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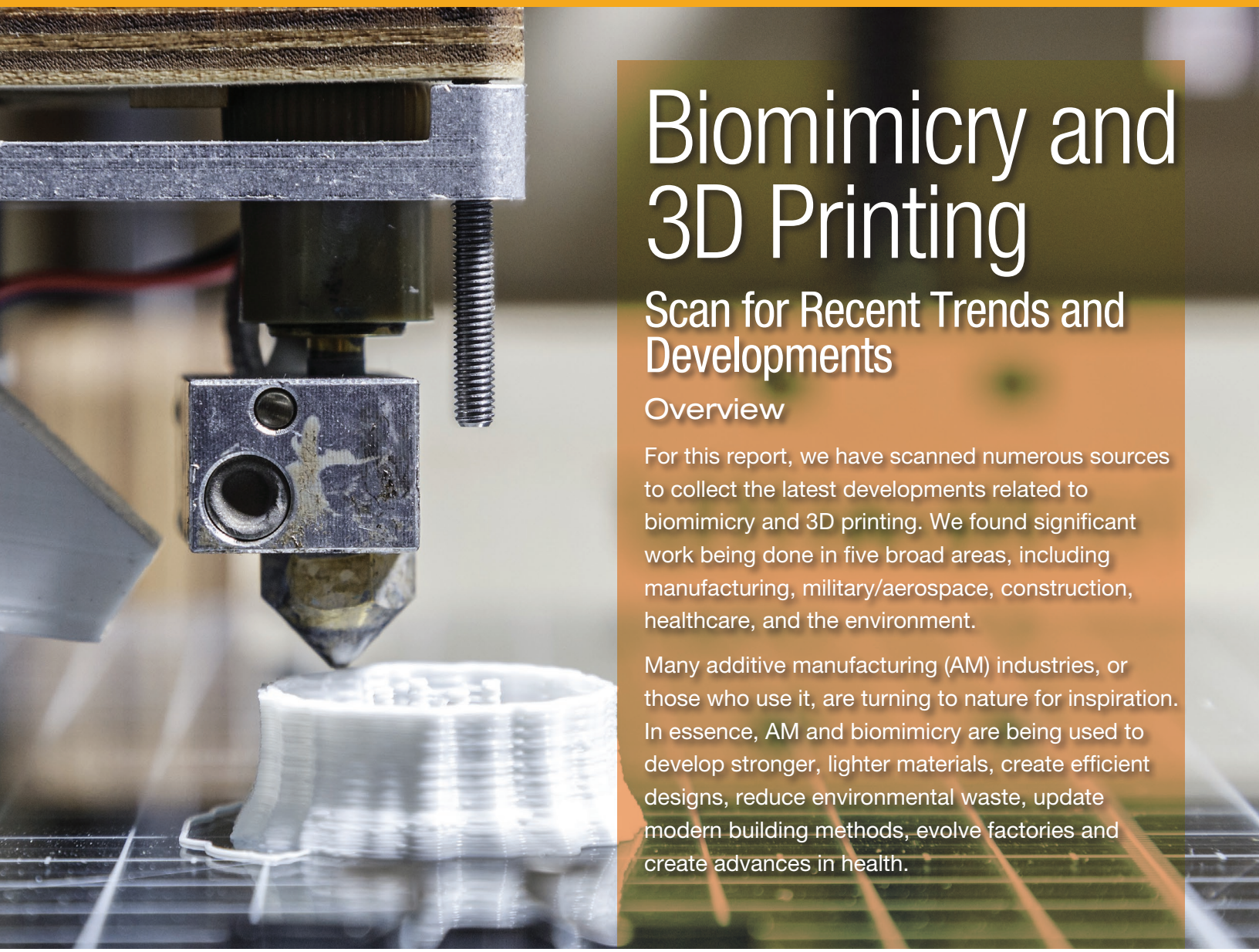
3D Printing Report—July 2016

3D PRINTING–A FAST MOVING MARKET



Biomimicry and 3D Printing

Scan for Recent Trends and Developments

Overview

For this report, we have scanned numerous sources to collect the latest developments related to biomimicry and 3D printing. We found significant work being done in five broad areas, including manufacturing, military/aerospace, construction, healthcare, and the environment.

Many additive manufacturing (AM) industries, or those who use it, are turning to nature for inspiration. In essence, AM and biomimicry are being used to develop stronger, lighter materials, create efficient designs, reduce environmental waste, update modern building methods, evolve factories and create advances in health.

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Manufacturing

Manufacturers are using 3D printing and biomimicry to develop layered structures that are both low-weight and extremely strong. CoÜanies are also looking at efficient ways to mold materials with methods taken from nature.

Demonstrating High-Performance Energy-Efficient Additive Manufacturing

HARBEC uses AM and biomimicry to develop ways to efficiently transfer heat and fluids within injection molds. Leveraging 3D printing, HARBEC and partners have demonstrated the potential for "growing molds" that incorporate principles of biomimicry, resulting in more energy-efficient and higher-performance molds for manufacturing.

3D Printing Biomimicry Leads to Righteous Ripping

By combining his knowledge of surfing and board construction with biologically inspired aerodynamics and additive manufacturing techniques, Roy Stuart is now able to sell performance enhancing and affordable surfboard fins.

Festo's 3D Cocooner builds 3D structures via a tripod robot

Positional data and control signals are sent to the tripod by an animation software program that uses a 3D shape model to parametrically generate a desired structure. Using the machine, it is possible to construct coÜlex shapes in three-dimensional space without any supports.

The coÜany has also developed 3D printed BionicANTs (Autonomous Networking Technologies) and eMotion Butterflies. The ANTs take not only their form but also their programmed behavior from nature, communicating with one another to coordinate action and movement. Festo believes the factory of tomorrow will be founded on intelligent coÜonents that can adjust theÙelves to different production scenarios as the ANTs do.

UC Berkeley, Autodesk Use Biomimicry to Develop Eco-Friendly 3D-Printing Materials

Autodesk is backing work from students at the UC Berkeley Center for Green Chemistry who are focusing on developing materials to replace stereolithography (SLA) resins, which are known toxins and have already proven deadly to aquatic life.

Butterfly Wings Inspire Aussie Scientists to 3D Print Stronger Structures for the Future of Electronics

An iÜortant part of *Callophrys Rubi's* anatomy may be the catalyst for a true breakthrough in the optics and photonics industries, areas which are continually iÜroving upon theÙelves due to a coÜetitive marketplace and constant customer demand.

Ultimately, their goal was a structure that's more durable and resilient and lightweight. As usual, we want it all—but often, 3D printing is capable of giving that; in fact, the research team was able to cash in on virtually every benefit the technology has to offer, taking a traditional design and iÜroving on it with unprecedented customization in this field, along with enjoying the self-sustainability of creating and re-creating models in the lab, all the while creating greater speed and higher resolution, and undoubtedly affordability. The team's particular 3D technique allows also for uniquely strong architectures, with accoÜanied high resolution.

Military / Aerospace

The Military and Aerospace industry is looking at biomimicry and 3D printing to develop stronger, lighter, more resilient materials. Developments include iÜact-resistant helmets, flexible armor, and lightweight wings able to travel long distances.

Micro Air Vehicles Go Batty for Biomimicry

Innovative membrane wings that work like artificial muscles have been successfully tested in-flight, paving the way for a new breed of unmanned Micro Air Vehicles (MAVs) that have iÜroved aerodynamic properties, can fly over long distances and are more economical to run. Inspired by bats, the wings change shape in response to the forces they experience and have no mechanical parts, making MAVs incorporating them easier to maintain.

Researchers Developing Super-Strong Materials Thanks to a 3D Printer and the Mantis ShriÜ

We knew from previous studies that the iÜact region allows the mantis shriÜ to transfer incredible momentum to its prey while resisting fracture, but it was exciting to reveal through our research that the properties of this highly iÜact-resistant material are created by the novel herringbone structure.

Learning from fish to develop new materials

Bulletproof uniforÙ and space suits iÜervious to micro-meteorites are two of the potential applications for new materials developed at the Technion-Israel Institute of Technology.

Innovation inspiration: What bones taught airbus about optimizing strength

The Airbus Group is taking innovation inspired by nature to the air by using 3D printing to help build a stronger, lighter-weight galley partition that mimics cells structure and bone growth.

Construction

Industries are looking to AM and biomimicry to create lightweight, renewable, and efficient means of constructing homes and buildings.

Siemens: 3D Printing Spider Bots are Able to Collaborate in Smart Printing TeaÙ, Covering Ground Autonomously

Researchers at Siemens in New Jersey have developed artificially intelligent 3D-printed spider bots that work in teaÙ to 3D print large structures. Researchers are developing their bots for the marine and aerospace industries and anticipate that they will be responsible for construction of parts such as fuselages and hulls.

A Mind-Blowing Dome Made by 6,500 CoÜuter-Guided SilkworÙ

The Silk Pavillion—an architectural experiment constructed at MIT, was "3-D printed" using 6,500 live silkworÙ.

NASA 3D-Printed Habitat Challenge

NASA has announced the winners of its 3-D Printed Habitat Challenge Design CoÜetition. The contest sought architectural concepts for how 3D printing might be used to create shelters on the Red Planet. The overall winner, Ice House, would be built using the planet's predicted abundant water supply.

Israeli Researchers Develop Algorithm for Self-Assembling 3D Printed Objects

The findings showed that high frequency vibrations can be used to aide bricks in self-assembling into a larger 3D object—a phenomenon that could dramatically change the future of consumer product assemblies. "Assembly rules are encoded by topographic cues iÜrinted on brick faces while attraction between bricks is provided by embedded magnets," explained the researchers in their paper. "The bricks can then be mixed in a container and agitated, leading to properly assembled objects at high yields and zero errors."

Healthcare

The healthcare industry is combining AM with biomimicry to print tissues. Advances in this area have led to 'bio-printing.' This medical advance may lead to the actual printing of skin, bones, and organs. Biomimicry also may allow for the creation of 'scaffolds' made of materials coÜatible with the body and fashioned in the shape of a tissue or organ; cells, ideally from the patient; and biomolecules, such as growth factors, to induce tissue formation.

Bioprinting: 3D Printing Comes to Life

While numerous biologic tissues have been printed and tested pre-clinically, challenges remain to further develop and harness 3D printing technologies for more coÜlex tissues and organs. As scientists move away from modifying existing printers and begin to design new technologies, the range of materials can be extended and methods to deposit materials and cells with increasing precision and specificity can be developed.

3D Printing of Scaffolds for Tissue Regeneration Applications

The current need for organ and tissue replacement, repair and regeneration for patients is continually growing such that supply is not meeting the high demand primarily due to a paucity of donors as well as biocoÜatibility issues that lead to immune rejection of the transplant. In an effort to overcome these drawbacks, scientists working in the field of tissue engineering and regenerative medicine have investigated the use of scaffolds as an alternative to transplantation.

Pleurobot the 3D Printed Salamander Yields Helpful Data for Researchers Hoping to Help Paraplegics & AÜutees

The hope is for part of a more noble cause in that with this research they will be able to translate some of this knowledge into helping paraplegic patients and aÜutees with creating iÜroved neuroprosthetic devices—an area where both 3D printing and robotics have been heavily integrated of late.

Environment

Biomimicry is being used in the very process of additive manufacturing (AM). This can happen through the energy needed for the 3D printers to operate and the materials used. Manufacturers are turning to nature to create renewable sources of AM materials while studying the animal kingdom for methods of extruding the materials.

Nature Is The Ultimate 3-D Printer: Can We Make Our New Manufacturing As Clean?

I believe biomimicry will be vital to four key aspects of this vision: local sourcing, smart structure, safe chemistry, and reverse logistics. After 3.8 billion years of making majestic designs from siÜle materials, nature has much to teach us. Imagine sourcing our 3-D printer polymers from CO2 (as plants do) or waste carbohydrates (as animals do). For structure, imagine borrowing organisÙ' highly evolved blueprints, just as Harvard's Don Ingber did to create an aluminum-strong, insect-inspired plastic named "shrilk." The chemistry inside the printer, if modeled on nature's recipe book, could retire the "heat, beat, and treat" of old industrial processes. The same chemistries that build a product from the bottom up can be reversed to break it down, allowing materials to be reincarnated into new products, just as the nutrients in a log find their way into insects, then rodents, then hawks.

Taken to its full extent, this biologically inspired manufacturing system would signal a sea change in our materials economy.

Towards Sustainable 'Biofriendly' Materials for Additive Manufacturing

Learning from the patterns and strategies found in nature—which have taken eons to evolve—can help guide the way to sustainable innovation.

Nature already assembles everything using incredibly sustainable *biofriendly* processes. The highly coÜlex results are made from 100% renewable resources, and (the Law of the Jungle notwithstanding) are typically non-hazardous to other living organisÙ.

Bio-Inspired 3D Printed Row-Bot Cleans Water Surface as it "Eats" Bacteria

Inspired by the aquatic water boatman beetle, Researchers at the University of Bristol have created a 3D printed robot that can self-propel, or 'row', along the surface of lakes and ponds, consuming microbes as it goes. Since the row-bot is powered by the microbes it eats, it does not require any recharging, and has the potential to be used in environmental monitoring and water clean-up systeÙ.