Comparison of Rapid Prototyping Processes - Various Applications

COMPRESSION

The following chart is directional only and should be viewed as a guideline as you begin your selection of the right RP process to use. Each part is unique and should be reviewed with your supplier.

	STEREO LITHOGRAPHY	SLS - POLYCARBONATE	SLS - FINE NYLON	SLS - PROTOFORM	SLS - TRUEFORM	FUSED DEPOSITION MODELING - ABS	SOLID GROUND CURING	CIRP
Tight tolerance	Best	Fair - Good	Poor - Fair	Poor - Fair	Good	Good	Good - Best	Good - Best
Fine detail	Best	Fair	Good	Good	Best, but parts are extremely fragile	Poor	Best	Good
Investment Casting Patterns - Need to consult foundry for preference	Good due to fine detail. Parts can be difficult to seal	Fair due to rough surface and dimensional inaccuracy	Not applicable	Not applicable	Good due to ease of burnout	Not applicable	Not applicable	Styrene Available
Large parts	Best	Poor for all SLS processes due to the small build envelope. Parts built in separate builds can have significant tolerance issues.				Poor due to limits of machine	Good	Not applicable (Best for parts 2 1/2" x 2 1/2" or smaller)
Speed	Good, except for parts with large cross sections	Best	Fair	Fair	Poor	Best, for small parts	Good - Best	Good (Best in material of choice)
Marketing models (high aesthetic need)	Best	Poor	Good	Good	Good, but extremely weak	Poor	Best	Fair - Good
Small gears	Best	Poor	Good if extra time is taken to scale and finish part to get detail necessary for teeth	Good if extra time is taken to scale and finish part to get detail necessary for teeth	Best due to detail for teeth, but extremely weak	Best right out of the build	Best	Good (Moderate - simple geometry)
Snap fits	Fair - Good. Depending on deflection	Not applicable	Best for single part needs	Fair - Good due to brittleness	Not applicable	Good	Fair - Good	Best for multiple, small parts
Living hinges	Not applicable	Not applicable	Good	Not applicable	Not applicable	Not applicable	Not applicable	Best
Bottles	Good	Fair	Best	Good	Poor	Limited to very small bottles with thicker walls	Good	Not applicable
Limited functionality	Good	Poor - Fair	Best for flexural needs	Best for high impact and heat deflection needs	Not applicable	Best for small gear parts	Good	Excellent
Thin walled parts	Best	Fair	Good	Good	Best, but extremely fragile	Over .030" only	Good	Over .030" only
Chemical resistance	Poor	Fair	Good	Good	Not applicable	Same resistance as its production counterpart	Fair	Best

For the complete Comparison of Rapid Prototyping Processes, please call toll-free 1-888-SPD-2MKT.

Commercial Technologies

The following are brief summaries of some rapid prototyping technologies available for commercial application.

Laminated Object Manufacturing
Helisys Inc., Torrance, CA.
Process: A thermally activated bonding agent laminates sheets of material, and a CO_2 laser scans the contour of each part layer and cuts away the unused material. Materials are relatively inexpensive and buildup is rapid. Post processing is not required.

Selective Laser Sintering
DTM Corp., Austin, TX.
Process: Models are constructed one layer at a time by a modulated 50-W CO_2 laser that sinters a thin layer of powdered material in an area defined by the geometry of the part. Some post-processing is required.

Stereolithography
3D Systems Inc., Valencia, CA.
Process: Depending on the system, a helium-cadmium laser (ranging from 20-35 mW) or a 200-mW argon-ion ultraviolet laser cures a liquid polymer (layer by layer) on a platform that is submerged in a vat of liquid polymer. Vertical support structure members are needed for extreme horizontal overhangs. Postcuring processing is a function of finish and detail. Engineers have developed a variation of stereolithography (called QuickCast) to build plastic patterns for direct shell investment casting in metal.

Fused Deposition Modeling
Stratasys Inc., Eden Prairie, MN.
Process: An extruding head deposits a continuous filament of thermoplastic polymer or wax at a temperature just above the material's flow point. Models are constructed layer by layer. Horizontal overhangs require no supporting structures.

Solid Ground Curing
Cubital America Inc., Troy, MI.
Process: A photomask covers incremental layers of liquid photopolymer that are cured with a 2-kW ultraviolet lamp. No support structure or postcuring is needed.

Direct Shell Production Casting
Soligen Inc., Northridge, CA.
Process: Ceramic shell—complete with integral cores—is manufactured automatically and directly from a CAD file without tooling or patterns of any kind. It creates the equivalent of ceramic shells made for investment casting by dipping a wax assembly into a ceramic slurry. There is no need for tooling or setup.

sections.

A focused laser beam, positioned by the X-Y system, cuts around the peripheries of the cross sections at speeds up to 15 ips according to geometrical information provided by the computer.

Models, prototypes, and patterns for investment and sand castings can be created. The company also offers prototyping services using its LOM technology.

Direct Shell Production Casting

This process is one in which the ceramic shell—complete with integral cores—is manufactured automatically and directly from a CAD file without tooling or patterns. It is a turn-key process that allows parts designed on a computer screen to be fabricated by simply pouring molten metal. It provides a complete solution, from customer's design data acceptance through mold design and production.

DSPC creates the equivalent of ceramic shells made for investment casting by dipping a wax assembly into a ceramic slurry. Because it eliminates the need for a wax pattern and since there is no need for tooling or setup for creating the ceramic molds, DSPC combines the advantages of casting and computerized numerical control (CNC) machining in a unique process for fabricating metal parts.

The Parts Now unit of Soligen Technologies Inc. recently achieved what it believes to be a new record in producing functional metal parts using DSPC.

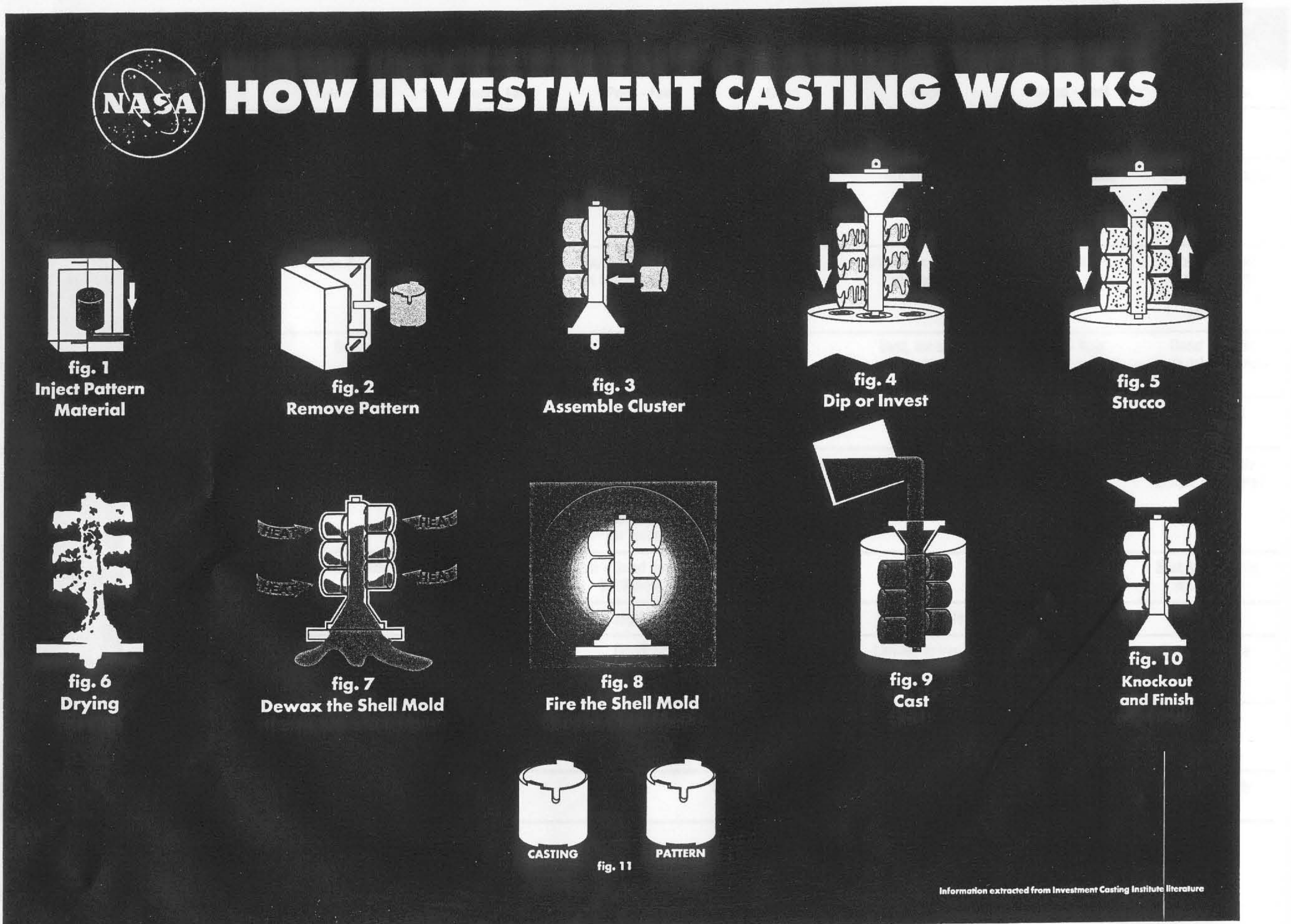
Caterpillar Inc. had approached Soligen with the need for a complex engine component within one week. The part design was sent to Soligen via modem on a Wednesday evening. By Friday, the DSPC system had completed two casting shells. On Monday, the parts were cast in A356 aluminum, heat treated on Tuesday, and finish machined on Wednesday. That same day the parts were shipped overnight to Caterpillar for installation on an engine.

Another company, DTM Corp., reports that its SLS process is compatible for use with actual investment casting wax. Sunstrand Power Systems, San Diego, CA, has used SLS to produce polycarbonate casting patterns for a new inlet housing design.

A rapid prototyping technology that has direct metalcasting applications is a variation of 3-D Systems' stereolithography process called QuickCast. The process uses a proprietary epoxy resin that withstands the ceramic moldmaking environment of investment casting better than traditional stereolithography materials. Instead of building a part that is solid plastic, a part constructed by the QuickCast method is two-thirds hollow with a honey-combed internal structure, which permits the plastic to collapse upon itself during investment casting wax burnout instead of expanding and cracking the shell mold.

FOUNDRY MANAGEMENT & TECHNOLOGY
Articles with More Information About
Rapid Prototyping

- "Subtractive Rapid Prototyping Techniques Define Their Niche," Doyle Skinner and Ron Gustafson, September 1997, p.74.
- "NASA Partnership Aims to Overcome Aerospace Casting Barriers," July 1997, p. 47. (T/D).
- "Encouraging Results from Computer-Aided Rapid Prototyping," April 1997, p. 62. (T/D).
- "Lead Time Compression at Wyman-Gordon," March 1997, p. 20. (O/R)
- "Italian Foundry Reduces Wood Pattern Use," September 1996, p. 94. (O/R)
- "Rapid Prototyping Update," June 1996, p. 39.
- "Patternmaker/Foundry Speeds Prototype Production," April 1996, p. 102. (O/R)
- "Good I-DEAS for Investment Caster," February 1996, p. 62. (O/R)


NASA
HOW INVESTMENT CASTING WORKS
fig. 1
Inject Pattern Material
fig. 2
Remove Pattern
fig. 3
Assemble Cluster
fig. 4
Dip or Invest
fig. 5
Stucco
fig. 6
Drying
HEAT
fig. 7
Dewax the Shell Mold
fig. 8
Fire the Shell Mold
fig. 9
Cast
fig. 10
Knockout and Finish
CASTING
PATTERN
fig. 11
Information extracted from Investment Casting Institute literature