Wonderbread Collectors

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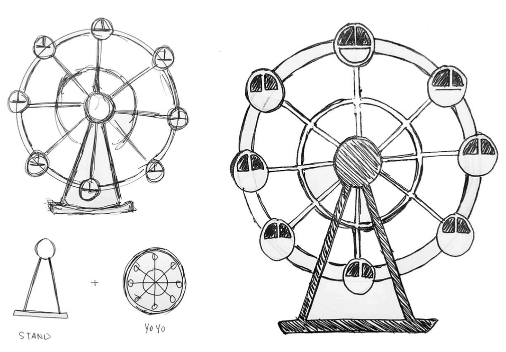
MITMECHE
2.008 Fall 2018

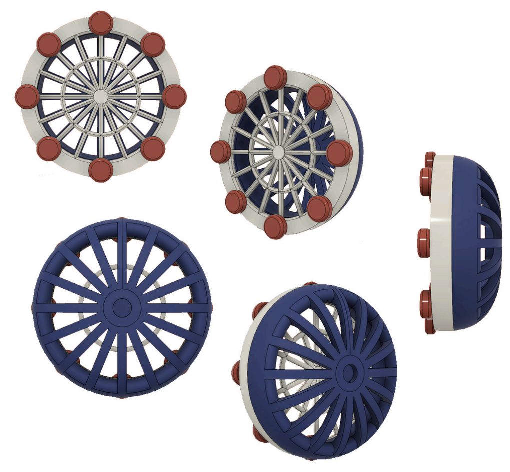
INTRODUCTION

design inspired by the Ferris Wheel
design goals: pushing complexity & beauty while maintaining manufacturability; imitating a real Ferris Wheel with as much accuracy as possible

IDEATION



DESIGN



CRITICAL DIMENSIONS

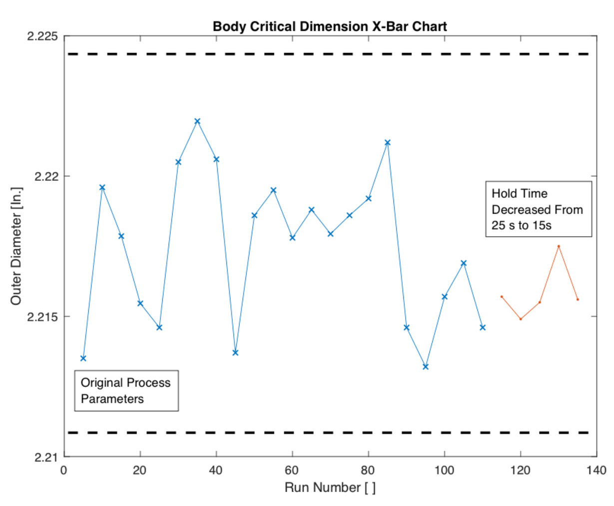
body: outer diameter of lip – to snap fit with snapring | OD = 2.220 in.

snapring: inner diameter of lip – to snap fit with body | ID = 2.216 in.

carriages: peg diameter – to snap fit into snapring holes | D = 0.122 in.

PRODUCTION RESULTS

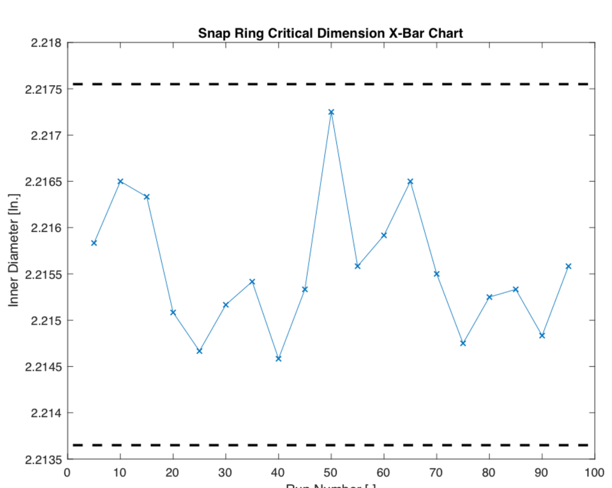
C_p= 0.5 | C_{pK}=0.5



$$C_p = \frac{ET}{NT}$$

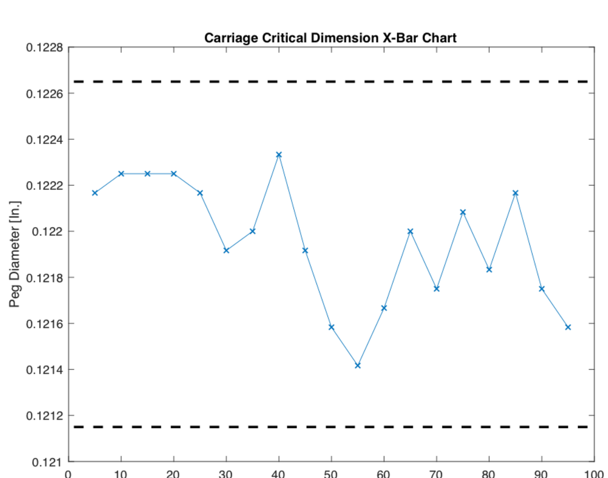
$$NT = 6 * \sigma$$
[natural tolerance]

$$ET = 3 * \sigma$$
[engineering tolerance]



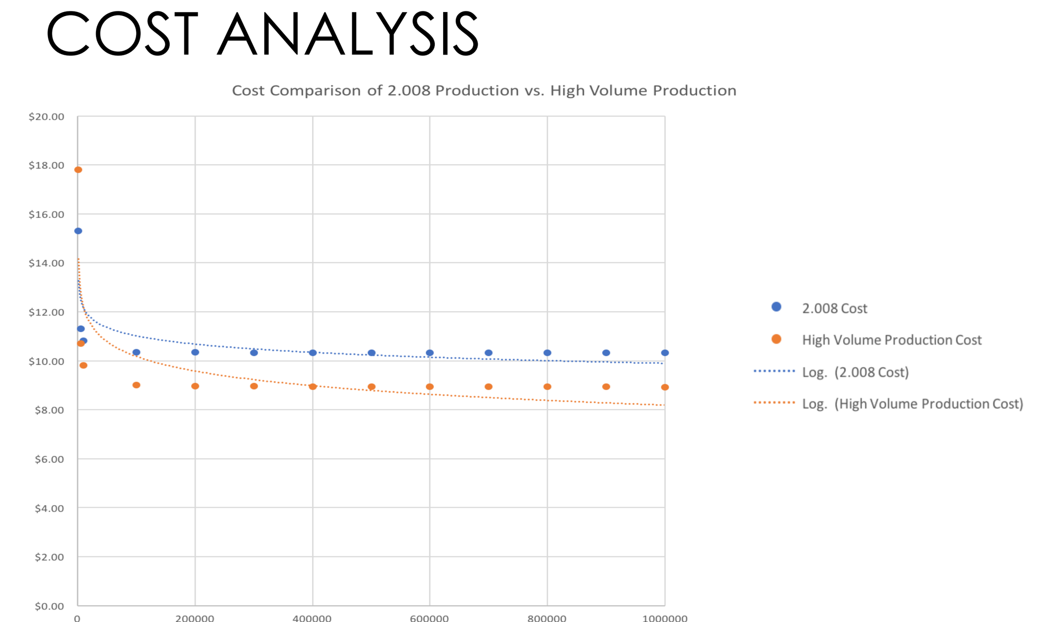
$$C_{pk} = [\min(mean - LSL, USL - mean)] \div 0.5NT$$

$$C_{pk} = \frac{1.5 * \sigma}{0.5 * 6 * \sigma}$$



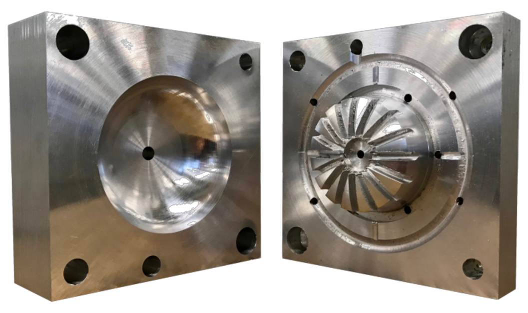
relatively low values for C_p and C_{pK} compared to industry standards, possibly because of our values for USL / LSL

COST ANALYSIS

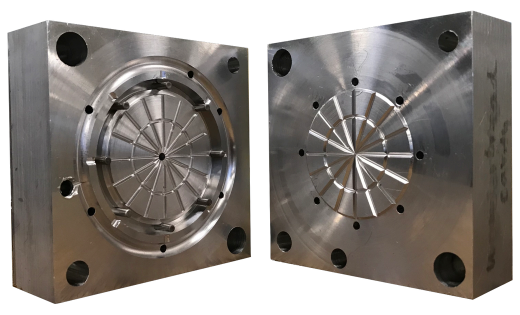


2.008 Cost	
total variable cost	$9.54
tooling cost (lifetime 1000 parts)	$768.00
total fixed cost	$5000
Additive Manufacturing	
total variable cost	$200.26
total fixed cost	$1500
High Volume Production	
total variable cost	$8.93
tooling cost (lifetime 1000000)	$5628
total fixed cost	$3250

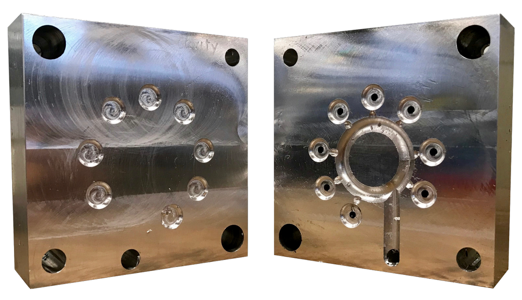
TOOLING



body mold
machined on CNC mill & lathe; 4 gates for IM, 11 ejector pins



snapring mold
machined on CNC mill & lathe; 8 gates for IM, 7 ejector pins



carriage tree mold
machined on CNC mill; , 8 ejector pins, makes 8 carriages

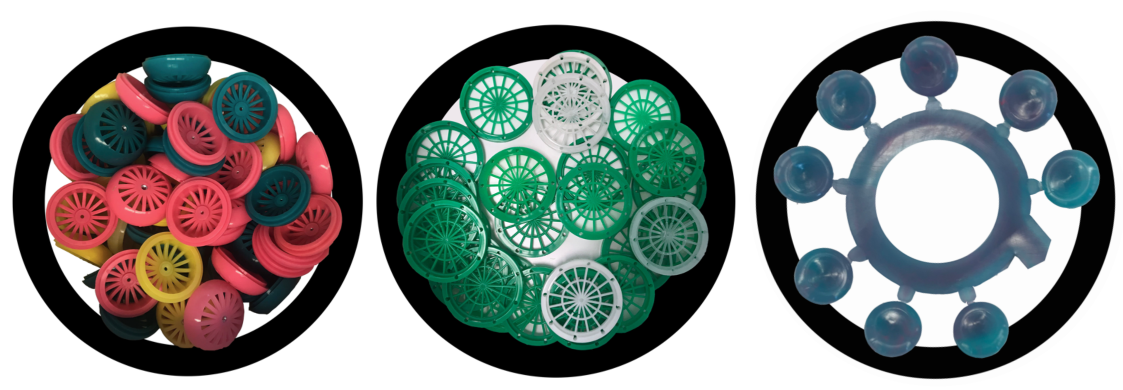
STRATEGIC TOOLING DESIGN

body: ejector pins placed on lip face so that surface flaws are masked post-assembly

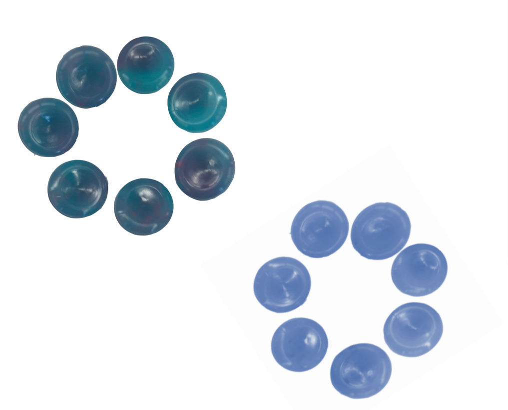
snapring: ejector pins placed on exterior runner & gates placed strategically so that carriages cover subsequent surface flaws

carriage: tree-like mold design so that one cycle makes 8 carriages – the number of carriages on one face of our yoyo – for ease of assembly; peg diameter matches ejector pin diameter for ease of manufacturing

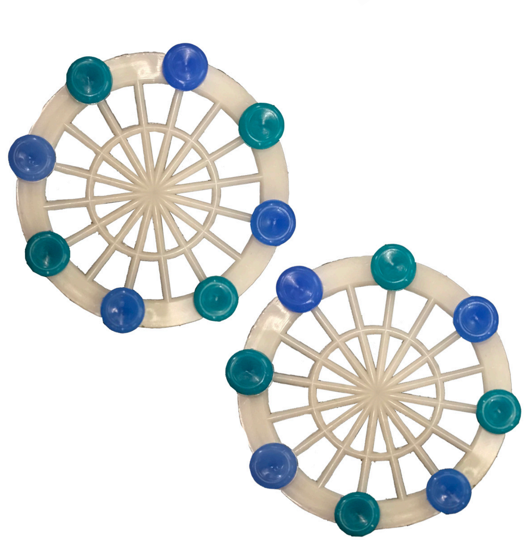
ASSEMBLY PROCESS



body + snapring + carriages



remove carriages from tree



insert carriages into snapring
fit: perfect snap fit!

press snapring and body together
fit: perfect snap fit!

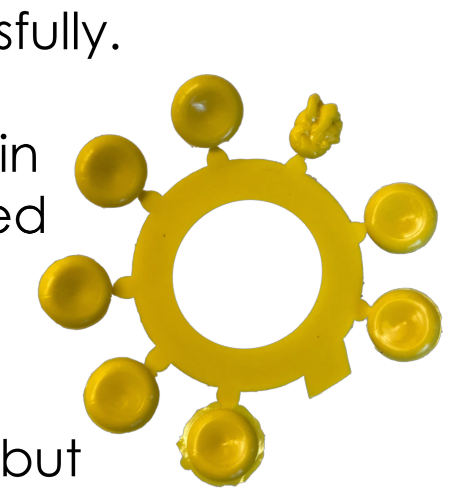
repeat for both halves

attach halves together with threaded rod and spacer

PROCESS OPTIMIZATION

body: because our body part was significantly higher in volume (thicker) than our other parts, our shrinkage calculations were inaccurate and thus our body-to-snapring snap fit was loose and unreliable. we solved this problem by machining .005" off of our body mold to increase outer lip diameter, and also by implementing rapid cooling (water submersion directly after ejecting) to decrease shrinkage.

snapring: our snapring initially failed to successfully eject and would instead get stuck in the core portion of its mold. this was partly due to the high complexity of the part, which had many thin beams that we couldn't place ejector pins on. additionally, we inserted pegs in the core side of our mold to make receiving holes for the carriage pegs, and the plastic, after injecting, would cool and shrink around those pegs, making it difficult for the part to eject. to solve the issue of the snapring repeatedly becoming stuck in the core mold, we moved the aforementioned pegs to the cavity side of the mold, after which the part ejected successfully.



carriages: one carriage in the tree consistently failed to fill completely. we adjusted parameters, increasing shot size & pressure/speed profiles, but this just increased flash while maintaining a short shot with one carriage. we realized that the problem was actually a gate in our mold, and we filed down the gate so that more plastic was able to flow through.

FINAL PRODUCT