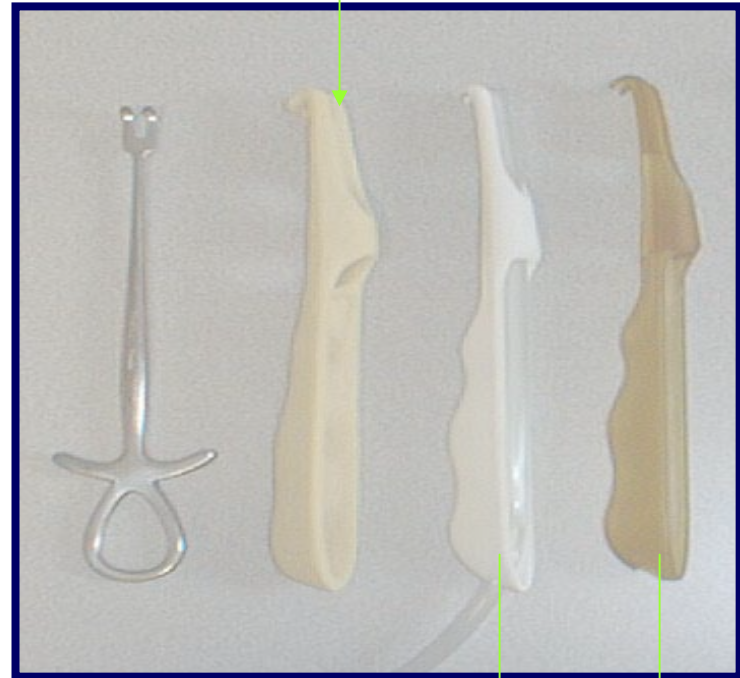
- Process, machined, EDM
- Tool Life: 12 - 250,000
- Benefits:
  - Low volume production
  - High accuracy
  - Most Thermoplastics
- Delivery: 4-6 weeks



# Types of Models

- Concept
  - Functional, bread boards, form
- Looks like model
  - Photography, presentations
- Looks like/ works like
  - Sales samples, market testing
- Tooling patterns
- Engineering check models
  - Confirm geometry,  
test production materials,  
prove function

Foam Study Model



Verification Model SLS

Clinical Trial Prototype,  
Autoclavable GE Ultem: CAM/CNC

# Concept Models

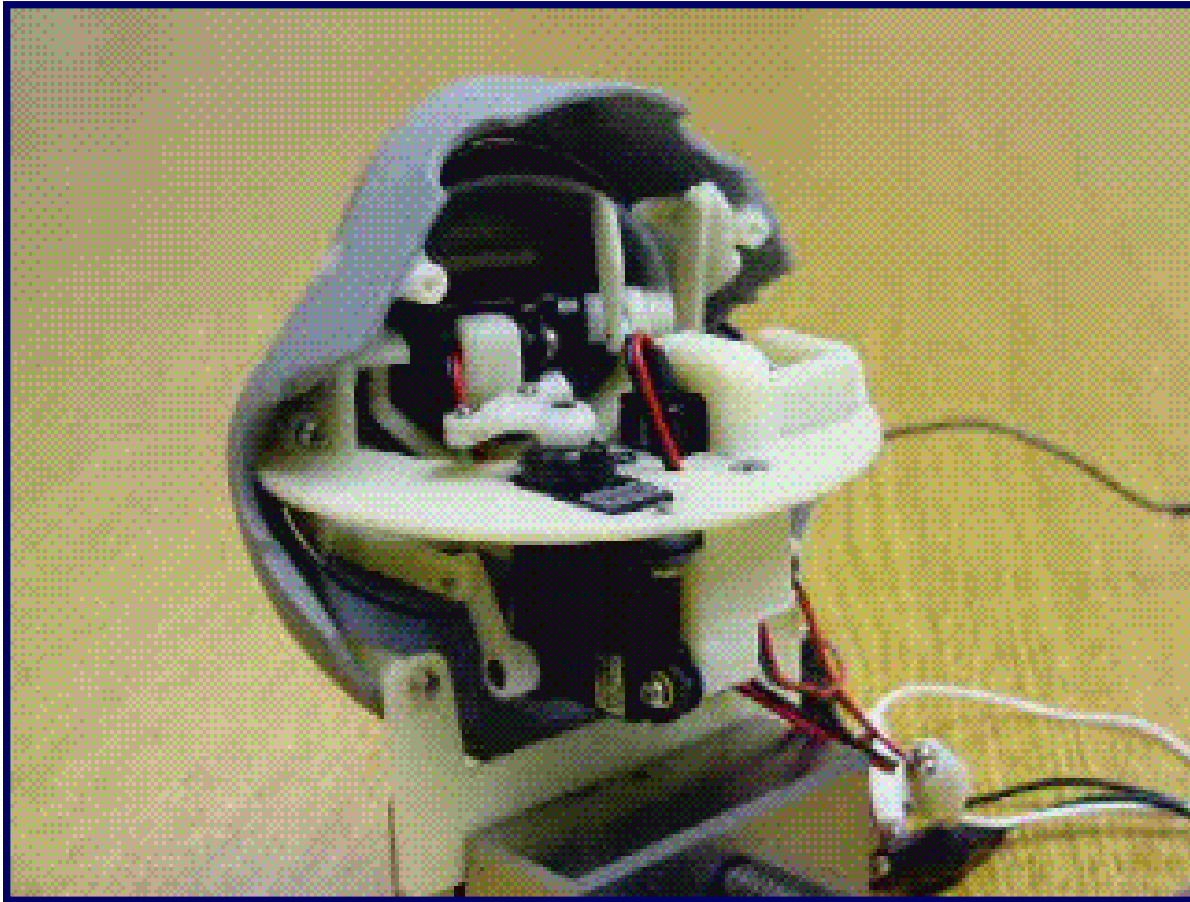
- Purpose; Study scale, develop form, explore ergonomics
- Input; Sketches, verbal description, 3D data
- Process and materials;
  - Hand build, foam, insulation or urethane, foam core, clay, cannibalize existing products
  - Rapid prototyping, Z Corp, SLS, SLA
  - Machining, block, tube and sheet stock
- Tolerances; Not important
- Quantity; Usually ONE

# Concept Model



Handmade foam model to explore form  
Chosen for speed, 3D data not available

# Concept Breadboard Model



Fabricated by hand

Chosen to accommodate many materials

# Looks Like Model (LL Model)

- **Purpose**, aesthetic
  - Shows surface finish; color, clear parts, labels, tactile materials

# Looks Like/ Work Like Model (LL/WL)

- **Purpose**, same as above including functional requirements.
  - Draft included only as it effects the performance.
  - Cored for function only.
  - Materials used to replicate production material performance.
  - Includes batteries, electronics, springs, LEDs .
- **Process and materials.**
  - Rapid prototypes, SLS, SLA.
  - Castings/ urethane, silicone.
  - Machining/ stock plastic.
- **Tolerances**, tight as needed.
- **Quantity**, 1-12.



# Looks Like/ Works Like



SLA master RTV Mold, Cast Urethane  
Chosen for production *like* resins

# LooksLike/WorksLike



Urethane Casting from SLA master and RTV molds  
Chosen to replication production parts in accuracy,  
color and texture

# Tooling Pattern



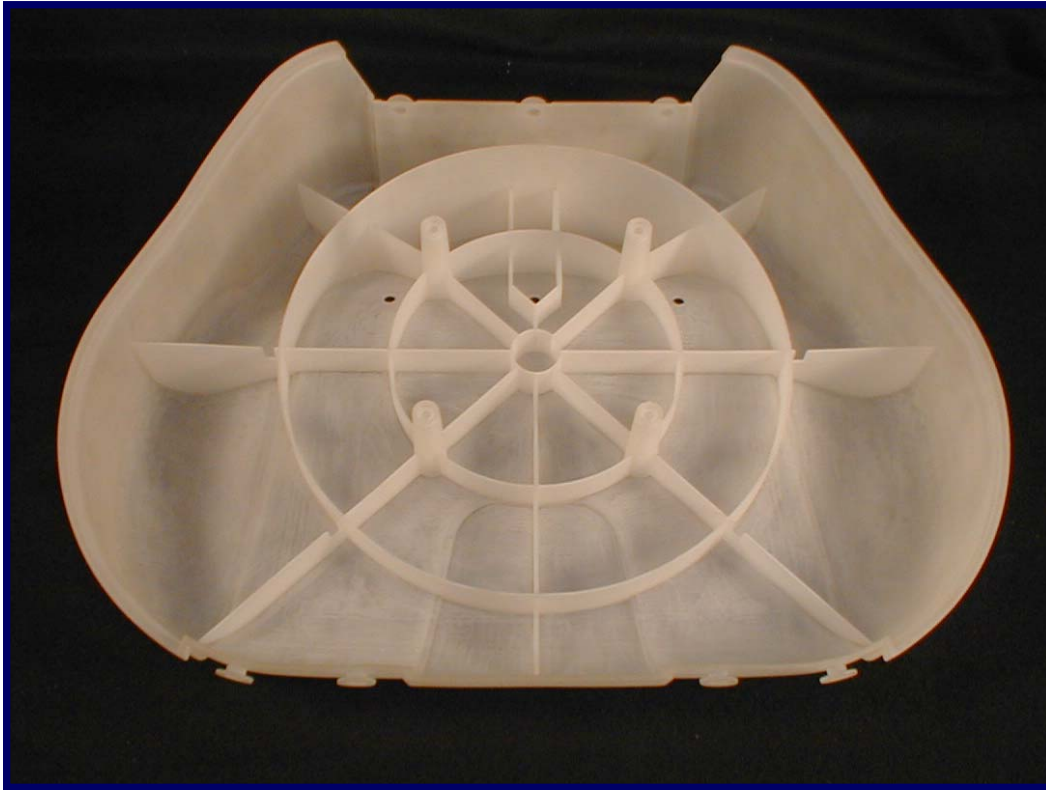
Fabricated by hand

Chosen to accommodate highly complex geometry

# Engineering Models

- Purpose, confirm geometry, test production materials, review function
- Input, 3D data, detailed part drawings
- Process and materials
  - Rapid prototyping/ SLS, FDM, SLA
  - CNC or machined/ production materials
  - Prototype molds/ production materials
- Tolerances, critical
- Quantity, usually ONE

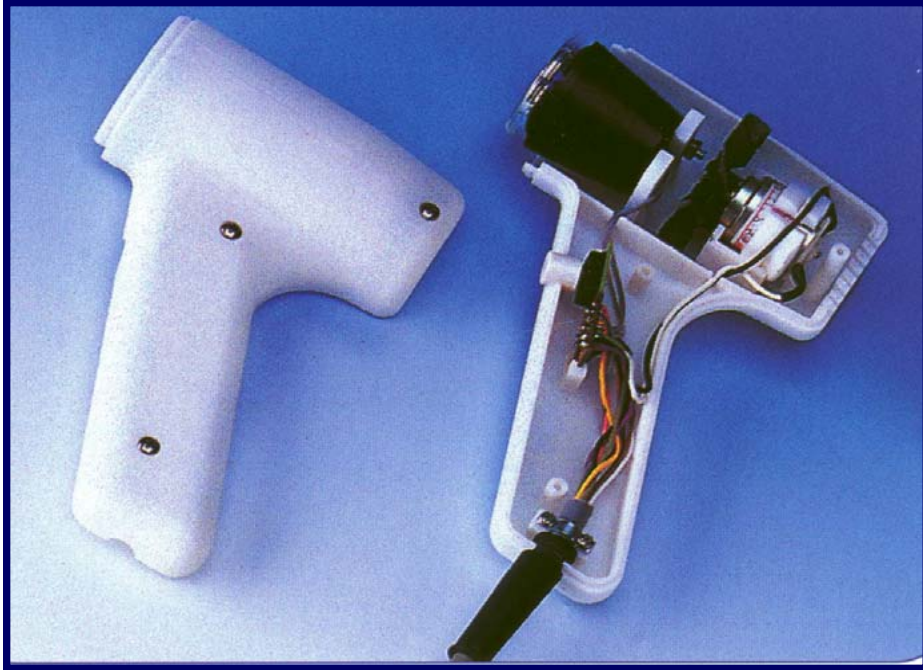
# Engineering Model



Rapid Prototype, SLA

Chosen for accuracy and speed

# Engineering Model

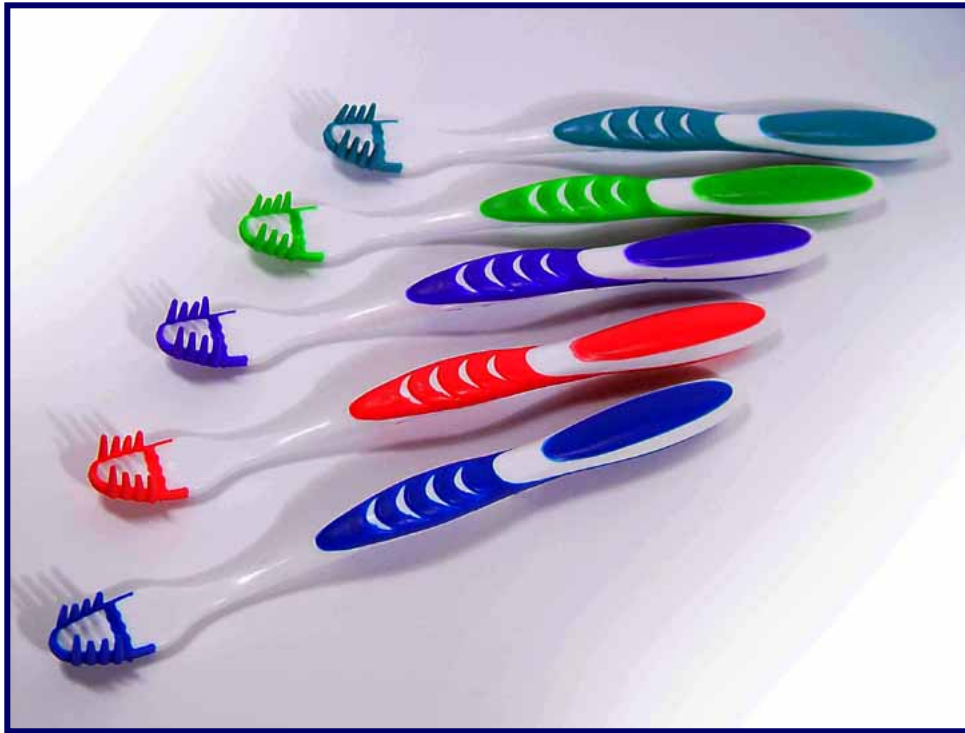


Rapid Prototype, SLS Glass Filled Nylon

Chosen for durability to withstand testing



# Prototype Molded Parts



Aluminum Prototype Injection Mold

Chosen to prove material adhesion and for market testing

# Qualifying your prototyping needs

- What type of model do you need?
- What type of input do you have?
  - sketches, control drawings, 3D data
- Is the production material required?
- What are the tolerances?
- How many do you need?
- When do you need it?
- Are you working within a budget?

# PD Efficiency

## **The right questions will improve PD efficiency**

- Identify risk in your project
- Formulate questions, that if answered, will reduce/eliminate risk
- Use models/prototypes to get the answers
- Target individual questions at first.

Repeat as necessary.

Can use other tools to answer questions.

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