THE EXECUTION TIME OF THE MODELS IN THE CASE OF *LOM* TECHNOLOGY

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KEY WORDS: execution time, LOM, Rapid Prototyping, RP model

ABSTRACT

The purpose of the present work is to establish the execution time of the models in the case of RP *LOM* technologies. This time is useful for finding the total execution time, because the machine offers only an evaluation of its own execution time.

The process starts with a general assessment of the execution time in the case of RP technologies, which are finally particularized for *LOM*.

1. INTRODUCTION

As we all know, nowadays one of the most important criteria when choosing the execution technology is the execution time.

That's why it is extremely important to establish this execution time as exactly as possible. But this can raise numerous problems, because nowadays there is a series of technologies (procedures) which differ little from one another. In this case it is absolutely necessary to study all the details in order to determine with great accuracy all the component times.

The Rapid Prototyping (RP) technologies are also in this situation. It is well-known that these are relatively new technologies which have known a great development in reference to the increase of applicability, of materials to be used, and of improving the quality. That's how a technology ended up having more variants of raw material used, for instance. Apart from the properties of the obtained model, this also defines the execution time.

On this approach, starting from a few general ideas we pass to presenting the modality of assessing the execution time in the case of ***L**aminated **O**bject **M**anufacturing* (*LOM*) technology, which uses as a raw material sheets of various materials.

2. THE EXECUTION TIME IN THE CASE OF RP TECHNOLOGIES

2.1. GENERALITIES

Similar to other technologies, the product's execution time in the case of RP technologies, which is in fact the RP model, is formed of more component times, i.e. a preparation time, an realization time and a time for ulterior processing. This can be written as follows:

$$T_M = T_P + T_R + T_U \quad (2.1)$$

where:

T_M - the execution time of the model;

T_P - the preparation time;

T_R - the realization time;

T_U - the ulterior processing time.

2.2. THE PREPARATION TIME

The preparation time is the amount of time necessary for checking the solid model and for transforming into a **.stl* file – the entry standard of RP machines. This transformation time depends on the complexity of the models to be done (see figure 2.1),

a) ***b)*** ***c)***

Fig. 2.1. RP models with different complexity

on the desired precision and on the performances of the IT equipment that has been used. This time category also contains the time needed for assessing the base and the necessary supports, respectively the sectioning.

It has to be reminded that the assessment of this time is pretty difficult due to the conditions previously presented and it is based on practical experience, i.e. that there are RP technologies which already don't need any supports, only a base, or no base too.

2.3. THE REALIZATION TIME

The execution time in the case of RP technologies defines in correlation with the nature of these execution technologies of the models, i.e. the stratified fabrication – as seen in figure 2.2. Therefore we can define the execution time as a sum of execution times of all layers: the base, the support and also the actual models.

That means we can write:

$$T_R = T_b + T_m + T_s \quad (2.2)$$

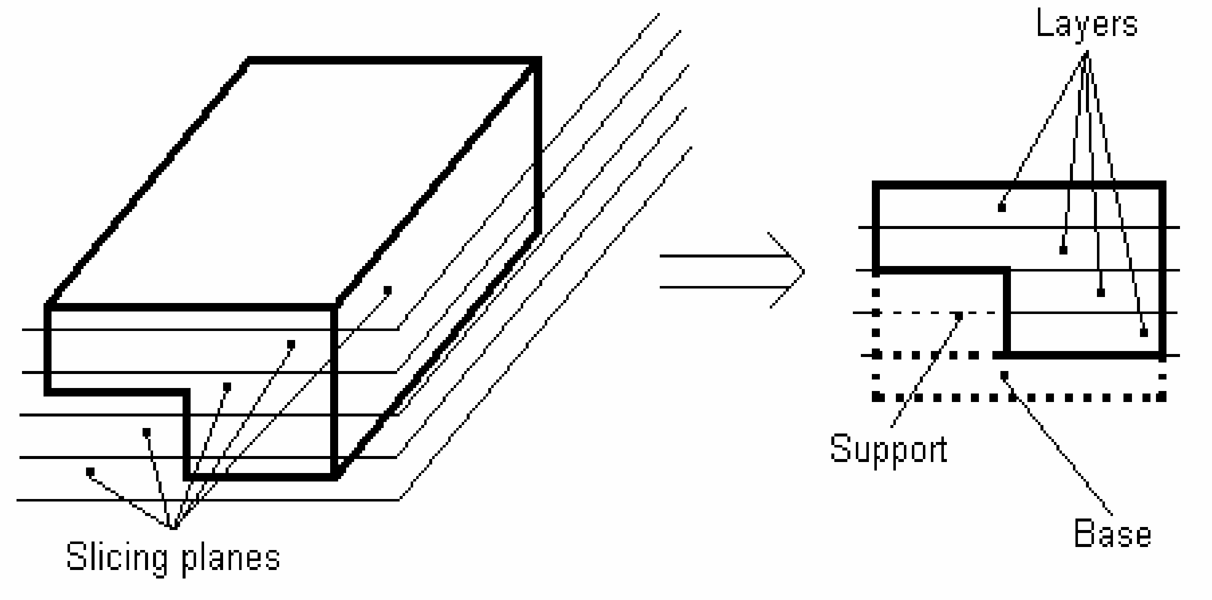

Fig. 2.2. The basic principle of RP technologies

where:

T_R - the realization time;
T_b - the realization time of the base;
T_m - the realization time of the actual model;
T_s - the realization time of the support (or supports).

At their turn these times can be defined as follows:

$$T_b = \sum_{j=1}^{m} t'_j \quad (2.3)$$

$$T_m = \sum_{i=1}^{n} t_i \quad (2.4)$$

$$T_s = \sum_{k=1}^{l} t''_k \quad (2.5)$$

where:

t'_j - the execution time of *j* section – of the base;
t_i - the execution time of *i* section – of the model;
t''_k - the execution time of *k* section – of the supports.

Replacing these last three relations in the relation (1.2) we obtain:

$$T_R = \sum_{j=1}^{m} t'_j + \sum_{i=1}^{n} t_i + \sum_{k=1}^{l} t''_k \quad (2.6)$$

The execution time for the base, the supports and the actual model are determined specifically for each RP technology. This work will assess the execution time for *LOM* technology.

We have to observe that in the case of some RP technologies the execution times of the model and of the supports superpose themselves.

We also need to remind that usually the RP machines evaluate themselves the execution time of the model. This is useful for an eventual reorientation in the workspace with the aim of reducing this time. But in this case we have to make sure that this fact doesn't affect negatively the quality of the model.

2.4. THE ULTERIOR PROESSING TIME

The ulterior processing time in some cases can be absent – when the technology assures the required quality. But in the case of its existence it can be very long, and also extremely small – depending on the complexity and the material the model is made of, and the required quality (precision and surface) respectively.

This amount of time can be usually determined experimentally, respectively on the basis of some analogies with other manual finishing operations.

3. THE EXECUTION TIME IN THE CASE OF *LOM* TECHNOLOGY

1.1. GENERALITIES

It is known that *LOM* technology realizes models from raw material in the form of sheets. These sheets are usually made of paper and seldom of plastic material. The work method is presented in figure 3.1. Based on this, we can also assess the way of defining various times, which form the total execution time.

The preparation time is a normal one, common with any of these kind of times in the case of RP technologies.

But the future processing time is a very long time, because the base and the supports have to be removed and they are being made together with the proper model. At the same time, when evacuating the base and the supports, the use of manual polishes may also be necessary in order to remove the marks of breaking. In the case of models made of paper sheets a lacquering may also be needed, in order to offer a time durability for the model.

1.2. ESTABLISHING THE REALIZATION TIME IN THE CASE OF LOM TECHNOLOGY

As it is known and it can also be seen in figure 3.1, in the case of this technology, the model is built together with the supports, which even contain it. Therefore we can't speak about separated times for the model and the supports. So the relation (1.2) becomes:

$$T_R = T_b + T_m \qquad (3.1)$$

And the relation (1.6) becomes:

$$T_R = \sum_{j=1}^{m} t'_j + \sum_{i=1}^{n} t_i \qquad (3.2)$$

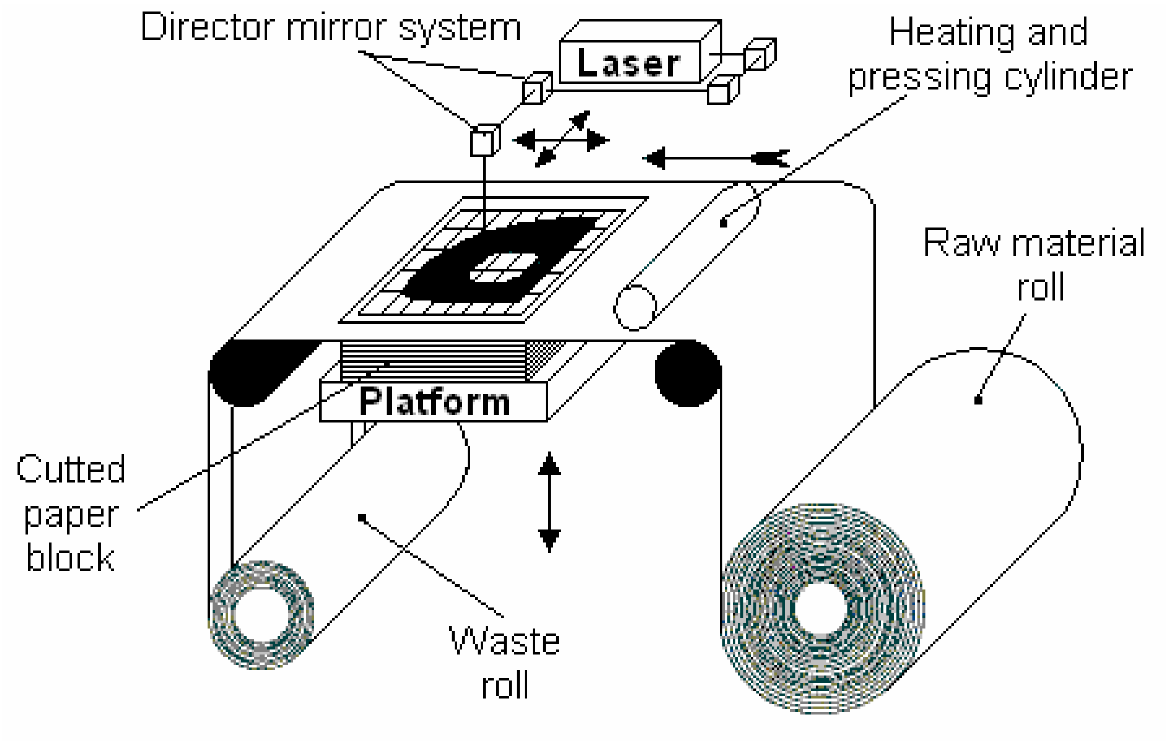

Fig. 3.1. The basic principle of LOM technology

The execution time of a base layer is given by the relation:

$$t'_j = \frac{C_{ext}}{v} + \frac{C_{\text{int}}}{v} + T_d = \frac{C_{ext} + C_{\text{int}}}{v} + T_d \qquad (3.3)$$

where:

C_{ext} - the exterior contour of the box;
C_{int} - the interior contour of the box;
v - laser's medium forwarding speed;
T_d - indexation time – i.e. moving the sheet forward and binding the current layer.

The execution time of a model's layer (and also of the supports' layer) is given by the relation:

$$t_i = \frac{C_{ext}}{v} + \frac{C_{\text{int}}}{v} + \frac{C_{m_i}}{v} + \frac{A_i}{v \cdot p_h} + \frac{A_i}{v \cdot p_v} + T_d \qquad (3.4)$$

respectively

$$t_i = \frac{C_{ext} + C_{\text{int}} + C_{m_i}}{v} + \frac{A_i}{v \cdot p_h} + \frac{A_i}{v \cdot p_v} + T_d \qquad (3.4')$$

where:

C_{m_i} - the contour of the model (the exterior and the interior summed, if this is the case) in the *i* section;

A_i - supports' aria in the *i* section;

p_h - the step of horizontal cuts;

p_v - the step of vertical cuts.

All the other notations correspond with those of the anterior relations.

Replacing relation (3.3) and (3.4') in the relation (3.2) we obtain the execution time as:

$$T_R = \sum_{j=1}^{m}\left(\frac{C_{ext} + C_{\text{int}}}{v} + T_d\right) + \sum_{i=1}^{n}\left(\frac{C_{ext} + C_{\text{int}} + C_{m_i}}{v} + \frac{A_i}{v \cdot p_h} + \frac{A_i}{v \cdot p_v} + T_d\right) \quad (3.5)$$

3. CONCLUSIONS

In order to be able to establish the execution time for the LOM technology, we have to replace the relation (3.5) in the relation (2.1). This way we have:

$$T_M = T_P + \sum_{j=1}^{m}\left(\frac{C_{ext} + C_{\text{int}}}{v} + T_d\right) + \sum_{i=1}^{n}\left(\frac{C_{ext} + C_{\text{int}} + C_{m_i}}{v} + \frac{A_i}{v \cdot p_h} + \frac{A_i}{v \cdot p_v} + T_d\right) + T_U \quad (4.1)$$

As it may be observed, this is a pretty complicated relation, but it deserves all the attention.

This work is a part of a series of the authors' works which aim to establish the execution time in the case of RP technologies. The present work is the second, and another will follow.

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