







- Prototyping (3D-print, Lasercutting, Assembly)
- Poster Layout
- Measurements of prints

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• 3D-print + measurements • Interface constraints"

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 Measurement • GPS Tolerance



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 Illustrations Concept development Alternative Mechanics

s214365 Tobias Canger Tolerance Chains • RSS - Analysis



Group 6



Concept & Gameplay

A fast-paced 1-on-1 game where players use flippers—like in pinball—to score goals on a curved, enclosed field. The ball never stops, and obstacles keep things unpredictable. First to 10 wins. Think foosball meets pinball — with real-time action and head-to-head intensity.







Flipper Mobility analysis

Data *links* := 4 : #*incl bottom ioints* := 5 : *constraints* := $2 \cdot 3 + 2 \cdot 1$

v c) 2D mobility of mechanism.

B := 3(4-1) - 8

DOF

Black spacers (axis) are bolted to the bottom plate. Bolts connecting yellow transfer-pin to handle and flipper is fixed with selftying nylon nots. Washers are added.

All bolts 3mm All holes for bolts and slot width in transferpin 3.2mm -0.1/+0.2 All spacers outer Ø6mm all holes for spacers 6.2mm -0.1/+0.2

Initial conceptual sketch Not final dimensions!



Interface Constrants



Measurements of Prints



Label	Description	Nominal	Measured	Variation	Tool
А	Outer height	17.30	17.39	+0.09	Caliper
В	Slot height	5.30	5.32	+0.02	Caliper
С	Axis Hole inner Ø	6.2	5.82	-0.38	Caliper

Interface & Part Design

The two identical interfaces of the transfer pin (pink) has been chosen. The mechanism has low tolerance requirements and permits "large" dimensional variation without affecting functionality. It does not rely on precise alignment or tight fits but transmits rotational motion through loosely connected parts, where clearance is acceptable—and even beneficial—to ensure easy assembly and avoid binding and finally low production price.

constraints := 8

B := 1

The interfaces are designed with "generous" clearances, comparable to ISO fits like H13/d13. This type of fit allows substantial play, making it suitable for low-precision, non-critical joints where manufacturing variation and other parameters should not hinder movement.



The axis are parallel (<1.5deg difference, 95% cases) but they are not confounded (>1mm distance)





Final Mechanism Solution

The mechanism was chosen due to its simplicity, allowing for straightforward 2D calculations and ease of fabrication using laser cutting. During development, several design iterations were made: the transfer pin was extended to increase momentum, and certain dimensions were adjusted to provide more material around weak points to prevent cracking. Initially, tight tolerances were used, but as testing showed they weren't necessary, they were widened to allow

Tolerance Specs & stack-up analysis



Sensitivity Analysis

"Circular Polar" tolerancing for laser-cut parts, +/- 0.1mm. "Cubic" tolerancing for 3D-printed parts, +/- 0.2mm.



for easier assembly and increased robustness





Study of the transmission axis and the possible collision between the shell and the flipper through the movement.



Variations are mainly due to shell's positioning and manufacturing.

