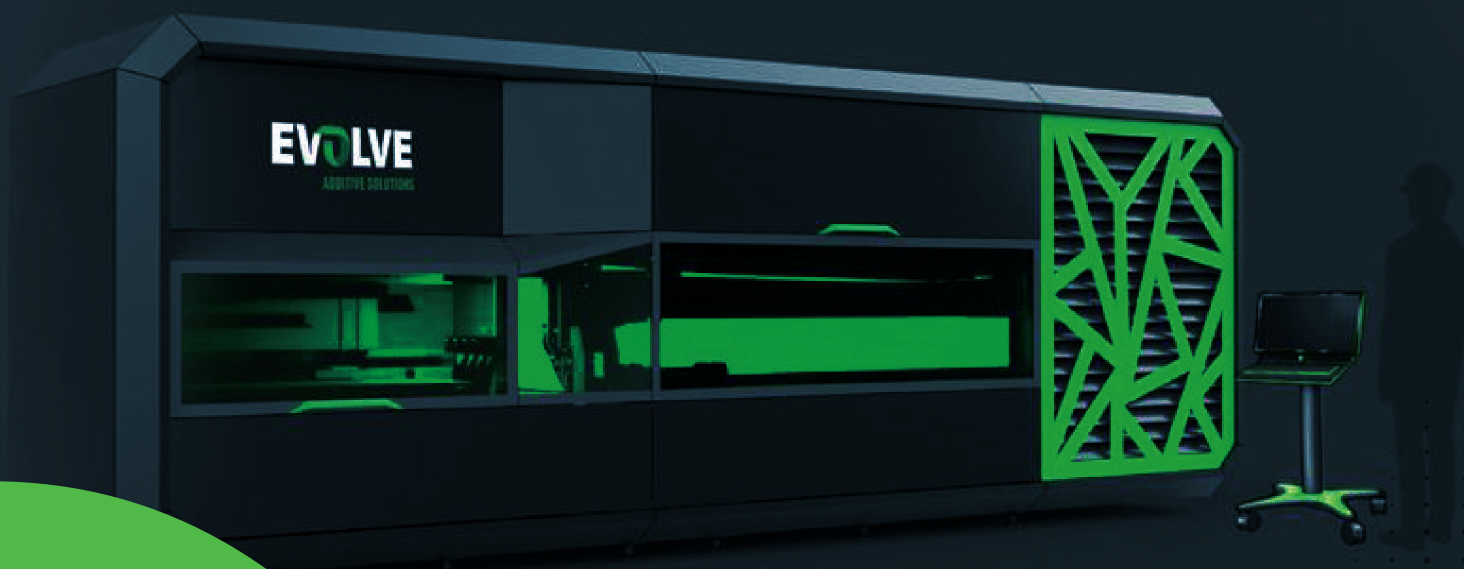
STEP TECHNOLOGY

A NEW PRODUCTION TECHNOLOGY DELIVERING ON THE PROMISE OF ADDITIVE MANUFACTURING



EVOLVE
ADDITIVE SOLUTIONS

STEP TECHNOLOGY

Selective
Thermoplastic
Electrophotographic
Process

INTRODUCTION

For the last two decades, additive manufacturing (AM) has made a significant impact for organizations by helping them to improve their product design and time to market by prototyping with various technologies. More recently companies have brought additive manufacturing to the production floor for jigs and fixtures allowing manufacturers to be more agile with their production lines. However, the promise of AM being used for production parts of 10,000, 50,000 or even a 1 million parts a year has fallen short. There are limited niche' application examples for certain technologies, but nothing that offers a true manufacturing solution with real world thermoplastics, surface quality and mechanical properties as well as the throughput demanded by manufacturers. What's more, no AM technology has had the ability to integrate into the manufacturing floor from both a hardware and software perspective.

Introducing Evolve Additive Solution's Selective Thermoplastic Electrophotographic Process (STEP). STEP is the first AM technology for polymers introduced in the last 20-25 years. STEP is truly unique and delivers on five key attributes manufacturers are demanding before they seriously consider AM for production purposes for volume manufacturing. This transforms what is an additive based technology into a machine tool with all of the benefits that additive manufacturing offers.

A STEP ABOVE THE REST — TECHNOLOGY OVERVIEW

This whitepaper is written to help you understand how the Selective Thermoplastic Electrophotographic Process, STEP, works, why it produces parts on par with injection molding and what its scalability potential is on the factory floor for manufacturing.

To understand the technology behind STEP it's important to understand the acronym STEP and its meaning — Selective Thermoplastic Electrophotographic Process. These words have been chosen carefully as they highlight key attributes that help fill the need manufacturers have demanded.

How does STEP actually work?

Unlike other additive technologies that has been brought to market in the last 10 years, most if not all have been derivatives of an existing technology, STEP is completely new to additive and has been designed and developed specifically for manufacturing. STEP's architecture utilizes three process phases that are the critical elements that enable STEP to deliver on the throughput and quality similar to injection molding.

Selective

The first word in STEP is "Selective". Selective because STEP has the ability to lay down particles in a very precise way. Each voxel (additive description for each 3D pixel) is precisely placed in a layer with a specific material. What's more, STEP is able to place two separate voxels of 2 different materials, side by side in the same layer. Taking it even further, STEP is able to place voxels of different colors side by side in the single layer. This selective capability of STEP opens up an entirely new world of applications, material choices, material attributes and color choices for the first time in a manufacturing solution.

Thermoplastic

The second word in the acronym STEP is "Thermoplastic". This is because STEP has the ability to print parts made with standard engineering thermoplastic such as ABS, Nylon, TPU or even in the future higher performing thermoplastics such as PEAK, PEK and others.

Electrophotographic

The third word is "Electrophotographic" which is a technology word for laser printer. STEP leverages the Kodak NexPress™ print engine, the highest deposition 2D print engine in the world, to image each layer. The use of electrophotography in additive is unique and it is one of the key elements that allows STEP to produce parts made of multi-material and color.

Process

The fourth word is "Process". Proprietary hardware and software combine to create a controlled, repeatable manufacturing capability. This eliminates the need to make trade-offs between quality, speed, cost and throughput.

HOW DOES STEP ACTUALLY WORK?

Unlike other additive technologies that have been brought to market in the last 10 years, most if not all have been derivatives of an existing technology, STEP is completely new to additive and has developed specifically for manufacturing. STEP's architecture utilizes three process areas that are the critical elements that enable STEP to deliver on the throughput and quality similar to injection molding.

First Process Area: Imaging

The first process area of STEP is imaging. STEP leverages a robust, proven and reliable electrophotographic 2D imaging engine from Kodak called the NexPress™. Similar to 2D printing each slice of STL file or "layer image", gets imaged onto a charged drum. Everywhere the layer is imaged, the drum becomes discharged. As the drum rotates, it passes in front of a toner station where the thermoplastic material (22-micron sized particles) is charged opposite of the drum. The toner transfers to the drum electrostatically only to the areas that have been imaged. The toned image is then transferred to another drum called the blanket cylinder which subsequently transfers the image to a carrying belt.

The imaging station has five engines. In the 2D printing world, these engines would be used to image different colored toner, typically cyan, magenta, yellow, and black and a fifth engine for specialty coatings.

In the STEP process these five print engines can be used for different materials. For a single material the print process would use two of the engines — one for support material and one for the part material such as ABS. It is important to note that within each layer only the area that has been imaged with a slice of a part is where the ABS toner is placed. The support material automatically gets placed side by side in the same layer where there are voids and require support for the finished part.

To carry this forward, STEP has the ability to utilize each of the remaining imaging engines for additional material. STEP is able to print parts made of more than one material. As an example, a part could be made from ABS and TPU built into the same part. In this example three of the print engines would be used — one ABS, one TPU and one for support. And again, the two different materials can be in the same layer, side by side, voxel to voxel.

The ability to use 2 (or even 3 materials) would open up many future capabilities for manufacturers. Of course, two materials could be used for over molded parts, but to take applications even further, parts could be blended to have different mechanical properties across the part providing more flexibility in one area and more rigidity in another. Another example could be core/shell structures where the bulk of a part could be made with a less expensive standard engineering grade material while the last 50 layers and internal passages could be made with a more expensive chemical resistant material. An additional application might be combining a rigid bracket with a rubber gasket into a single assembly not only reducing mold costs, but possibly assembly labor or time that traditional manufacturing and assembly would take.

Second Process Area: Alignment

Regardless of the AM technology used, alignment of one layer to the next is a critical process step. However, for parts that are intended for production the perfection of alignment is even more critical due to surface finish requirements and layer to layer material entanglement to achieve bonding. For STEP, the alignment process is a significant contributor to the part appearance and mechanical properties.

From a high-level perspective, the alignment process brings an incoming layer (which is on the belt) and the growing part (which is on the build platform) together underneath the transfuse roller. There are two components to this alignment step. The first is alignment from print engine to print engine. As explained in the imaging process, part material and support or a 3rd, or 4th part together in a single layer. Placement of these individual materials in the exact area is vital. Fortunately, this is a challenge that has been solved by the years of innovation in 2D printing and specifically for STEP in the NexPress. With some enhancements of the STEP process, Evolve leverages the technology in place to solve the inter-layer challenge.

The second component in the alignment step is positioning an incoming layer to the growing part. Once a layer is imaged to the belt it begins to travel to the lower section on the system. Under full closed loop control the system controls itself to get near perfect alignment between layers. This is accomplished by utilizing a fiducial to mark where a layer has been placed on the belt. The fiducial is detected by a high-precision image sensor that knows exactly where the layer is placed. The system then instructs the build platform to speed up or slow down so that the incoming layer and the building part meet precisely at the fusing station (the third step in the process) to merge the two together.

Although explained simply in 2 paragraphs the alignment process is extremely sophisticated with strategic intellectual property that has been developed by Evolve Additive Solutions for the last nine years. Without the extensive development, trial and error, and ultimately implementation into STEP Alpha and Beta systems, this essential part of the process would be inferior and not allow the STEP technology to meet the requirements of the most demanding production applications.

Third Process Area: Fusing

The last stage in the STEP process is fusing. Similar to the imaging and alignment processes the fusing step is unique compared to other additive technologies and is a primary reason the part quality and mechanical properties rival injection molding.

While a layer image is traveling on the belt it passes in front of a heating lamp. This lamp is controlled to heat the layer on the belt to a precise temperature (temperatures vary based on the material type) so that the layer becomes partially sintered although still staying on the belt electrostatically. At the same time the layer is heated, the growing part also passes underneath a heater and is heated to a similar temperature as the incoming layer. The incoming layer and the growing part merge under a roller that also applies heat and pressure to actually fuse the layer and part together. Once fused the merged part passes underneath a cooling element to extract heat. The process repeats itself until the part is fully built.

In short, the process mimics the injection molding process of utilizing heat, pressure and cooling to form a completed part. Unlike other powder bed technologies this process applies uniform heat across the entire build platform and is not subject to the thermal issues often plaguing powder bed technologies.

This is what allows STEP to produce parts with mechanical properties similar to injection molding because it's essentially mimicking the injection process with each and every layer. This is also what enables STEP to produce parts made with either amorphous or semi-crystalline materials. Manufactures utilize a wide range of materials in their traditional process and will demand the same from their additive technologies. STEP's process of fusing layers together to build parts with a wide variety of materials, high-quality surface finish and mechanical properties similar to traditional processes opens up a whole new world of possibilities for STEP customers.

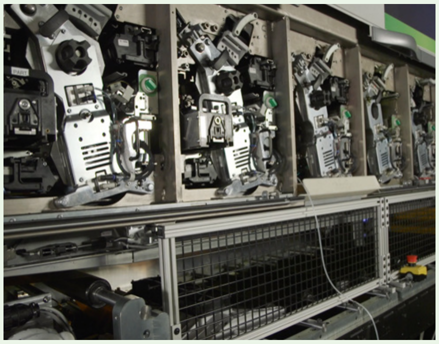
As stated in the opening you can now see that STEP is truly unique and is unlike any other AM technology on the market. Today's STEP manufactured parts are in line with injection molded parts from both mechanical properties and surface finish standards. We at Evolve have made huge strides in the last few years to advance the technology, and are excited about the advancements we have made to make this the production system of choice for manufactures across the globe in automotive, industrial, consumer goods, medical, aerospace and more.

TECHNOLOGY SNAPSHOT: 3 STEPS PROCESS

New and Unique Technology that Leverages a Highly Reliable Electrophotographic Technology

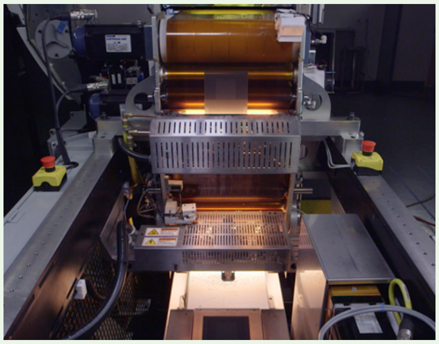
1 IMAGING

PROVEN ELECTROPHOTOGRAPHY IMAGING TECHNOLOGY FROM INDUSTRIAL 2D PRINTING



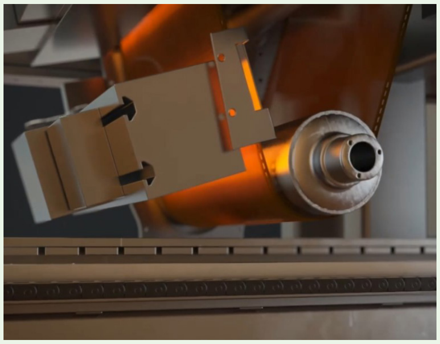
2 ALIGNMENT

EVOLVE PROPRIETARY TECHNIQUES FOR ENSURING MULTIMATERIAL IMAGE QUALITY DURING PRINT



3 FUSING

NEW AND EVOLVE PROPRIETARY: USES HEAT + PRESSURE TO ACHIEVE FULL FUSION



HEADQUARTERS
5600 Rowland Rd, Suite 180
Minnetonka, MN 55343
952 314 2161
info@evolveadditive.com

MATERIAL TECHNOLOGY CENTER
285 Metro Park, Unit 100
Rochester, NY 14623

WWW.EVOLVEADDITIVE.COM