MTRL 466: Design Project 2018

Optimal Support for SLA Printing in co-operation with NewPro3D

Stereolithography (SLA) along with other forms of 3D-printing has grown out of the rapid prototyping field into an established manufacuturing route. While on the one hand, companies like Formlabs (https://formlabs.com) offer low cost desktop SLA printers other companies are seeking to make SLA a true bulk manufacturing platform. Perhaps the clearest example of such an application of SLA printing is the partnership between Carbon3D (https://www.carbon3d.com) and Addidas for the bulk production of the soles of sneakers.

As additive manufacturing (including 3D printing, and SLA printing in particular) moves away from its rapid prototyping roots toward the fabrication of structural engineering components, there is an increasing need to optimize for part quality, cost and reproducibility. The rapid assent of additive manufacturing has meant that much of the "recipes for success" are hidden in trade secrets, empirical know-how and educated guesses. The next leap in additive manufacturing, the one which will allow it to be accepted as a bulk manufacturing technique, requires that we reduce empiricism with quantitative understanding of inter-linkages between design, processing and part.

NewPro3D

NewPro3D (https://newpro3d.com) is a local Vancouver startup with patented technology which it claims allows it to SLA print faster than any other 3D-printing technique on the market. NewPro3D's "Intelligent Liquid Interface" (ILI) technology is the key to achieving such high print speeds. In traditional SLA printing systems, each printed layer bonds to the print window during solidification requiring several mechanical steps to debond each layer. NewPro3D's ILI technology prevents this bonding, eliminating the need for mechanical steps and enabling faster printing speeds. NewPro3D is on the verge of selling its first commercial products for application in the rapid prototyping and medical fields but also with an idea to bulk manufacturing.

The Problem

One of the strengths of additive manufacturing is its ability to generate complex shaped components, even components with intricate internal cavities. In order to achieve such shapes, however, supports must be added to the design to ensure that the part maintains it shape during the printing process. These supports (usually vertical struts) are added to the design automatically by "slicer" software which takes in an .stl CAD file (created by software like autoCAD or solidworks) and prepares it for 3D printing by preparing 2D slices that the printer will fabricate, layer by layer. Often a conservative approach is taken to applying these supports, leading to unnecessary material waste at additional time and cost. The challenge is that the selection of support locations is generally based on rough "rules of thumb" – e.g. that an overhang can't be at an angle in excess of some critical angle or that a "bridge" can't be longer than a certain distance. For example, in the software used by NewPro3D, supports are recommended for 90° overhangs longer than 2.5 mm.

The broadest goal of this project is to provide guidance to NewPro3D regarding the need for support structures in its printing. To do this you will need to identify why support structures are required, i.e. what bad things happen when they are not there and what impact do they have on the quality of the print. As part of this, we would like to recommend a standard calibration test piece that could be printed for a given set of printing parameters (temperature, material, print speed) to confirm the conditions required for supports. A rational starting point for this will be to use existing rules/strategies and to try to reverse engineer what existing approaches are aiming to achieve. Finally, we would like you to provide an analysis of the incremental cost, both economically and environmentally, associated with the incremental increase or decrease in support structures for a given design.

Toolbox

You will have at your disposal a large variety of tools that you can employ to interrogate this problem.

People: Aside from me (Chad), senior PhD student Sebastian Medrano (medrano.seb@gmail.com) will be a primary contact for this project. Sebastian has been working with NewPro3D over the past several months with a focus on the mechanical properties of printed materials. A second PhD student, Will Sparling (was@Dal.Ca) will be a secondary contact for this project. Will will run a tutorial session for interested group members for some specialized software that may be of interest. Will's PhD work is focused on metallic additive manufacturing but he has a wealth of experience in 3D-printing in general. Finally, we will have contact with David Slade at NewPro3D. David graduated from MTRL several years ago and has recently joined NewPro3D as their materials specialist. As NewPro3D is a small company we will have to carefully ensure that we manage our communication with them so as to not overwhelm David (who is very busy with his day-to-day activities).

Software:

1) CAD & Slicer software: As noted above, slicer software (e.g. https://www.slicer.org) is needed to generate the code (gcode) fed to the 3D-printer. This software also typically will generate supports. This can allow you to test and see what the conventional software suggests for supports for a given design of your choosing. There is also the chance to test some designs using the software used by NewPro3D
2) Finite element software: For designs with complex geometry or with complex mechanical loading, finite element software can be used to assess mechanical deformation
3) Life cycle analysis: One can make use of the basic LCA functionality incorporated in the CES software used in MTRL 280.

Hardware:

1) FDM printer: You can have access to a small FDM printer if you would like to test print geometries to test ideas surrounding supports. This printer will be setup in Frank Forward and will be available when you want. While support requirements in FDM and SLA are not identical, the FDM printer can be used to give first order concepts a try.
2) Printing at NewPro3D: A limited number of test prints to prove “proof of concept” will be possible at NewPro3D.