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STRUCTURED PMI SOLUTION

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Technical Disclosure Title

Structured PMI solution

Short Title

A platform providing a growing library of shape descriptors and their associated geometric dimensions and tolerances and other desired properties along with intended post processing action descriptors that the digital manufacturing industry may use to facilitate communication between various parties

Technical disclosure

Geometric dimension and tolerances (GD&T) have been developed long before additive manufacturing. They are typically focused on basic shapes that can be molded and detoured. Current GD&T along with some other descriptors are referred as product manufacturing information (PMI) which are attached to part designs. Various Computer Aided Designs (CAD) tools use different PMI structure variations to capture their respective PMI allowing semi-automated down-stream process. Most CAD tools have developed import export mechanism to exchange PMIs with other well-known tools. Some standard such as the STandard for the Exchange of Product model data with compliant Numerical Control (STEP-NC) aim at facilitating communication between various CAD tools and various physical inspection machines but are incomplete to serve growing additive manufacturing needs and are not rigorously adopted in the industry.

As many more descriptors are needed to capture the complexity of new shapes and new automation and degrees of customization made possible in additive manufacturing, the current PMI descriptors are not rich enough.

Besides, as a digital manufacturing process can mass produce custom parts, it will not be able to rely on statistical sampling to vet the quality of a large batch of identical parts that use to come from the same mold. Instead of using a manual process to read unstructured PMI and measuring a part per thousand or per million, each custom part arriving in a random position in a batch should be red and scanned automatically and vetted against its CAD's PMI. Given the throughput required, physical inspection won't be possible, and digital scanning will prevail. Some other down-stream processes are currently relying on workflow implementations that are customized to the type of parts that they are processing. As digital manufacturing departs from classical batch production to mass custom part production, a growing variety of down-stream processes will have to adjust dynamically to a growing plurality of part types.

While GD&T standard provides a base to build from, it lacks descriptors for digital manufacturing and its symbols and structure which were made for human readability do not seem optimized for automation. ISO 10303 standard often called STEP and STEP-NC are rightly focused on solving the type of issue

describe here, but they seem mainly focused on traditional manufacturing scope or on the niche of automated dimensioning by physical inspection.

To scale PMI into the additive manufacturing industry, a solution can be stood up to host a PMI structure standard that can be enriched by new shapes and features along with process descriptions as they come up. Allowing their monetization to accelerate their creation.

Structured PMI solution proposes a way to describe an ever-growing diversity of shapes and features, and plurality of down-stream process description made possible by digital manufacturing. It offers a solution to automate the usage of these PMI descriptors across various parties from a designer down to an end consumer of the part who wants to know how a part complies to its design. Besides it may help any parties involved along the digital manufacturing chain for example in packing, printing, de-caking, cleaning, dyeing, surface treating, scanning, vetting, underwriting, track and tracing and potentially learning one more time how the part differed from its GD&T's intent before being recycled.

Like mobile apps may be downloaded for free and for fee, a business model for a structured PMI solution may be:

1. Pro bono and solely based on brand return to its sponsors or to the overall industry growth
2. Fee based: Structured PMI contributors and structured PMI solution may be paid based on number of designs and number of parts printed (both referencing a given structured PMI). Structured PMI usage can be captured in a 3D printing process and monetized by the packing tool upstream and the quality assurance process downstream when recognizing that a given PMI-id has been used.

Note: In the fee mode, a contributor fee per PMI-id used will likely remain very small as it is intended to recoup the cost of creating that structured PMI. Any one feeling that such contributor fee is too steep may easily create a clone of that PMI and rework a CAD to call that clone and net the fee out. However, a base solution PMI fee can apply on either thus securing revenue for a platform that can run them.

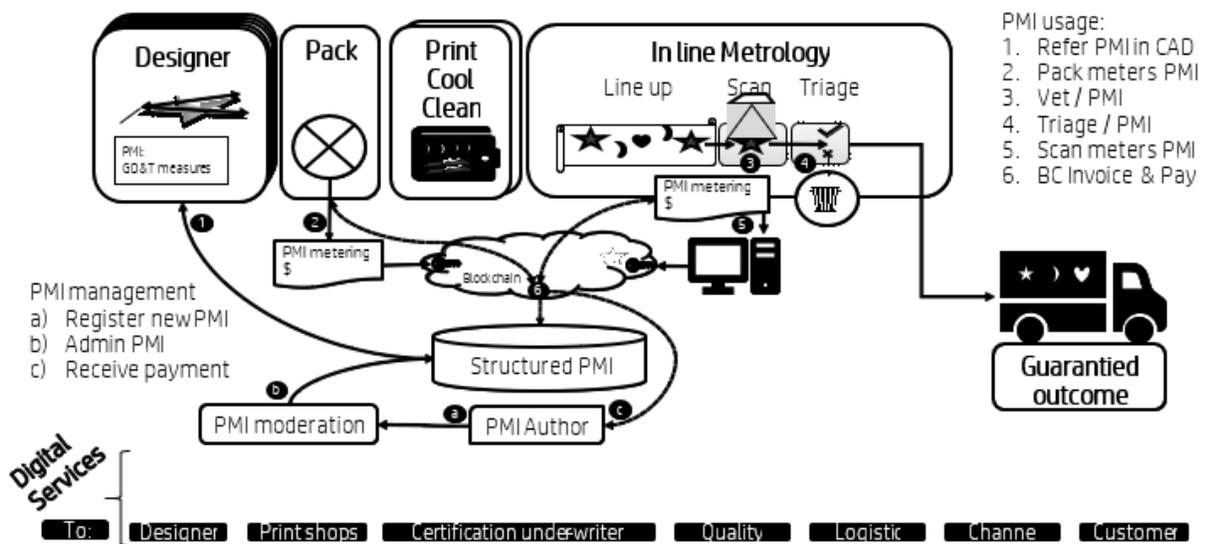
As illustrated in figure 1 such a solution can comprise of:

- A structured PMI management system:
 - o A platform hosting a logical framework containing:
 - A set of PMI descriptor types each specifying the number and the types of attributes they must contain
 - Unique reference per PMI descriptors within each PMI types
 - o A PMI moderation process:
 - A portal where new authors may register, enter their financial details and set PMI fees.
 - A portal where authors may propose new PMI of an existing type (preferably) and PMIs of a new type (Rare and more complex
 - A validation step to check if a new PMI respects the structure of an existing type at which point it may be activated.

- A control step to check why a new PMI type may be needed with the view to minimize these types
- Structured PMI solution setup by which:
 - A packing tool or a 3D printer or a 3D metrology system can register to the solution in order to access its various unique structured PMI
 - Via a certified module coupled with the HW that ensures all structured PMI in use will be metered (for example a blockchain enabled module)
- A PMI usage operation:
 - Such that a designer may freely refer to an existing structured PMI in a CAD's PMI and adjust its parameters
 - A mechanism (for example via block chain) that collects usage of a structured PMI at a registered station (For example packer, printer, scanner, ...)
 - A mechanism (for example via block chain) that bills a party using a structured PMI and credits both its author and the platform.

Figure 1: Structured PMI enables manufacturing at scale

Any beneficiary of structured PMI registering its action may pay a nominal fee to the author and the platform



Such a system can increase interoperability between various value add providers in the industry and accelerated PMI innovation fueled by fair profit pools retributing PMI authoring investments and the cost of running the platform. In such a model, PMI authoring prices may remain limited by natural competition like in any platform business. And positive brand impact for each participant may rise by establishing a platform business and using block-chain both of which increasing their company's valuation ratio according to Gartner.

Disclosed by Patrick De Marcillac, HP Inc.