MxD 14-02-04	Category: PO to 1st Article, Recurring Manufacturing
Title:	Automated Assembly Planning: From CAD Model to Virtual Assembly Process
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Problem Statement:

Manufacturing is dominated by two main activities: making individual parts and assembling these parts into a product. It is often the case that many individual parts are created by other manufacturers (OEMs), which introduces many additional logistical challenges such as procurement, shipping, receiving, and planning the orchestration of the suppliers. While manufacturing processes may vary amongst manufacturers, a common problem is planning how to assemble a given product. Since assembly operations are labor intensive, it is important to plan their execution carefully. According to the literature, approximately one third of the total labor for manufacturing a product is dedicated to assembly operations. Therefore, any effort to automate and optimize the process is highly relevant. Automated Assembly Planning (AAP) tools could provide significant benefit to reducing time and cost for multiple industries, ranging the assembly of small (electric toothbrushes made by Procter & Gamble) to large products (airplanes made by Boeing).

Summary of Findings:

- Design of a revolutionary geometric reasoning scheme to efficiently derive geometric and mating constraints from the tessellated models.
- Implementation of a novel complex geometry detection tool to identify fasteners, gears and springs in a tessellated assembly model.
- Creation of an efficient graph representation of the assembly model to generate the valid assembly candidates.
- Application of an AI recursive optimized search to explore the search space for the optimal assembly plan.
- Implementation of a Gaussian Process model to evaluate assembly time and the predictive uncertainty based upon tessellated models.
- Implementation of an evaluation method to evaluate the physical stability to achieve more stable assembly options.
- Use of Multi-objective optimization evaluation to satisfy user requirements of assembly time, minimizing uncertainty, and physical stability.
- Completion of a minimum cost rotation search to optimize the rotation during the assembly process.
- Implementation of a user interaction tool to effectively interact with the IC.IDO virtual reality platform for receiving and applying user feedbacks.
- Use of an Online Gaussian Process model to learn user feedback of actual assembly times to increase model accuracy.
- Scheduling of the generated assembly plan for optimally allocating workers throughout the assembly operations.

A short video on the outcomes of their project can be found at:
https://www.youtube.com/watch?v=FRv0CYLHfec&feature=youtu.be.