

# Automated Assembly Planning: From CAD Model to Virtual Assembly Process

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## Abstract

Assembly planning is a crucial task for every manufacturing product. In general, assembly operations consume more than 30% of the total manufacturing time and cost. Therefore, any effort in optimizing assembly will have a significant impact on the economic success of manufacturing. Finding an optimal assembly plan by hand is tedious and perhaps impractical for the large models. This research introduces an automatic computational tool in automated assembly planning (AAP) to automatically transform a CAD assembly into a set of assembly instructions. The goal is to make this transformation with as little user commitment as possible. Thus, automation is applied on every detail of the work. The work has five main divisions: geometric reasoning, complex geometry detection, graph representation, AI Planning and post-planning. To have the most general assembly planning tool, tessellation is considered as the representation of the input model. A revolutionary reasoning scheme is implemented to efficiently derive geometric and mating constraints from the tessellated models along with detection of complex geometries including fasteners, gears and springs. The mating information between assembly parts are stored in a liaison graph which is the starting point of an artificial intelligence planning procedure. Various graph-based algorithms are implemented to generate feasible assembly candidates. The AI planning evaluates every assembly candidate with complex statistical models and produces multiple instructions in terms of a detailed assembly tree or called *Treequence*. In the post-planning section, an optimization algorithm is applied on the generated treequence to find the optimal orientation of the subassemblies in the entire assembly process. A scheduling approach is also implemented to allocate the workers throughout the assembly tasks. The efforts of this PhD work can be visualized and edited by either a web-interface or IC.IDO virtual reality platform. The implemented tool can accommodate changes after a user has seen the result.

**Tuesday, March 21, 2017**

**10:30 AM, Rogers 226**



**School of Mechanical, Industrial, and Manufacturing Engineering**