Reverse engineering

Engineering

The manufacturers should be capable In delivering products In fulfilling the total satisfaction of customers, product In higher quality, short delivery mime, at reasonable cost & fulfill all the safety requirements, Rapid Prototyping technology employ various engineering, computer control & software techniques Including laser, optical scanning, photosensitive polymers, material extrusion & deposition, powder metallurgy, etc. To directly produce a physical model layer by layer (Layer Manufacturing) in accordance with the geometrical data derived from a AD CAD model.

RPR can deliver working prototype at the early design stage of the new product cycle so manufacturers can use the working prototypes in bridging a multi- spindled team composed of the marketing, design, engineering & manufacturing people to design right at the first instance in catering for the customers. The term rapid prototyping (RPR) refers to a class of technologies that can automatically construct physical models from Computer-Laded Design (CAD) data. These " three dimensional printers" allow designers to quickly create tangible prototypes of their designs, rather than Just two-dimensional pictures.

Such models have numerous uses. They make excellent visual aids for communicating Ideas with co-workers or customers. In addition, prototypes can be used for design testing. For example, an aerospace engineer might mount a model airfoil in a wind tunnel to measure lift and drag forces. Designers have always utilized prototypes; RPR allows them to be made faster and less expensively. Keyboards: rapid prototyping, techniques, qualitative features, applications. 1 Rapid Prototyping The term rapid prototyping (RPR) refers to a class of technologies that can automatically construct physical models from Computer-Laded Design (CAD) data.

In addition to prototypes, RPR techniques can also be used to make tooling (referred to as paid tooling) and even production-quality parts (rapid manufacturing). For small production runs and complicated objects, rapid prototyping Is often the best manufacturing process available. Of course, " rapid" is a relative term. Most and complexity of the object. This may seem slow, but it is much faster than the weeks or months required to make a prototype by traditional means such as machining. These dramatic time savings allow manufacturers to bring products to market faster and more cheaply.

In 1994, Pratt & Whitney achieved " an order of magnitude [cost] reduction, time savings of 70 to 90 percent" by incorporating rapid rotating into their investment casting process. 2 The Basic Process Although several rapid prototyping techniques exist, all employ the same basic five- step process. The steps are: 1 . Create a CAD model of the design 2. Convert the CAD model to SST (extraterritoriality) format 3. Slice the SST file into thin cross-sectional layers 4. Construct the model one layer a top another 5.

Clean and finish the model CAD Model Creation: First, the object to be built is modeled using a Computer-Aided Design (CAD) software package. Solid meddlers, such as Pro/Engineer, tend to represent 3-D objects more accurately than wire-frame meddlers such as Autocrat, and will therefore yield better results. The designer can use a pre-existing CAD file or may wish to create one expressly for prototyping purposes. This process is identical for all of the RPR build techniques. Conversion to SST Format: The various CAD packages use a number of different algorithms to represent solid objects.

To establish consistency, the SST (extraterritoriality, the first RPR technique) format has been adopted as the standard of the rapid prototyping industry. The second step, therefore, is to convert the CAD file into SST format. This format represents a three-dimensional surface as an assembly of planar triangles, " like the facets of a cut Jewel. " The file contains the coordinates of the vertices and the direction of the outward normal of each triangle. Because SST files use planar elements, they cannot represent curved surfaces exactly.

Increasing the number of triangles improves the approximation, but at the cost of bigger file size. Large, complicated files require more time to pre-process and build, so the designer must balance accuracy with manageability to produce a useful SST file. Since the . TTL format is universal, this process is identical for all of the RPR build techniques. Slice the SST File: In the third step, a pre-processing program prepares the SST file to be built. Several programs are available, and most allow the user to adjust the size, location and orientation of the model.

Build orientation is important for several reasons. First, properties of rapid prototypes vary from one coordinate direction to another. The pre-processing software slices the SST model into a number of layers from 0. 01 mm to 0. 7 mm thick, depending on the build technique. The program may also generate delicate features such as overhangs, internal cavities, and thin-walled sections Layer by Layer Construction: The fourth step is the actual construction of the part. Using one of several techniques RPR machines build one layer at a time from polymers, paper, or powdered metal.

Clean and Finish: The final step is post-processing. This involves removing the prototype from the machine and detaching any supports. Some photosensitive materials need to be fully cured before use. Prototypes may also require minor cleaning and surface treatment. Sanding, sealing, and/or painting the model will improve its appearance and durability. 3 Rapid Prototyping Techniques Most commercially available rapid prototyping machines use one of six techniques. At present, trade restrictions severely limit the import/export of rapid prototyping machines, so this guide only covers systems available in the U.

S. 3. 1 Extraterritoriality Patented in 1986, extraterritoriality started the rapid prototyping revolution. The technique builds three-dimensional models from liquid photosensitive polymers that solidify when exposed to ultraviolet light. As shown in the figure below, the model is built upon a platform situated Just below the surface in a vat of liquid epoxy or certainness. A low-power highly focused UP laser traces out the first layer, solidifying the model's cross section while leaving excess areas liquid. Next, an elevator incrementally lowers the platform into the liquid polymer.

A sweeper re-coats the solidified layer with liquid, and the laser traces the second layer atop the first. This process is repeated until the prototype is complete. Afterwards, the solid part is removed from the vat and rinsed clean of excess liquid. Supports are broken off and the model is then placed in an ultraviolet oven for complete curing. Figure 1 : Extraterritoriality. 3. 2 Laminated Object Manufacturing In this technique, developed by Helices of Torrance, CA, layers of adhesive-coated sheet material are bonded together to form a prototype.

The original material consists of paper laminated with heat-activated glue and rolled up on spools. As shown in the figure below, a feeder/collector mechanism advances the sheet over the build platform, where a base has been constructed from paper and double-sided foam tape. Next, a heated roller applies pressure to bond the paper to the base. A focused laser cuts the outline of the first layer into the paper and then cross-hatches extra material, making it easier to remove during post-processing. During the build, the excess material provides excellent support for overhangs and thin-walled sections.

After the first layer is cut, the platform lowers out of the way and fresh material is advanced. The platform rises to slightly below the previous height, the roller bonds the second layer to the first, and the laser cuts the second layer. This recess is repeated as needed to build the part, which will have a wood-like texture. Because the models are made of paper, they must be sealed and finished with paint or varnish to prevent moisture damage. 3. 3 Selective Laser Sintering Developed by Carl Declared for his master's thesis at the University of Texas, selective laser sintering was patented in 1989.

The technique, shown in Figure 3, uses a laser beam to selectively fuse powdered materials, such as nylon, lassoer, and metal, into a solid object.

Parts are built upon a platform which sits Just below the surface in a bin of the heat-fusible powder. A laser traces the pattern of the first layer, sintering it together. The platform is lowered by the height of the next layer and powder is reapplied. This process continues until the part is complete. Excess powder in each layer helps to support the part during the build.

SSL machines are produced by DAM of Austin, TX. Figure 2: Schematic diagram of selective laser sintering. 4. Applications of Rapid Prototyping Technology Extraterritoriality - Rapid manufacturing of small detailed parts, Patterns for investment casting Laser Sintering - Rapid manufacturing of parts, including larger items such as air ducts Patterns for investment casting Scanning Applications These are more efficient in the production process by producing digital AD models of manufactured parts when a blueprint is not available in order to remunerate the part.

To reverse engineer a non-metallic part, the part is scanned and transformed into a wire mesh model format in real-time. There is no need for an additional step to image is dimensioned and can be exported into a CAD program for accurate production. Facts does not require an articulating arm, reflector markers to be placed on the object, or the object be placed on a turn table. This hand held, free- form method creates tremendous flexibility in terms of the types of objects which can be scanned. Future Developments Many RPR companies and research labs are working to develop new materials. For example, the University of Dayton is working with Helices to produce ceramic matrix composites by laminated object manufacturing. An Advanced Research Projects Agency / Office of Naval Research sponsored project is investigating ways to make ceramics using fused deposition modeling. As mentioned earlier, Sandra/Standard's LENS system can create solid metal parts. These three groups are Just a few of the many working on new RPR materials.