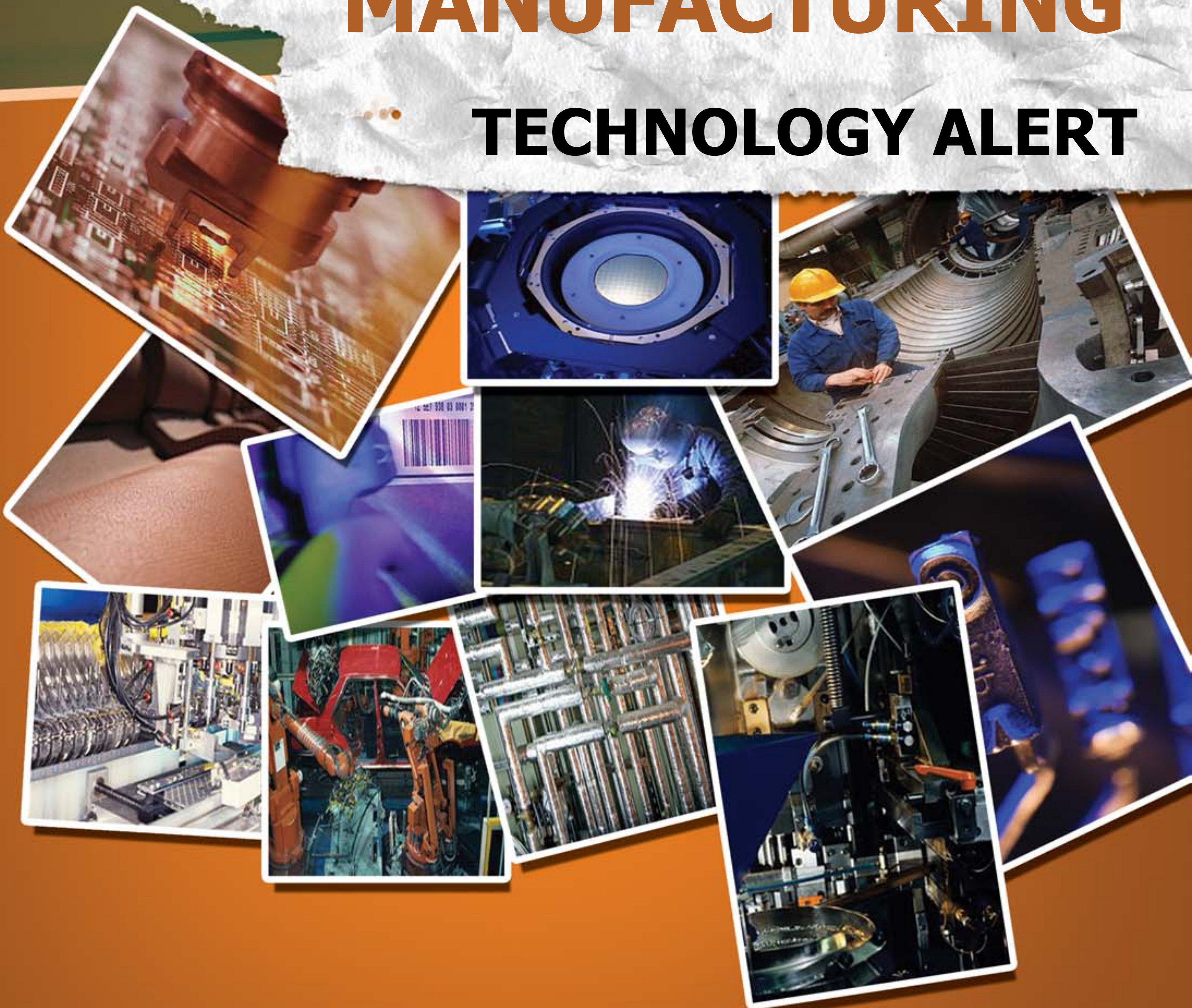
TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT



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1. ADVANCED 3D PRINTING MATERIALS

A key driver for continued advancements and further proliferation of three-dimensional (3D) printing, or additive manufacturing arena, is the improvement in key and innovative materials used in 3D printing. Advancements in 3D printing materials will help in further growth of various types of 3D printing equipment technologies, including, laser sintering, fused deposition modeling, and stereolithography. Laser sintering, created at The University of Texas at Austin, typically uses a carbon dioxide laser to generate heat to process and fuse small particles of plastic, metal, ceramic, or glass powders into a 3D format.

In laser sintering, there are opportunities for powder materials that are able to withstand temperatures close to the melting point during the building process, without undergoing degradation. There are also opportunities for materials in laser sintering that are able to provide improved capabilities such as higher temperature capability, flame retardancy, flexibility, impact strength, ductility, tensile strength, and consistent mechanical or dimensional properties.

Polyamide (nylon) 12, the dominant material used in laser sintering, is able to endure temperatures very close to the melt point without degrading. However, polyamide (PA) 6 also has potential to find expanding opportunities in laser sintering, as it can exhibit higher heat resistance and stiffness. PA 6, though, has been more difficult to process than PA12.

In laser sintering, there are also opportunities for materials such as PEEK (polyetheretherketone), PAEK (polyaryletherkeone) or PEKK (polyetherketoneketone) in applications such as aerospace or medical implants. Opportunities for such materials would be further enhanced with reductions in cost and improvements in the efficiency of processing them. There are also opportunities in fused deposition modeling for carbon nanotube-reinforced PEEK (and other materials).

In fused deposition modeling, there are opportunities for such emerging materials as carbon fiber reinforced polymers, including carbon fiber-reinforced ABS (acrylonitrile butadiene styrene) or polylactic acid (PLA), as well as stronger, more flexible thermoplastic elastomers, non-yellowing PLA, polyphenylene sulfide, which are not so difficult to be woven into spools.

Fused deposition modeling (FDM) entails melting and selectively depositing a thin filament of thermoplastic polymers in a cross-hatching mode to form each layer of an object. The 3D object is built one layer at a time. A plastic filament or metal wire provides material to a heated extrusion nozzle that controls the flow; and the nozzle is heated to melt the material.

Areas in which the FDM materials could be further improved include tensile, impact and flexural strength; accuracy; durability; stability; material adhesion; and capability to create less porous models.

In stereolithography, the first commercialized 3D printing or rapid prototyping technique, a part model is typically built using a photocurable polymer. An ultraviolet laser traces the first layer of the part through a focused beam of ultraviolet light. The resin is cured until the entire area within the cross-section of the slide is solidified.

In stereolithography, opportunities exist for enhanced photopolymer resins, and for composite resins offering improved stiffness, ease of processing, and enhanced heat deflection temperature (temperature in which the polymer would deform under a load).

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2. NOVEL DESIGN SOFTWARE FOR DEVELOPMENT OF PRODUCTS IN HEALTHCARE SECTOR

Advancements in design software play a key role in the development of products such as orthotics for patients. A company based in the UK has developed software for the healthcare sector.

Delcam, a UK-based computer-aided software company, has developed a novel version of its OrthoMODEL software used for designing and manufacturing of custom orthotic insoles. The latest OrthoMODEL software is said have the capability of displaying multiple two-dimensional (2D) and three-dimensional (3D) models simultaneously in addition to a wide range of improvements with respect to the user interface for simplifying the workflow and reducing design time. The company believes with this new version of the OrthoMODEL they would be able to represent a significant leap in bringing together 2D image and 3D scan data. Representing both types of data would help the user to decide the features that are required in the orthotic. This new software also enables multiple 2D images to be imported and overlaid onto the 3D scan data. This feature results in the creation of a dynamic data for the user would be able to interpret the information that are represented by the 2D images in correlation with the 3D model. This extra dimension that is offered by OrthoMODEL allows multiple images to being displayed at the same time. For instance, the user would be able to overlay the photographic image of the plantar surface and an image from a pressure system and also would be able to view the data from both images, which is overlaid on the 3D scan. The ability to vary the scanner, image, and orthotics transparency allows the user to get detailed information about the various elements that works together for influencing the overall design. By getting detailed information about the various elements, the user would then be able to take informed decisions about the design changes based on the various needs and requirements.

Another feature of this new version is the significantly updated user interface. A new image to page capture feature imports and presents multiple images in addition to the display utilities on the alignment and design pages for making the enhancing the user interface and enabling decisions on the orthotic design that is to be made at a faster rate and more accurately. The software has also been updated to allow the user who uses the Delcam's iQube scanner to send orders containing either the scan data or the finished design through to the range of on line labs that can carry out the manufacturing. This benefits the user in using the digital designs without having to invest in a computer numeric control (CNC) mill or router.

The advantages of this version of the OrthoMODEL are the significantly enhanced user experience and other improved capabilities for increasing the design of orthotics.

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3. ROBOTIC REINS FOR SAFE NAVIGATION IN EMERGENCY SITUATIONS

Emergency response situations have always been a priority across the globe. Keeping in mind that quick responses facilitate saving lives; rigorous training is always given to emergency response personnel, especially fire fighters. However, firefighting and consequent rescue operations can lead to accidents, causing both physical and mental agony to the rescue personnel. One of the most common causes of accidents during fire rescue operations is due to the inability of the firefighters to see the objects in blind spots, especially in smoke filled buildings. This might also result in delayed response, leading to eventual loss of human life. Stakeholders across the globe are developing solutions to overcome these hurdles. One of the key areas explored is the use of sensors and robotics to minimize risk for firefighters.

In this regard, a joint effort by researchers from King’s College London and Sheffield Hallam University, has led to the development of reins that can help robots behave like guide dogs for easy identification of objects and obstacles. The use of the robots along with the reins will help firefighters navigate inside smoke filled buildings and without harm and help in gaining vital seconds in a rescue operation.

Funded by the Engineering and Physical Sciences Research Council (EPSRC), UK, the development involves a small mobile robot that is equipped with tactile sensors. This robot could lead the way with the firefighter following behind while holding the reins. The sensors help in identifying obstacles and sending signals o the firefighters through vibrations. The details such as size, shape, and stiffness of the obstacles are sent to the firefighter. This helps the firefighter move without any mishap in the smoke filled buildings, minimizing accidents.

The firefighter will also be equipped with a special sleeve that can cover the entire arm. This sleeve is incorporated with electronic microvibrators that can help interpret the signals sent by the robot and turn into detailed data, which can be analyzed by the firefighter who would be trained to interpret them. The robot also can sense any hesitation or resistance from the user and has the ability to adjust its pace accordingly. It is also programmed to predict the user's next action based on the previous movements.

At present, firefighters can find it difficult to navigate within buildings for rescue operations as smoke badly affects visibility. With only around 20 minutes of oxygen availability per firefighter, the situation becomes hazardous many a time. The use of the mobile robot and rein will help the firefighters move more quickly and easily.

The team conducted trails using blind-folded volunteers who were guided by a robot for testing the efficiency. The research team has completed the proof of concept and plans to develop prototype for testing the innovation in real world scenarios. The research team is also involved in developing visual language for using robotics in domestic scenarios and is also planning to explore the use of reins and haptic signals by elderly people at home.

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4. PATENT ANALYSIS OF LAMINATED OBJECT MANUFACTURING PROCESS

Laminated object manufacturing (LOM) is a 3D printing or additive manufacturing process in which a carbon dioxide laser is employed for creating successive cross sections of a three-dimensional (3D) object. In this process, the object is manufactured from layers of paper, coated with a polyethylene on the backside. A base on which the paper can be attached to, is then created using a special tape down onto the platform. Once the base is created, the paper is then fed through using small rollers. As the paper is fed through, a heated roller is then used for melting the coating on the paper, which enables the other successive layers to bond with the previous layer that has been created. Layers of adhesive-coated paper laminates can be successively glued together and cut too shape via a laser cutter (or knife).

The LOM process can use inexpensive materials, such as copier paper, and objects can have the look and feel of wood. However, it can be time-consuming to remove the extra material from certain objects. It appears that, at present, there has not been significant commercial providers providers of LOM equipment. Mcor Technologies Ltd., provides selective deposition lamination (SDL) technology, a variation of LOM, that uses a tungsten carbide blade (rather than a laser) to cut each layer of paper. Water-based adhesive is selectively applied where needed. A higher density of adhesive is deposited in the area that will become the part, and a lower density of adhesive is applied in the surrounding area serving as the support.

The patents exhibited include applications or additive manufacturing developments that might potentially employ LOM or other additive manufacturing techniques.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Metallic structures having porous regions from imaged bone at pre-defined anatomic locations	January 23, 2014/ US 20140025181 A1	Tom Vanasse, Gautam Gupta, Jason Meridew	Tom Vanasse, Gautam Gupta, Jason Meridew	A method of forming an implant having a porous region replicated from scanned bone, the method comprising imaging bone with a high resolution digital scanner to generate a three-dimensional design model of the bone; removing a three-dimensional section from the design model; fabricating a porous region on a digital representation of the implant by replacing a solid portion of the digital implant with the section removed from the digital representation; and using an additive manufacturing technique to create a physical implant including the fabricated porous region.
Three-dimensional modeling apparatus, method of manufacturing a three-dimensional object and three-dimensional object	December 31, 2013/ US 8616872 B2	Sony Corporation	Takeshi Matsui, Junichi Kuzusako, Hiroyuki Yasukochi	Provided is a three-dimensional modeling apparatus including a supply mechanism, a deposition area, a variable mechanism, a discharge mechanism, and a control means. The supply mechanism supplies a powder material. In the deposition area, the supplied powder material is deposited. The variable mechanism varies a volume of the deposition area per a predetermined layer thickness, and thus the powder material is deposited per the predetermined layer thickness in the deposition area. The discharge mechanism discharges liquid for forming a three-dimensional object to the deposited powder material, the liquid being capable of hardening the powder material. The control means causes the discharge mechanism to discharge the liquid to the powder material, to thereby form a main body being an object being as a target to be modeled and a frame body being an object to be formed in a periphery of the main body, of the three-dimensional object.
System and method for additive manufacturing of an object	October 2, 2013/ EP 2643149 A1	Stratasys Ltd.	Avraham Levy, Keren Regev, Claudio Rottman, Shai Hirsch	The method comprises sequentially forming a plurality of layers in a configured pattern corresponding to the shape of the object (12), thereby forming the object (12). The formation of each layer comprises dispensing at least one uncured building material (24), and at least partially curing the uncured building material (24), wherein for at least one layer, the curing is initiated at least t seconds after commencement of curing of a layer immediately preceding that layer. The t parameter is longer than the number of seconds required for the formation of the layer.
Process and system for manufacturing a customized orthosis	September 17, 2013/ US 8538570 B2	University Of Delaware	Steven J. Stanhope, Elisa Schrank	A process and system for fitting, customizing and manufacturing an orthosis for a subject. 3-dimensional coordinates for a plurality of landmarks corresponding to anatomical characteristics of the subject, means for attachment of the orthosis to the subject, and a reference plane are digitally acquired. Then, coordinates of one or more virtual landmarks corresponding to one or more anatomical joint centers or joint projection locations are calculated. The landmarks are clinically aligned in a reference position of one of the anatomical joint centers and a customized digital model of the orthosis is created using the clinically aligned landmarks. Finally, the orthosis is fabricated using a computer aided manufacturing process, based upon an output from the customized digital model

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Process and apparatus for fabrication of three-dimensional objects	September 4, 2013/ EP 2632696 A2	Eugene Giller	Eugene Giller	A fabrication process and apparatus for producing three-dimensional objects by depositing a first polymer layer, printing a first ink layer on to the first polymer layer, depositing a second polymer layer on to the first ink layer, and printing a second ink layer on to the second polymer layer. The deposition and printing steps may be repeated until a three-dimensional object is formed. The inks used to form at least one of the first and second ink layers may include dyes or pigments so that the three-dimensional object may be a colored three-dimensional object.
3D (Three-dimensional) desktop printing method and system	July 22, 2013/ CN 103341976 A	Chen Gong	Chen Gong, Caidao Sheng	The invention relates to a 3D (Three-dimensional) desktop printing method and system. Compared with the traditional method, the difference is characterized in that an adhesive is only sprayed in the current layer of contour area in the printing process, and the cutting is carried out on a layer after the adhering is carried out on the layer. The method and the system provided by the invention have the beneficial effects of greatly saving processing auxiliary materials and reducing the manufacturing cost of processing equipment.
Method of manufacturing structural object and structural object	July 11, 2013/ WO 2013102963 A1	Sony Corporation	Takeshi Matsui, Nobuhiro Kihara, Junichi Kuzusako, Tatsuya Minakawa, Kazuo Niizaka	There is provided a method of manufacturing a structural object, including using rapid prototyping technology, forming a structure body from a powder material whose main component is a water-soluble compound. The formed structure body is impregnated with an adhesive that provides adhesive function upon reaction with moisture contained in the structure body.
Surgical drill templates and methods of manufacturing the same	March 19, 2013/ US 8398396 B2	Straumann Holding Ag	Matteo Taormina	The present invention concerns a drill template, comprising: a base body made by casting or rapid prototyping; at least one reinforced portion made by casting or rapid prototyping; and at least one guiding hole within the at least one reinforced portion made by drilling or milling. furthermore, the present invention concerns a method of manufacturing a drill template, comprising the steps of: forming a base body by casting or rapid prototyping; forming at least one reinforced portion by casting or rapid prototyping; and forming at least one guiding hole within the at least one reinforced portion by drilling or milling.
Stereolithographic Rocket Motor Manufacturing Method	November 15, 2012/ US 20120285016 A1	Fuller Jerome K.	Jerome K. Fuller	A hybrid rocket motor is manufactured by photopolymerizing the solid fuel grain in a stereolithography method, wherein fuel grains in a plastic matrix are deposited in layers for building a solid fuel rocket body in three dimensions for improved performance and for a compact design,
A method of manufacturing wing structures.	April 9, 2009/ WO 2009044362 A2	Alenia Aeronautica Spa, Giovanni Mazzocchi, Giovanni Lanfranco	Giovanni Mazzocchi, Giovanni Lanfranco	The inner structure (20) of a wing is first fixed on the top surface (11) of the bottom panel (10). The inner structure and the top panel (12) are retained separately in the respective forms which they must assume in accordance with a predetermined wing profile. The top surface (21) of the inner structure (20) and the bottom surface (14) of the top panel (12) are scanned. The three-dimensional digital images of the scanned surfaces are processed, so as to generate a three-dimensional mathematical model representing the distances between the scanned surfaces. On the basis of the mathematical model one or more inserts (70) with a variable thickness corresponding to the distances between the scanned surfaces are manufactured. The inserts are then arranged between these surfaces and finally the top panel (12) is fixed to the structure (20), thus obtaining the predetermined wing profile..

Exhibit 1 depicts patents related to laminated object manufacturing process.

Picture Credit: Frost & Sullivan

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