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Chapter 11: Additive manufacturing – HINTS

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Exercise 11.1 Run several Internet searches with different time ranges (e.g. for 2010, 2011 and 2012), using both '3D printing' and 'additive manufacturing' as your keywords. Each time, compare the top-five search results. What, or who, are these?

Hint 11.1: this will be straightforward, but take your time to do this well.

Exercise 11.2 With typical layer thicknesses of 100 µm (and as thin as 16 µm in extreme cases) and a printing speed of 10 sec/layer, roughly how long would it take to produce an ordinary coffee cup?

Hint 11.2: note that the Exercise does not specify the direction of printing, nor the number of coffee cups printed in one batch.

Exercise 11.3 For additive manufacturing, STL has another, somewhat older meaning. What is this?

Hint 11.3: again, a simple Internet search will help you.

Exercise 11.4 What are your expectations of the material properties (strength, stiffness, ductility) of vat photo-polymerised parts made of thermosetting plastics? What about rubbers?

Hint 11.4: difficult question! If necessary, go back to your material science books to see what exactly determines the strength of thermosets and rubbers. Also consider processing: how important is e.g. the role of increased pressure or elevated temperature during shaping for the final material properties? Do these process conditions apply for typical vat photo-polymerization equipment?

Exercise 11.5 Search the Internet to find the largest part sizes that the three sub-principles mentioned so far can print. Make sure to compare only equipment for polymers. Which one 'wins'?

Hint 11.5: here, it helps if you go directly to the websites of leading suppliers (the names of which will have come up in Exercise 11.1). Alternatively, simply search for 'SLS largest printer' and similar search terms – but be sure to distinguish 'one-off' experimental equipment from regularly available printers.

Exercise 11.6 What are the base prices and melting temperatures for aluminium, magnesium, tin and zinc? Which one(s) would be suitable for home applications of AM using material extrusion, based on these data?

Hint 11.6: regular domestic ovens can reach 250°C without specific problems. Pottery kilns can go much higher, but be aware that processing molten metals (especially highly reactive metals such as aluminium and magnesium) is *very* dangerous at temperatures beyond 400°C because of their potential for reacting with water vapour from the air.

Exercise 11.7 As a percentage of the input material, how much waste would you have if you made a coffee cup using sheet lamination?

Hint 11.7: simply assume the coffee cup to be a hollow cylinder, closed at the bottom, with certain dimensions and wall thickness.

Exercise 11.8 Make an AM overview. Which of the seven sub-principles are (currently) suited for metals, which for plastics, and which for both? Which allow small-series production, and which are more suited for prototyping? What kind of part finishing is needed?

Hint 11.8: simply analyse the text carefully, recording all data that are asked here.

Exercise 11.9 From Figure 11.6, estimate the (average) tensile strength and ductility in both planes. How large are the differences? And how do these properties compare against those of a standard injection-moulding grade of PA?

Hint 11.9: a straightforward comparison; you will find the differences to be quite significant. For the comparison with PA, we recommend you consult the CES EduPack, selecting an unfilled grade of PA66.

Exercise 11.10 Estimate the extra cost of making the CAD file, assuming it takes 15 minutes of time for a skilled operator. How does this affect the product retail price?

Hint 11.10: Chapter 8 can help you with labour costs. Another hint: the retail price typically is at least three times the manufacturing costs, due to taxes, margins and the like.

Exercise 11.11 What would be the market value of a custom-fit 3D-printed bicycle helmet that has no certified performance?

Hint 11.11: you could say it is better than nothing, but now try to see this situation from the perspective of e.g. a health insurance company.