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Rapid Tooling Guidelines For Sand Casting

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Series Preface

Mechanical engineering, an engineering discipline forged and shaped by the needs of the industrial revolution, is once again asked to do its substantial share in the call for industrial renewal. The general call is urgent as we face profound issues of productivity and competitiveness that require engineering solutions among others. The Mechanical Engineering Series features graduate texts and research monographs intended to address the need for information in contemporary areas of mechanical engineering.

The series is conceived as a comprehensive one that covers a broad range of concentrations important to mechanical engineering graduate education and research. We are fortunate to have a distinguished roster of consulting editors on the advisory board, each an expert in one of the areas of concentration. The names of the consulting editors are listed on the facing page of this volume. The areas of concentration are applied mechanics, biomechanics, computational mechanics, dynamic systems and control, energetics, mechanics of materials, processing, production systems, thermal science, and tribology.

Austin, Texas — Frederick F. Ling

Preface

Sand casting is a versatile manufacturing process with a history that dates back thousands of years. As automation and production technologies have evolved with time, sand casting methods have advanced to realize improved adaptability and efficiency. The process is now used for both large and small dimensioned products in both high volume and small batch production lot sizes. Many metals and alloys that can be poured in a foundry can use the sand casting process.

A chronic challenge in managing sand casting production is the efficient (cost, time) fabrication and maintenance of the elements that form the sand molds, specifically patterns and core tooling. Traditionally, sand casting patterns and tooling are produced manually from wood or dimensionally stable synthetic materials. The advance of numerical controls and computer numerically controlled (CNC) machining dramatically improves the efficiency and reliability of this form of tooling production.

With the invention and commercialization of the stereo lithography process in 1986, a variety of new and improved layered manufacturing processes were introduced to the marketplace. The working materials of these processes evolved from laser cured epoxy to wood like layered paper, engineering plastics and other forms. With the appropriate part data, rapid prototyping processes could produce patterns and core box tooling directly, hence the dawn of rapid tooling. While CNC fabrication processes are accurate, they consume a considerable amount of working material to get to the net tooling shape. They are also time consuming, often a critical variable in a world of short supply chains.

In this environment of dynamic technological change, the use of either CNC or emergent rapid tooling techniques to produce parts that have uncertain demand curves, like military hardware, becomes an important question for procurement professionals.

In an effort to inform such decision, the authors undertook an analysis of how tools and sand castings may be produced for a variety of part geometries. With the support of the Defense Logistics Agency, Clinkenbeard, and Lufkin, the authors developed best practice guidelines for rapid tooling of sand castings. The methodology used included:

- Identification and selection of components (w/ solid model) suitable for sand casting;
- Evaluate tooling error sources for sand casting;

- Produce the rapid tooling (by either CNC, RT or a combination) and create castings;
- Express tool path selection framework for sand casting;
- Dimensional metrology investigation of rapid tooling patterns, molds and resultant castings using best practices;
- Analysis of tooling related costs and lead times.

The results of these investigations provide the research foundation for this book.

Acknowledgement

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