3D printing & the rapid prototyping of a hand-cranked fan

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Abstract

Rapid prototyping and computer numerical control systems have altered the manufacturing landscape in the recent half-century. As a result, time-to-market of new products have been reduced >90% and designers are able to produce and test many inexpensive prototype iterations, thereby increasing the quality of the final product. In the 21st century, rapid prototyping is experiencing continued growth as innovations in 3D printing are distributing the means of production directly to the designers and end-consumers. What the internet did for accessibility to communication, 3D printing is doing for manufacturing and design. This report is intended to provide the reader with suitable background information on the electromechanical and computational components of various 3D printing systems and to document the design process of a mechanized, hand-cranked fan. The information provided within is adequate to put any technologist onto the path of building their own 3D printer. As a proof of concept, the report demonstrates the reverse engineering and production of an entirely pre-assembled, mechanical, hand-cranked fan.

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1.0 Introduction

The digital age of manufacturing has arrived. With the advent of 3D printing this technology has given rise to output devices that allow rapid customization and manufacturing applications, revolutionizing how firms develop, fabricate and consume products. 3D printing is now considered a “disruptive technology with a potentially tremendous socioeconomic impact” (Bickel et al., 2013). More recently innovations in 3D printing technologies have spurred progressively sophisticated devices at competitive prices. Affordable 3D printers are today more readily available than ever before, and in addition a number of secondary markets have also sprung up consisting of 3D printing services that let individuals design and manufacture items with the click of a mouse. As a result 3d printers have channelled a number of previous technologies to account for advancements within computational models.

What is 3D Printing?

3D printing specifically refers to the production of three-dimensional solid objects of nearly any shape imaginable produced through shapes and digital models. Consequently, 3D printing has been described as an “additive process” (Brown, 2013) according to which an industrial robot (under computer control) fabricates an object. Also known as “rapid prototyping” the technology of 3D printing has evolved significantly over the last several decades. After its initially introduction in 1984 by Chuck Hill of 3D Systems Corp., the 3D printer has been expanded into a number of mass market production.

Appendix A

Material Data Sheet for fine powdered polyamide PA2200			
General Material			
Test Type	**Test Standard**	**Value**	**Unit**
Average grain size	ISO 13320-11	56	µm
	Laser diffraction	2.2	mil
Bulk density	EN ISO 60	0.45	g/cm^3
Density of laser-sintered part	EOS method	0.93	g/cm^3
		58	lb/ft^3
Mechanical properties			
Tensile modulus	EN ISO 527	1700	Mpa
	ASTM D638	247	ksi
Tensile strength	EN ISO 527	48	MPa
	ASTM D638	6962	psi
Elongation at break	EN ISO 527	24	%
Elongation at break	ASTM D638	24	%
Flexural Modulus	EN ISO 178	1500	Mpa
	ASTM D790	217	ksi
Flexural Strength	EN ISO 178	58	MPa
	ASTM D790	8412	psi
Charpy - Impact Strength	EN ISO 179	53	kJ/m^2
Charpy - Notched impact strength	EN ISO 179	4.8	kJ/m^2
Izod - Impact strength	EN ISO 180	32.8	kJ/m^2

Izod - Notched impact strength	EN ISO 180	4.4	kJ/m^2
Ball indentation hardness	EN ISO 2039	78	N/mm^2
Shore D - Hardness	ISO 868	75	--
	ASTM D2240	75	--
Thermal Properties			
Melting point	EN ISO 11357-1	172-180	℃
Vicat softening temperature B/50	EN ISO 306	163	℃
	ASTM D1525	325	F
Vicat softening temperature A/50	EN ISO 306	181	℃
	ASTM D1525	358	F

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