INTRODUCTION

Manufacturing dominated by “material subtraction” saw a sign change in 1987 with the advent of 3D printing, also known as Additive Manufacturing (AM) and Rapid Prototyping (RP). 3D printing realizes complex objects in layers directly from their CAD definitions. Its primary benefit is "total automation" which helps in rapid launch of new products ahead of competition. Its other benefits are excellent geometric and material complexities as illustrated in the figures. 3DP has come a long way in terms of materials, quality and process capabilities. It could initially make only polymer components whereas ceramic and metallic parts are possible today. In terms of geometric quality and material homogeneity and variety also, 3DP parts have improved tremendously. Several pre-/in-situ/post-build processes have emerged today to improve the surface quality (e.g. liquid polishing) and material integrity (e.g. Hot Iso-static Pressing (HIP)). 3DP, together with these allied processes, is known as Rapid Manufacturing (RM). RM facilitates rapid development of even very serious products such as an aero-engine or a medical implant. It is considered a very important driver of the "Third Industrial Revolution" along with Internet and 3D scanning.

Hitherto impossible/difficult geometric and material complexities can be realized with ease using 3D printing today. Some of these geometric capabilities are (a) conformal cooling channels, (b) direct assemblies and (c) customized solutions for aesthetic, ergonomic and bio-medical applications. These material capabilities are (a) variety of monolithic polymeric, metallic and ceramic materials, (b) lattice structure, (c) gradient matrix in density and composition and (d) non-equilibrium matrix. While traditional Design for Manufacture (DFM) restricts the designers, Design for 3D Printing (DF3DP) gives them more freedom with these design possibilities.

The large variety of RM processes available today fall into three major groups: (a) 3D Printing, (b) RM for polymers and (c) RM for all materials. “3D printing”, refers to cheaper AM processes (say, under Rs. 5 lakhs) which can be part of any design office just as 2D printers. These are limited to only polymers, have hardly any material options and have no assured accuracy. Their usage is in quick physical realization of a design for visualization and reviews. "RM for polymers" refers to the processes which cater to mostly polymeric components but with assured quality, wide material variety and durability for more serious applications of form, fit and functional tests. "RM for all materials" is the highest level which includes metals and ceramics and it goes beyond prototyping. RM, through its many facets of direct and indirect routes (Vacuum Casting, Epoxy Tooling, Rapid Casting etc.), can be useful in regular production as well. While 3DP has linearity of cost with quantity, RM has the distinction of cost reducing with quantity. While "total automation" is the goal in 3DP, RM focuses on "optimal automation".
Program Overview

The goal in this course is to give an overview of the various RM technologies. After giving the necessary background in CAD modeling and Reverse Engineering, various popular RP processes will be discussed in detail. These will include Fused Deposition Modeling (FDM), Selective Laser Sintering (SLS), Stereolithography Apparatus (SLA), 3D Printing (3DP) and Laminated Object Manufacturing (LOM). The second part will deal with the indirect processes which can duplicate the RP masters into multiple non-metallic pieces required in pre-production runs and limited-editions. These include Vacuum Casting, Epoxy Tooling and Spray Metal Tooling. Thirdly the six groups of RM processes will be dealt in great detail. Particular focus will be on metallic objects including Rapid Casting. Hybrid Layered Manufacturing (HLM) and Segmented Object Manufacturing (SOM) are our two interesting metallic RM processes at advanced stages of development. These will be demonstrated. All the presentations will start with the detailed description of the process and then highlight on important applications and case studies. Some of them will be accompanied by actual or video demos. Some modules will be presented by the domain experts in aerospace, automotive and medicine.

Course Coordinator

Dr. K.P. Karunakaran is presently a Chair Professor in our Department of Mechanical Engineering. He has over 3 decades of professional experience. He, a 1984 graduate, worked as a CNC programmer in Hindustan Aeronautics Limited for about 9 years. He has been teaching and researching at IIT Bombay in the areas CNC, RM and Computer Graphics since 1994. He was a consultant to Mercedes-Benz Technology Centre in Stuttgart in 2000. He has been associated with Fraunhofer institutes in Stuttgart and Darmstadt since 1998 through summer visits. He is a Humboldt Fellow. He was a Visiting Professor in the University of Metz in 2005 and in Ecole Centrale de Nantes since 2006. He launched OptiLOM, a pre-processor for LOM-RP, in collaboration with DaimlerChrysler and Materialise during EuroMold 2002. His two new RM processes, viz., HLM and SOM are at advanced stages of development. HLM which presently uses MIG deposition is being extended for TIG and laser depositions. RW-MAVs and Helicopters without tail rotors are his passions..

Contact

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Targeted Audience

• Working professionals
• Industrialists
• College teachers
• PG students

Registration and Course fees

The participation fee is Rs. 15,000. Teachers and students need to pay only Rs. 12,000. The fee is inclusive of service tax of 15%. The payment should be in favor of “The Registrar, IIT Bombay – CEP A/C”. Participants must make their own travel arrangements. Campus accommodation is very limited. We can arrange your stay in nearby places on request.