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ECONOMY BASED BACKUP MODE TRIGGER

HP INC

Economy based backup mode trigger

Abstract

In additive manufacturing, the different heat sources used can have limited lifetimes. When the lifetime of such element is relatively short, it incurs high losses in the form of wasted builds and reduced yield. In order to reduce these losses, there may be contingency plans, or “backup printmodes”, that enter into effect when such a heat source is lost (e.g. a heating lamp burns out).

Printmodes used as backup will typically incur extra costs per layer due to tradeoffs by design, therefore one should minimize their use as possible, based on cost optimization. This document describes a method to determine if, for a particular job, it is worthwhile to the job until the end (starting from the moment that the heat source is lost).

Problems Solved

If a heat source malfunctions during a print job (typically a fusing lamp), some printmodes can switch to a backup printmode. That backup printmode allows to finish the print job and salvage the contents of the plot. Whether to switch or not to the backup mode, and how many layers to print in the backup mode is not a trivial decision. The backup printmode will typically incur an extra cost. This may be due to increased rejection rate of parts, higher time per layer or accelerated degradation of the remaining fusing lamps. The decision can be made on a purely economic basis, minimizing the cost of producing the parts included in the job.

Description

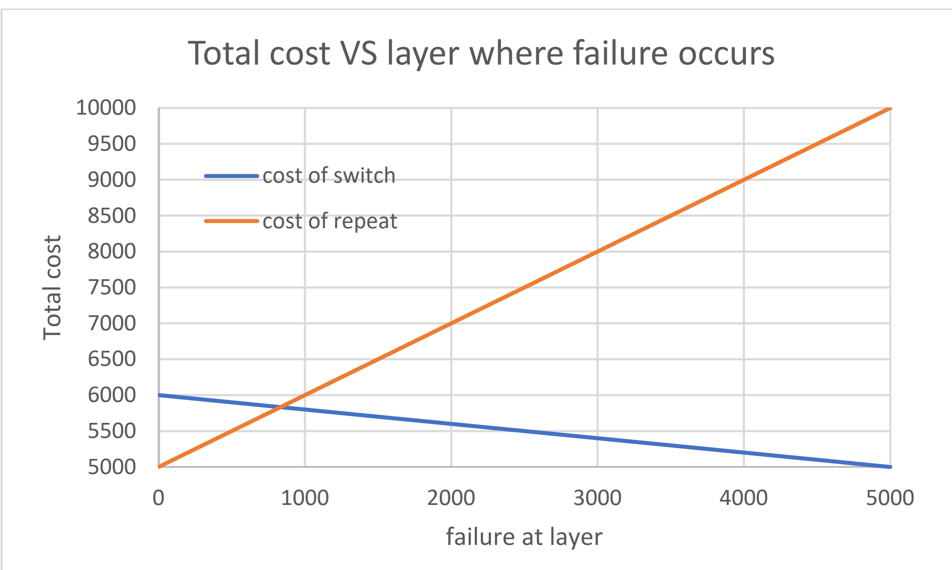
When printing a job using printmode A, there might be a printmode B available in case a fusing lamp is lost during the print. The overall cost per layer of printmode B will usually be higher than the layer cost of mode A (otherwise mode B would have been the default printmode). Specifically, the backup printmode may consist in:

- Applying a higher voltage to the remaining lamps, accelerating their degradation
- Slowing down the carriage to compensate for the missing lamp, and increasing time per layer
- Compromising part quality and increasing rejection rate

If we denote the cost per layer of a printmode $C_L(A)$, then we can argue that

$C_L(A) < C_L(B)$.

The entire cost for a plot of N layers, where the transition to mode B was done at layer n will be $n*C_L(A) + (N-n)*C_L(B)$. The alternative to consider is printing again the entire job in mode A, for a total cost of $(N+n)*C_L(A)$. To illustrate, here is the cost chart of printing a 5000 layer job with failure at the nth layer (assuming mode B is 20% more expensive, per layer, than mode A) plotted VS the layer where the failure occurs (n):



This allows quantitative optimization of the decision whether to abort a plot or proceed in mode B. For clarity, we define the layer from which it becomes economically favorable to complete the job rather than abort it as the **critical layer**.

This model is an approximation, the expected cost should be predicted based on a more detailed model that accounts for the amounts of agents for each part.

For jobs that are to be printed multiple times (such as in short/medium run production), the designer of the job can predetermine what will be the critical layer.

In case the decision is to abort, an additional degree of optimization can be achieved by considering whether printing a few more layers in mode B allows us to finish off a few parts, that are otherwise guaranteed to be rejected. Parts that cannot be finished during the additional layers are not printed.

Once a decision is made, a message is displayed to the user (on the screen or via an application) which explains the cause of failure, the decision made and offers a choice to override the decision. To allow enough time for the user to override an abort decision, the backup mode must always be triggered for a minimal duration of a few minutes.

An additional level of optimization is achieved if parts can be tagged as “sensitive” to indicate that they may not be printed in printmode B. If the economic decision-making module decides to continue in printmode B, these parts will automatically be removed from the plot to avoid wasted agents and material.

Advantages

The proposed process optimizes the use of a backup printmode, taking into consideration the economic impact of the backup mode, to minimize the total cost of printing.

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