Selecting the Right Rapid Prototyping System

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Brief History

When I started in the rapid prototyping industry with 3D Systems in March of 1989 it was just months after the very first SLA system, the SLA-1, was introduced at the Autofact Show in Detroit in 1988. This first rapid prototyping system was invented by Chuck Hull, an engineer trained in photosensitive polymers. SLA systems use a vector scanning laser to cure one thin layer of liquid photopolymer at the free surface of a vat. The Z-stage indexes down and the laser then constructs the next layer. The early adopters of this revolutionary technology included GM, Baxter, AMP, Pratt & Whitney, and Apple Computers (among others). These early pioneers pushed the technology to new heights by offering 3D Systems valuable feedback on what was truly needed — significantly improved accuracy.

Layer additive rapid prototyping companies emerged in the early 1990's offering additional technology choices. DTM, along with the University of Texas, developed Selective Laser Sintering. Here a laser beam is used to precisely sinter (or melt) nylon powder one thin layer at a time. Stratasys soon offered Fused Deposition Modeling. A thermoplastic spool is melted at the nozzle and deposited with a XY plotter style motion.

Just after the year 2000 two more technologies emerged, digital light projection and PolyJet. EnvisionTec developed a photopolymer technology using digital light projection. Very small mirrors (like those used in LCD Projectors) are accurately positioned to selectively cure the free surface of a liquid photopolymer. PolyJet™ from Objet utilizes conventional print-head technology to deposit a photopolymer and quickly cure it one layer at a time with UV exposure. This is the first technology with the ability to deposit two separate materials—allowing users to dial in desired surface hardness and shades of grey.

Selecting the Right RP Technology from a Service Provider

Table 1 below identifies the most popular current rapid prototyping methods for: consumer electronics, business products, defense, aerospace, and automotive. In the right hands, these technologies will reduce development time, thus shortening time to market. Furthermore, better products are released and costly mistakes are identified and corrected before they become a real problem.

Table 1 - Rapid Prototyping Technologies

Layer Additive RP Technologies	Material
Stereolithography (SLA)	Photopolymer
Selective Laser Sintering (SLS)	Thermoplastics, metals (particles)
Fused Deposition Modeling (FDM)	Thermoplastics, Eutectic metals
Digital Light Projection (DLP)	Photopolymer
PolyJet™	Photopolymer
3D Printing (3DP)	Various
Electron Beam Melting (EBM)	Titanium alloys
Laminated Object Manufacturing (LOM)	Paper, vellum
Other Popular RP Technologies	**Material**
Cast Urethane	Various polyurethanes
QuantumCast™	Advanced Formula Polymers (AFP)
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CNC	Various

The first step is to select a reputable service provider that offers a breadth of RP solutions. This protects the customer from getting a solution that is force fit, like a size 6 shoe on a size 10 foot. Each project has a separate set of important requirements. Skilled project engineers can quickly match the solution that best fits each unique project. Sometimes delivery is the driving factor, other times mechanical properties drive the decision. Often final product testing and early market trials are accomplished with CNC'd prototypes and/or QuantumCast enclosures. So, when considering RP options, it is best not to limit oneself to only layer additive methods.

For small quantities, when mechanical properties drive the decision, CNC is often a very good solution. Skilled CNC programmers can turn projects quickly and deliver prototypes fabricated with: Polycarbonate, Polycarbonate with 20% glass fill, ABS, Delrin, PEEK, Ultem 1000, and other popular materials suitable for electronic enclosures.

For intermediate quantities (i.e., 5 to 50) with stout mechanical performance requirements, a popular proven solution is QuantumCast™ (figure 1). This next generation cast urethane technology offers a variety of high performance characteristics like high heat deflection temperatures, high flex modulus, and at the same time high impact strength. Threaded insert strength is often an issue. QuantumCast™ offers a proprietary technique for securing threaded inserts (figure 2) with twice the strength of adhesive bonding.

Purchasing an RP System

There are many choices ranging from a Desktop Factory 3D printer for under $5,000 to a high end Direct Digital Manufacturing System for about $750,000. In any case, it is prudent to perform an ROI examining all the costs of ownership. Some of the costs to consider are: the purchase price of the system with applicable taxes, the cost of the materials (material waste should be understood), maintenance costs, consumables not covered by maintenance contract (like print heads, lasers, etc.), labor to prepare build files, labor to clean parts (remove supports, sand, finish, paint, assemble, etc.), electricity, and any special environment for the system (some need labs, some are noisy).

Finally, a good question to ask is: Is the system sufficiently versatile enough to satisfy the majority of your in-house needs?

Figure 1 *– QuantumCast™ with soft over-mold.*

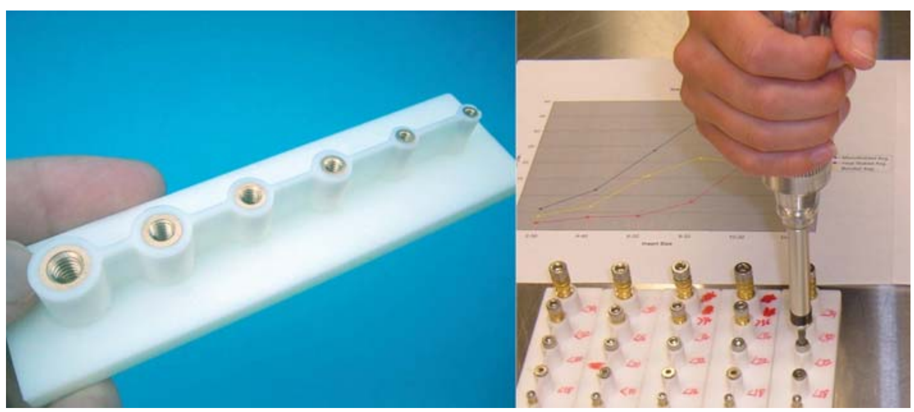

Figure 2 *– Secure threaded inserts using QuantumCast™, shown testing pull-out strength.*