Laboratory for Manufacturing Systems and Automation

«DESIGN FOR ADDITIVE MANUFACTURING: GEOMETRIC PARAMETERS & FRAMEWORK»

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Abstract

Additive Manufacturing (AM) is one of the fastest growing and most promising manufacturing technologies, offering significant advantages over conventional manufacturing processes. Flexibility, inherit design freedom, and cost-free geometrical complexity. However, design freedom is not infinite; AM processes have their own limits that should be understood and respected in order to bring optimum results at manufacturing. **In this work a review of design rules and considerations will be introduced accompanied with the inner mechanics and their affection on the resulted product.**

Albeit precocious the hype created throughout the additive manufacturing community and media, seems underpromised. The real value and the advantageous nature of AM technologies will only be exploited by a change in the design philosophy. The existing DFM of conventional manufacturing processes contributes to the **psychological design inertia** which misleads the engineer to adapt his design. On the one hand this inertia obstructs the full exploitation and optimization of the production process by AM technologies and one the other hand creates issues and obstacles as certain geometries that can be effortlessly created by conventional manufacturing, are extremely difficult to be produced with AM technologies. That is, with the AM technologies most constraints and limitations related with conventional procedures are abolished. The question of whether AM technologies is the future of personalized production can be determined once designed products follow the mentality imposed by AM's nature and basic rules. Therefore, the question of replacing conventional treatments with the new additive AM technologies will be redefined to a more specific one: what will be the part and the extent of the manufacturing industry that AM technologies will occupy and what is the seriousness of the design boundary to the result.

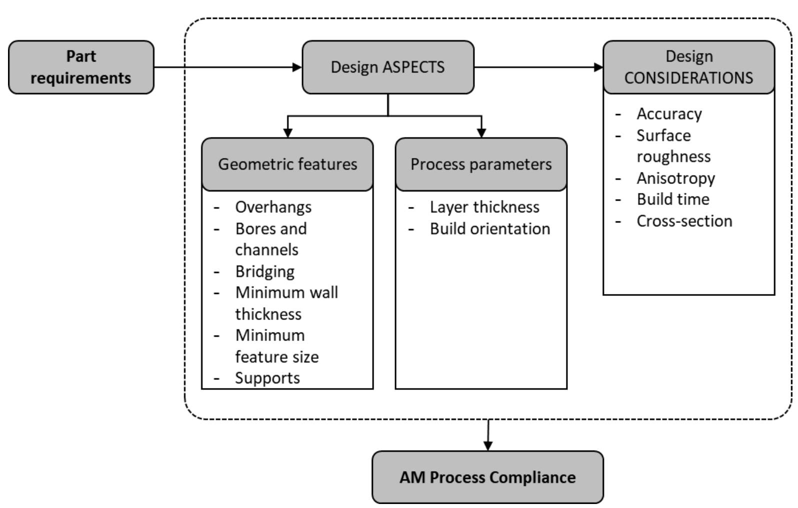
DfAM Defining Terms

Design ASPECT:

Is defined as any particular feature or variable of the entire design process. Design aspects can be either geometric features of the part or parameters of the AM technology and process .

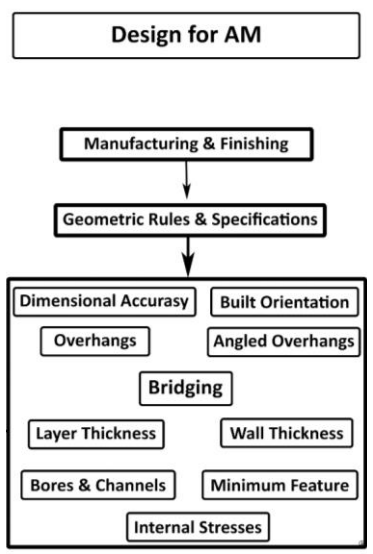
Design CONSIDERATION:

Is a resulted affection on the manufactured part. That includes mechanical properties, KPIs or First-Time-Right manufacturing.



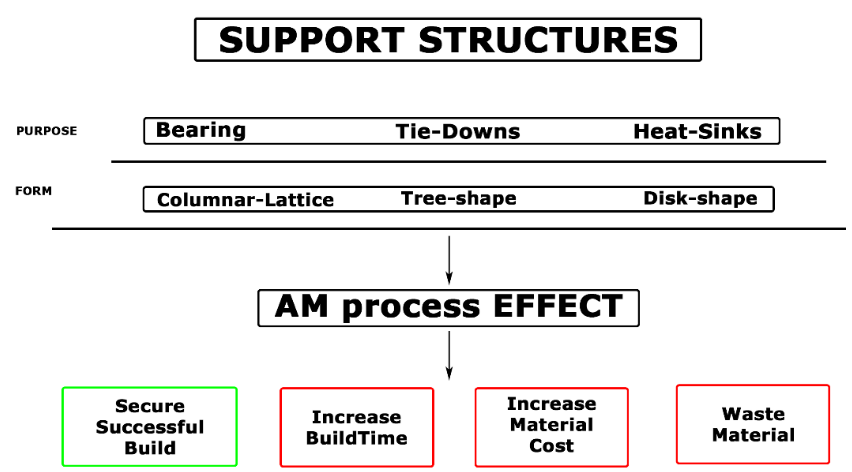
Approaching the multidisciplinary problem of DfAM

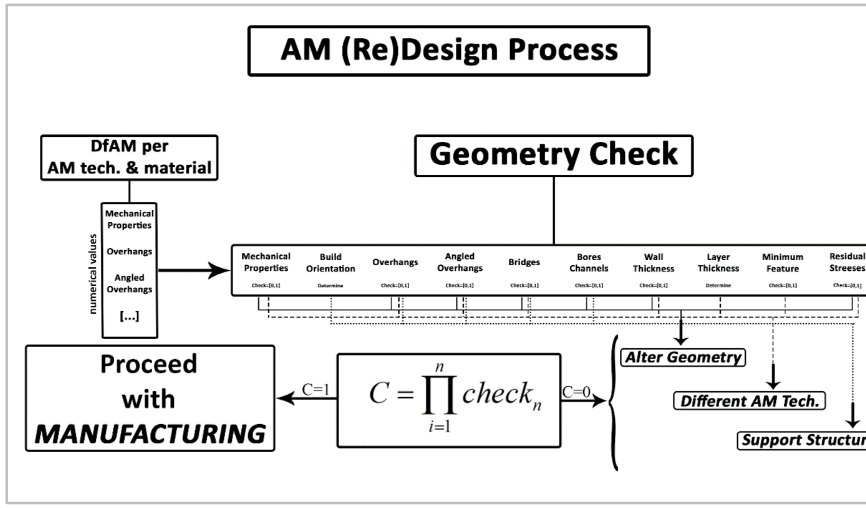
The design process is conventionally approached in a linear fashion where as the design stages progress, new considerations and limitations are introduced dictating the geometrical shape of the part design. That is, the part's geometry is highly corelated with its outcoming properties when manufactured. Deciding upon the specific aspects of a part's design is not of a dual nature as a single design aspect can affect multiple design considerations.

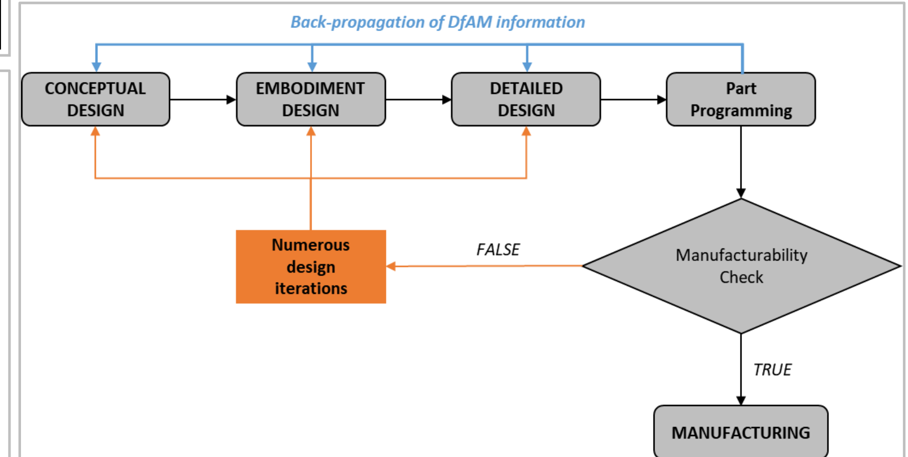


Support Structures

Supports to a part can be: bearing structures, tie-downs, or wafer supports They are a widely talked topic that has produced controversy to the scientific AM community. The most asked question regarding supports is whether a part design can be successfully manufactured without them. Seeking a simple yes or no answer will prove pointless as it is a multi-disciplinary feature of the build. The initial design phase of a part aims to achieve a geometry that does not need additional supports and can be self-supporting. When a part design cannot follow the considerations presented above supports are created to have a successful print.







Conclusions

Designing a part or assembly of parts to be manufactured with an AM technology has to abide to a specific set of rules to ensure manufacturability. The backpropagation of the DfAM information and the mechanics of the peripheral post-processes is essential for the optimization of AM production. It also aids the decision-making process of whether to manufacture with an AM technology or with traditional manufacturing.

Further Work

As of further steps of this current work is the development of the design framework in order to accomplish the following:

- Identify and categorize the data and information from all the AM processes
- Intergrade AI algorithms to better analyse and interpret live data during manufacturing.
- Creating function driven parts with generative design that abides the DfAM rules and secures manufacturability.