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THE VARIATION OF TEMPERATURE WITH THE HEIGHTS OF 3D PRINTED ABS PARTS

BY

BRUNO RĂDULESCU* and MARA-CRISTINA RĂDULESCU

“Gheorghe Asachi” Technical University of Iași,
Faculty of Machine Manufacturing and Industrial Management

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Abstract. This paper presents the influence of the temperature on vertical to the part that has more than 100 mm.

Keywords: 3D printing, the influence of the temperature, part design, rectangular parts, production process.

1. Introduction

3D Printing allows the fabrication of complex metal or polymer parts through the successive addition of material. 3D printing by highly used on polymer extrusion as a recent process that is inexpensive, safe and easy to use.

Currently used for prototyping and for the production of non-critical parts, this process is still in the development stage and is not yet commonly used in the industry.

*Corresponding author; *e-mail*: bruno.radulescu@academic.tuiasi.ro

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Additive manufacturing is defined as a process allowing to build a part by successive addition of material from the 3D model of the object. Additive manufacturing has some advantages comparing by conventional material removal (machining or grinding) or formative (casting, bending, forging, electro erosion etc.) manufacturing technologies (Savu, 2019).

First of all, additive manufacturing allows the fabrication of complex geometrical parts, that would be expensive or impossible with traditional methods.

Secondly, additive manufacturing does not require any supplementary devices, which allows decentralizing production in favour of local manufacturing. In addition, small production shops such as product customization and replacement of broken parts through reverse engineering are cost-effective. Small batch production also allows for shorter lead times and lower inventory levels, thereby reducing warehousing costs (Gershenfeld, 2012).

2. Designing and 3D printing of a rectangular part

The role of this paper is on the one hand to determine the temperature drop of the 3D printed part measured vertically and on the other hand to identify the minimum thickness of a part to be printed so that the part is functional (Hwang, 2015; Xu, 2021).

In order to get conclusive results we started with 3 pieces with the following dimensions.

All the pieces are squares with a side of 40x40 mm and a wall thickness of 0.5, 2.5 and 5 mm (Fig. 1).

The parts height is 100 mm.

The thickness of 0.5 mm is due to the minimal thickness that the Prusa slicer can use to assure the 3D printing. The parts that have a thickness inferior to that dimension can't be printed.

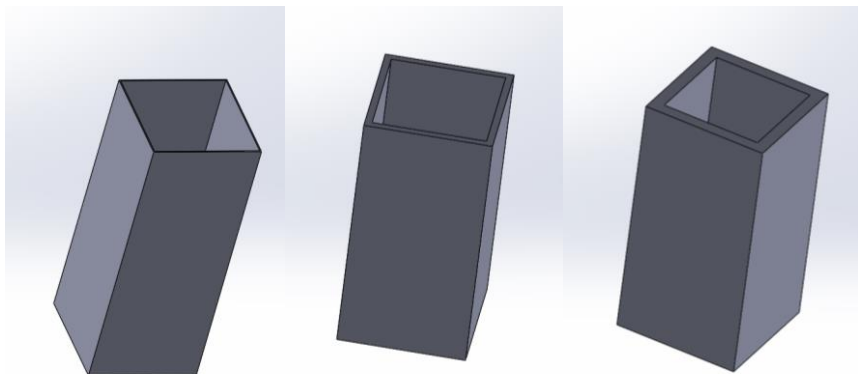


Fig. 1 – 3D parts.

For the 3D printing the parameters used are like it follows. The 3D printer used for these tests is the Prusa i3 MK3.

The material used for these tests is ABS and has the characteristics shown below Table 1 and Table 2.

Table 1
*Recommended printing settings (**)*

Recommended printing settings	Values
Nozzle Temperature [°C]	250 ± 10
Heatbed Temperature [°C]	100 ± 5
Print Speed [mm/s]	up to 200
Cooling Fan Speed [%]	30 (0–50*)
Bed Type	satin sheet; smooth PEI sheet;

Table 2
*Mechanical properties of 3D printing (**)*

<i>Mechanical properties</i>	Values
Tensile Yield Strength [MPa]	42 ± 1
Tensile Modulus [GPa]	1.6 ± 0.1
Elongation at Yield Point [%]	3.4 ± 0.2

The thickness of the extruded material is 0.2 mm the infill degree is 25%, and in order to keep the adhesion of the specimens, the Brim command will be used, which allows us to create an additional contact surface between the part and the 3D printer table.

Some of the 3D printing parameters will be by default, but for others like, fill patern, we will chose the option Gyroid, as seen in the Fig. 2.

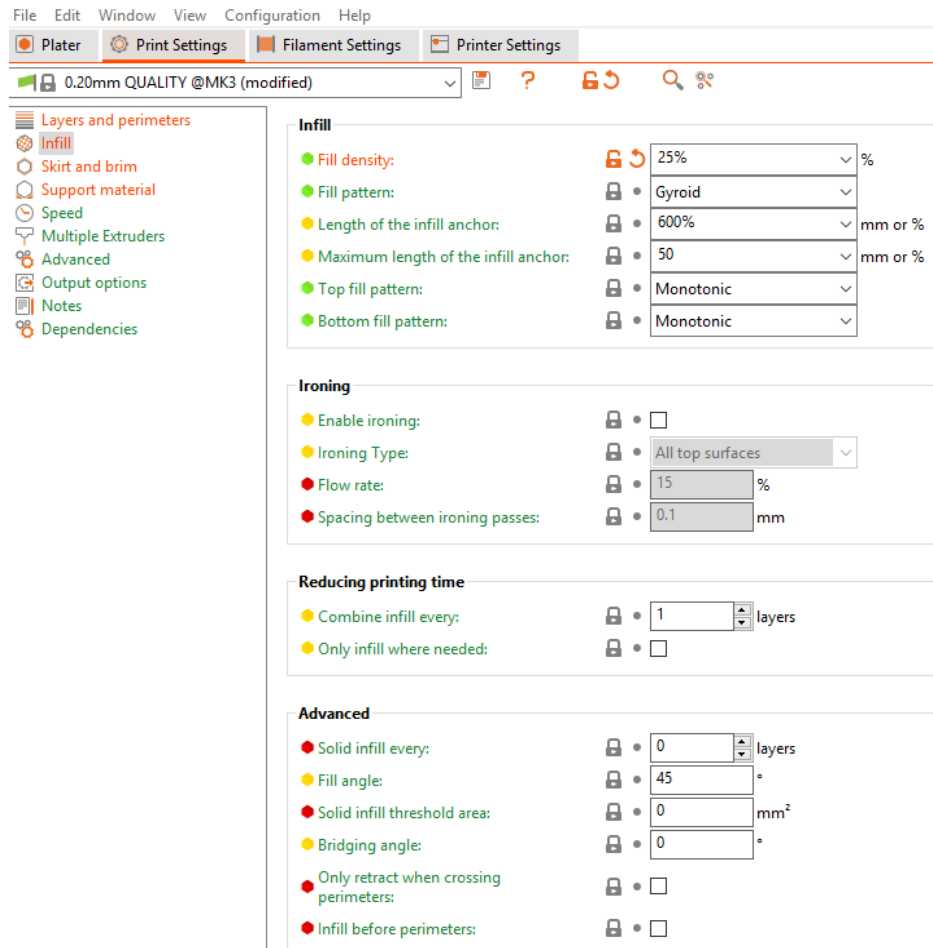


Fig. 2 – Infill properties.

Regarding the speed of printing, we proposed a speed on 120 mm/min for the infill speed and a speed of 60 mm for the external, small perimeters and perimeters, as seen in the Fig. 3.

In order to print the 3 parts according to the conditions, it is necessary to go through a program called slicer, which generates the program that will print 3D the parts, will be according to the conditions entered.

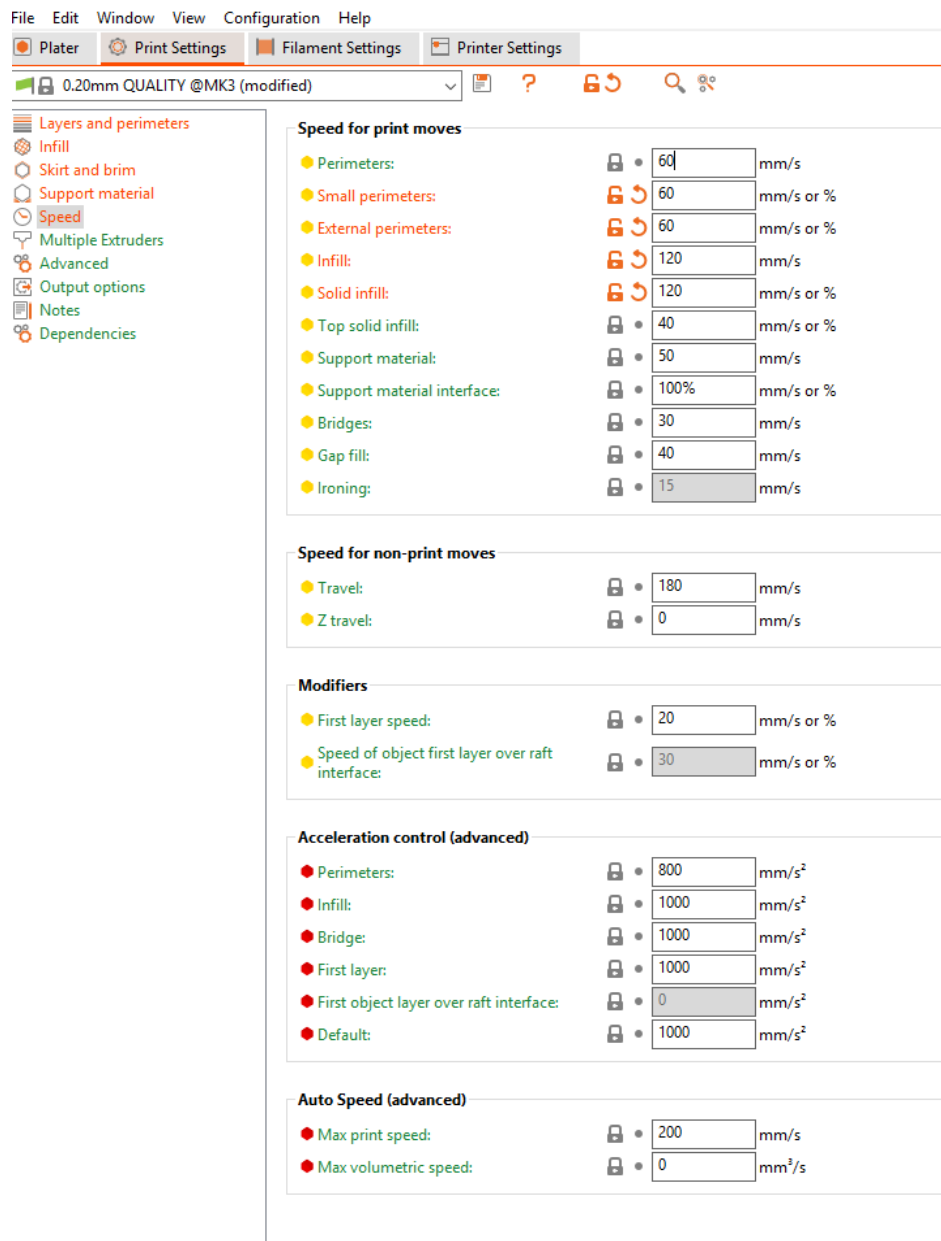


Fig. 3 – Speed for print moves.

The 3D printing parts are oriented to the bed sheet like in the Fig. 4 and we will monitor the temperature on 0.5 mm, 25 mm, 50 mm, 75 mm and 100 mm.

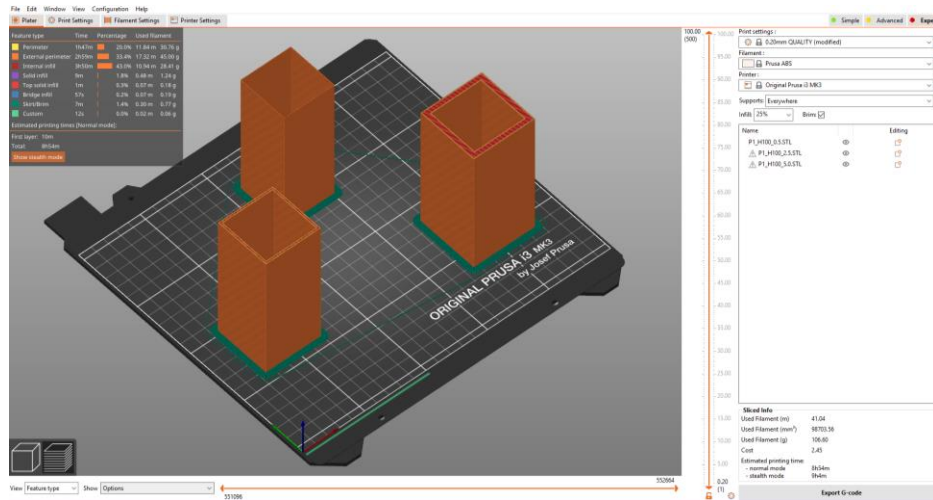


Fig. 4 – 3D printing part on the bedsheet

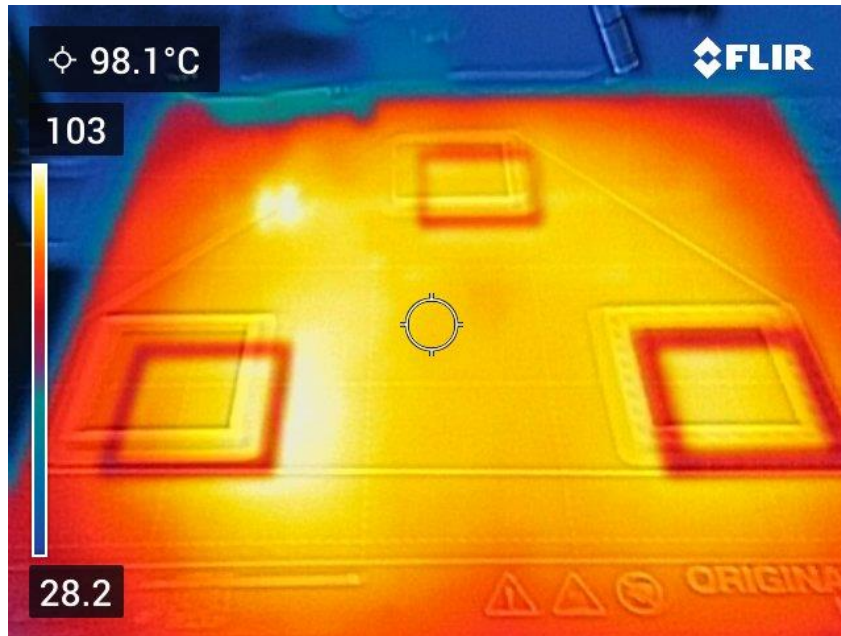


Fig. 5 – Temperature of the bedsheet.

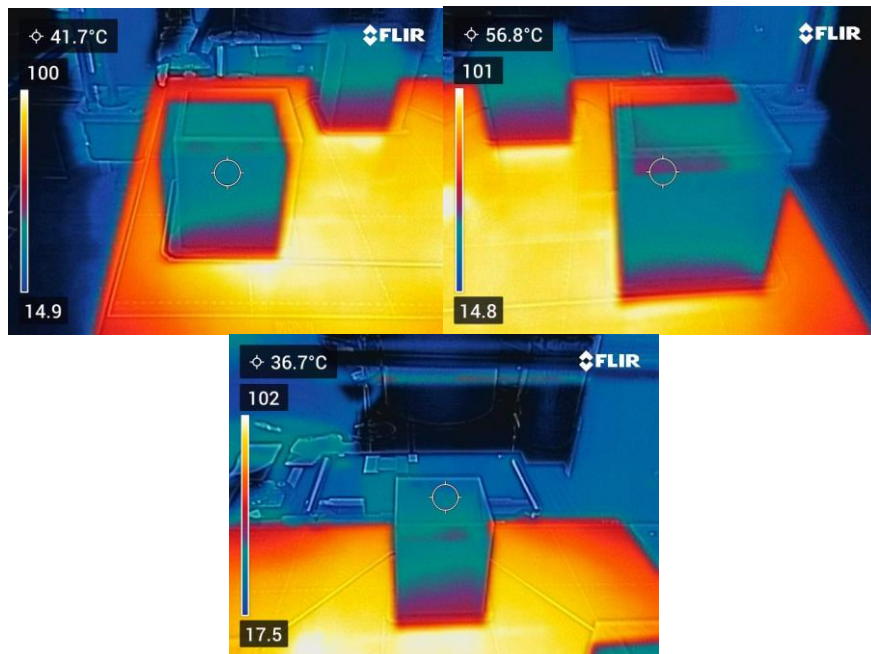


Fig. 6 – Printing temperature for Z50mm.

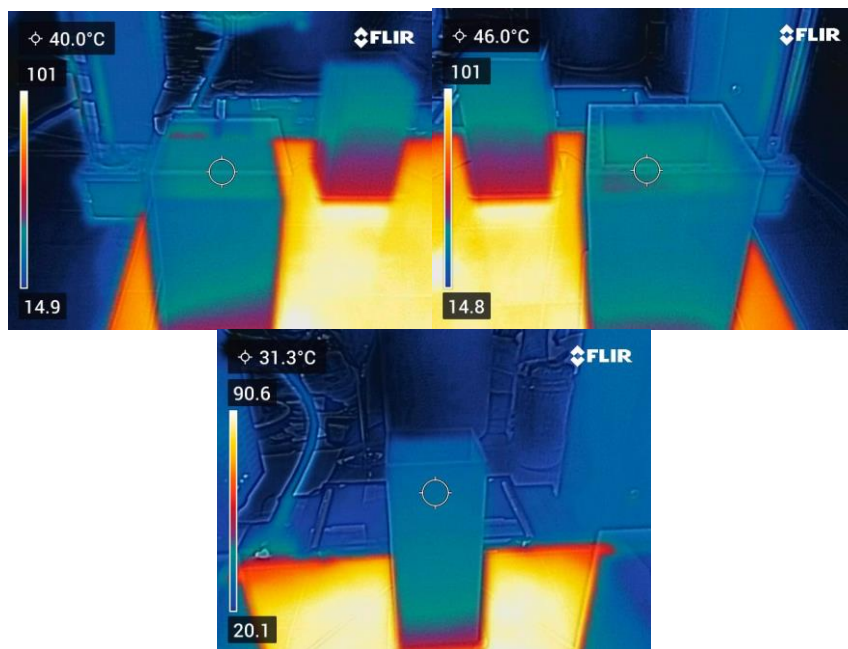


Fig. 7 – Printing temperature for Z75mm.

To be able to monitor the temperature we used a thermal imaging camera from FLIR Cx-Series.

In the Fig. 5 we can see the temperature of the bedset and also that on the edges the temperature is significantly colder. This also could have a bad influence on the printing process.

In the Fig. 6 and Fig. 7, we can identify the influence of the part thickness on the temperature.

We can see that there is a difference of 15°C between the part that has the thickness of the material of 5 mm and the part that has the thickness of the material of 0.5 mm.

We can see that there is a difference of 10°C between the part that has the thickness of the material of 5 mm and the part that has the thickness of the material of 0.5 mm.

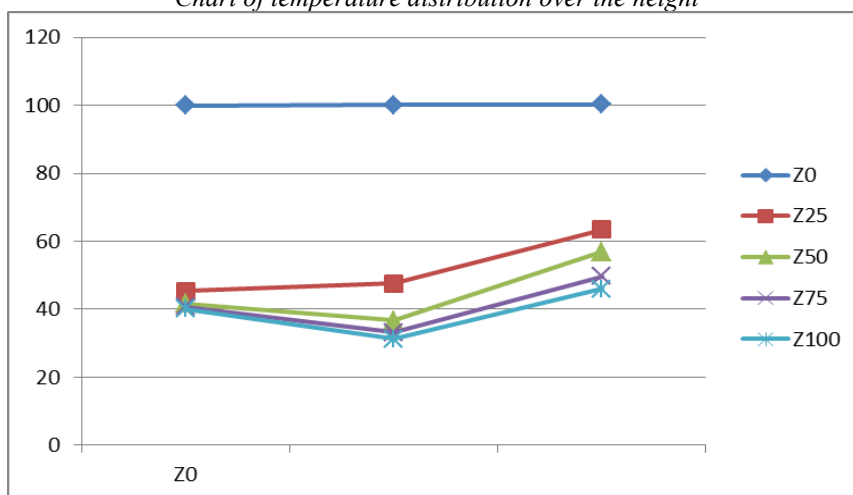
Also there is a difference of temperature between each measurement on Z. In our case between Z50 and Z100.

In the Table 3 below are the measurements taken during the 3D printing.

Table 3
Temperature distribution over the height

Height	2.5 mm	0.5 mm	5 mm
Z0	100	100.1	100.2
Z25	47.3	45.6	63.4
Z50	41.7	36.7	56.8
Z75	40.7	33.2	49.7
Z100	40	31.3	46

Table 4
Chart of temperature distribution over the height



3. Conclusions

Changing the technology isn't easy. Not for the technology by itself, but more for the people's mentality. Using in a matter of domestic problems the new technologies, will help to integrate those technologies.

Regarding the results, we can conclude that the temperature of the part in the printing zone is changing with the heights of parts.

The temperature is changing faster in the first 25 mm then after these heights.

More tests could be done for studying the variation of temperature.

This will bring also an advantage to the very volatile markets where there is the pace of 3D printing.

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VARIAȚIA TEMPERATURII CU ÎNĂLȚIMEA UNEI PIESE IMPRIMATE 3D

(Rezumat)

Această lucrare prezintă influența temperaturii pe verticală la partea care are mai mult de 100 mm.