What is Direct Digital Manufacturing?

Posted by Waldo - 2011/11/15 14:25

THE NEXT INDUSTRIAL REVOLUTION?

No matter what name it goes by; Direct Digital Manufacturing , Additive manufacturing , Additive Free-form Fabrication , Solid Free-form Fabrication, Rapid Prototyping , Layered manufacturing or 3D printing; its hip, cool and the newest thing. This technique physically constructs or manifests 3D geometries directly from 3D CAD models. The history of the process begins in the mid-1980s. It was originally known as Rapid Prototyping because the technology was used exclusively to make Prototypes of parts without having to invest the time or resources to develop tooling or other traditional methods. As the process and quality controls have evolved, the market for additive manufacturing has grown to include production applications and consumer products.

Additive Manufacturing or Direct Digital Manufacturing is an extension of Rapid Prototyping to real parts for use as final products (not prototypes). As of 2010, the equipment has become competitive with traditional manufacturing techniques in terms of price, speed, reliability, and cost of use. This has led to the expansion of its use in industry. There has been explosive growth in the sales and distribution of the hardware. A new industry has emerged to create software to enable more effective use of the technology, one use of which is the customization of products for consumers. The number of materials that the industry uses increased greatly in the decade. Modern equipment can utilize a broad array of Plastics and Metals .

As the speed, reliability, and accuracy of the hardware improves, additive manufacturing may replace or complement traditional manufacturing in creating end-use products. One advantage often cited is that Additive manufacturing eliminates much of the labor associated with traditional manufacturing. With 3D printing, you send the file to the machine and leave while it works. Another often cited example is that production can make any number of complex products simultaneously so long as the parts will fit within the build envelope of the machine.

One of the main technologies used for additive manufacturing is Selective Laser Sintering , a process which uses laser energy to fuses (melts) granular or powdered material to create a solid object. Another technology is called Fused Deposition Modeling (FDM), which is commonly used for rapid prototyping but is becoming more and more popular in direct digital manufacturing. In total, there are more than 25 different 3D printing technologies used for a wide variety of processes. Learning all of them is complicated and time consuming, luckily Kraftwurx takes care of the details so you can focus on what you do best!

At Kraftwurx, we believe the future is Digital and we're the vanguard of this emerging trend.
Advantages

GREEN: Only the energy necessary to form the part is expended, and waste is eliminated. This contrasts with conventional Machining , in which energy is used to smelt metal into Ingots , which become Billet Materials . These billet materials are then machined, removing a great deal of the material to produce the final part. The energy used to create the original block of material is wasted.

Low material waste: Since the process only forms the desired part, there is almost no waste formed, again in contrast to conventional machining. The absence of waste enhances energy efficiency, as energy is not used to transport or dispose of waste. With the elimination of traditional parts machining, petroleum-based cooling fluids are no longer a necessary waste byproduct.

Speed: Generally the actual 3D print process is far slower than traditional techniques, however, traditional techniques often require ancillary processes and procedures (intermediate steps) to form the final product. 3D printing technologies eliminate these steps. Considering this, products can be brought to market faster and sometimes cheaper by using 3D printing rather than traditional processes such as castings and forgings. Since no special tooling is required, 3D parts can be built in hours or days.

Complex Geometries: Additive manufacturing technologies allow designing to the process and the creation of more efficient designs without limitations of other processes. Internal passages and features can be created that could not be created with traditional methods.

Materials

METALS: A variety of metals are currently available including alloys of 17-4 and 15-5 Stainless Steel, Maraging Steel, Cobalt Chromium, Inconel 625 and 718, and Titanium Ti6AlV4. Almost any alloy metal can be used in this process once fully developed and validated. These materials are not considered to be compliant with ASME specifications for the grades of metals they represent and are generally considered "approximately similar to" the material grades they mimic.

POLYMERS The variety of non-metallic materials used includes an array of photopolymers based on acrylics as well as an assortment of wax-like substances and even ABS Plastic . It is important to note that many of these materials are not considered production-grade as they are brittle, lack good mechanical properties and generally age poorly. Also, the exact compositions of these materials is a closely guarded secret of the manufacturers.
Applications

Applications using this technology include direct parts for a variety of industries including aerospace, automotive, dental, fashion, military, medical and other industries that use complex parts of small to medium size. The Tooling industry uses it to make direct tooling inserts. In particular production of small batches or one off components. Often products can be optimized by taking complex geometries with multiple components in an assembly and simplifying it to fewer sub components and joints. This is one of the key advantages of the technology. Build volumes of existing equipment continue to grow and as the hardware becomes faster along with larger volumes, new uses become feasible.
Technologies

There are presently about 25 3D printing technologies (This list is not all inclusive). The oldest is Layered Object Manufacturing . The next oldest is Stereolithography . More recent technologies include selective laser sintering, Direct Metal Laser Sintering (DMLS), inkjet technologies, Fused Deposition Modeling , Polyjet Matrix and many variations. All of these technologies take a 3D Model , compute cross-sections of that model, and then deposit the cross-sections sequentially on top of each other until the final geometry is achieved. Overhanging parts are supported by a second material in many cases or by the material in powdered form such as in the case of Selective Laser Sintering.

To visualize how 3D printing works, consider a coffee cup. If you were to slice the coffee cup into wafer-thin layer like you would meat on a slicing machine at a Deli and save each layer and then re-stack them in order, you would re-create the shape of the original object. 3D printing accomplishes this by deposition of very thin layers on top of each other from sliced 3D models or CAD data within a computer system.

Varying the layer thickness affects the model surface finish and other parameters including but not limited to mechanical properties. Many methods have been devised to improve surface finishes; these usually slow down the printing process.
Direct Digital Manufacturing Usage

In 2006, I met Terry Wohlers in Chicago at the RAPID convention. According to Terry, at that time there were approximately 50 commercially viewable examples of 3D printing being used for tooling or intermediate parts but very few end-user parts. The technology is still new and its use is directly dependent on users' knowledge of Engineering to design a part and effectively use the printing equipment. The growth of the market is nevertheless fast, and was estimated in 2006 to be as high as 35% annually according to Mr. Wohlers.

The earliest use of the term Direct Digital Manufacturing is a relatively new term. In fact Digital Reality's founder Chris Norman created the Wikipedia Page for Direct Digital Manufacturing.
Digital Manufacturing is The Future!

Digital Reality is the holder of a very complex patent pending process for Direct Digital Manufacturing called Made-To-Order Digital Manufacturing Enterprise. Digital Reality filed non-publication requests on the patent applications however; the company has also notified 4 companies of the patents that are entering the market segment for consumer-driven customization through 3D additive fabrication.

Digital Reality was founded by Chris Norman, a 16 year veteran of the Engineering & Manufacturing segment and expert in product development. Mr. Norman is a 16 year member of the Society of Manufacturing Engineers. Mr. Norman has shard his vision for a future that is digital in public, and print since first exposure to 3D printing in 1995 while earning his BS Manufacturing Engineering at Texas A&M University. Mr. Norman also holds an MBA in Technology Management.

How do we get from where we are today to a future for Digital Manufacturing? That is the "million-dollar question". In 2007 Mr. Norman was pitching a venture to the Texas Emerging Technology fund for just that concept. Mr. Norman was asked "why do we need your solution". The answer was simple: "Consumers are never going to design and ENGINEER their own products. They may embellish them or tweak them but they will never start from the ground up to design a finished good themselves. That drives a need for two things: A Way to embellish products without disturbing the underlying design intent and a way to store product designs efficiently and make quality designs available to the public. Any cad model is just a 3D model until an engineer ensures its going to do whatever it is supposed to do!

Where does all this lead? It leads to a future where products are made with 3D additive fabrication and produced on-demand with personalization and customization included. This idea led to the patent and creation of tomorrow's digital fabrication system titled Digital Factory...

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