User Guide

Version 1, August 2023

Why Flatapult®?

Flatapult® was developed from years of positive experience with hands-on problem-based learning exercises in classroom training programmes for engineering, manufacturing, quality, Lean and CI.

The Challenge

These valuable learning benefits were challenged by the transition of learning delivery from physical classrooms to remote 'virtual' training delivery, initiated as a result of the Covid-19 global pandemic. How could we maintain these valuable learning experiences? How can we continue to connect with 'hands-on' learners? Digital simulations are impressive, but typically expensive, and yet the learner remains detached from reality and a fully 'hands-on' experience.

Development of Flatapult®

Flatapult® was conceived to address the challenge described above – a low-cost, flat-pack learning aid that could be distributed cost effectively by post. It was sketched out in concept, then developed into a 3-dimensional designs, and physical models before final design.

Developing the product, brand, and supporting material also became a hands-on learning experience for my teenage children during school holidays and weekends – what better work experience than to develop, test, protect, manufacture and market a product or service?

We hope this combined product and supporting resources offer you a highly engaging learning experience – as learner or instructor.

Steve Fannon, Director & Founder, I4Excellence Ltd.

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Introduction

Flatapult® enables hands-on experience of process, measurement, variation, experimentation for learning programmes in science, engineering, quality and Lean Six Sigma.

As a low cost, easily shipped, sustainable product, Flatapult® can be incorporated into classroom, virtual and e-learning programmes, given away to learners as part of the learning package. This allows learners to participate in interactive 'learning by doing' activities throughout their training and allows continued exploration of methods and tools beyond the classroom.

As a combined product and service, Flatapult® will provide access to learning exercises and challenges, designed for use with Flatapult® hardware and hosted on our website - just point your learners to the challenge and set them free.

To see the Flatapult® in full action, follow the QR code:

https://youtu.be/r8Loe7Jc8tl

What’s in the Box?

Inside the Flatapult® packaging, there are:

- 2 side panels
- 2 main arms
- 1 cross cup
- 2 cups
- 4 connectors
- 4 wooden bushes
- 3 washers
- 1 coach bolt
- 1 wing nut
- 1 main arm propulsion bands
- 1 arm cup retaining band

Construction

Construction of the Flatapult® is guided by a short video – this is imperfect, therefore development of your own instructions as a ‘Standard Operating Procedure’ could be a useful initial training exercise.

To view the full step-by-step construction video, scan the QR code:

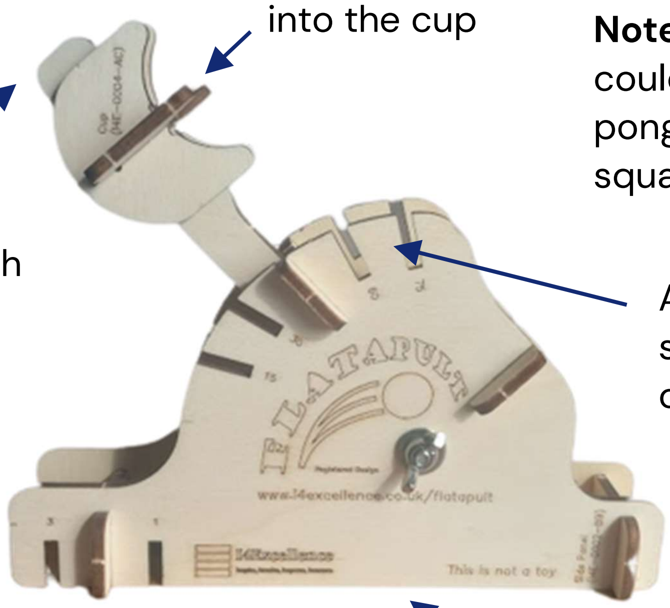
https://youtu.be/Ke9N2J3MzO8

Safe Operation

Place projectile into the cup

Note: Safe projectiles could include: ping pong ball, airflow ball, squash ball

Pull back and release to launch the projectile



Adjust settings to study their effect on performance.

Ensure that the Flatapult® is placed on a flat and stable surface before use.

Beware of additional hazards while working this exercise	Beware trip hazards - maintain 5S in your working space	Beware uncontrolled projectiles!

The Flatapult® is a learning aid, not a toy.

- Use only safe projectiles which will not cause damage or injury on impact or landing
- Check the surrounding area before launching projectiles
- Make sure hands are clear from the path of the arm as it is released
- Be aware of used projectiles that may represent a hazard in the working area – tidy-up as you work
- Recognise that the Flatapult® will jump (recoil) after launching due stored energy and inertia.

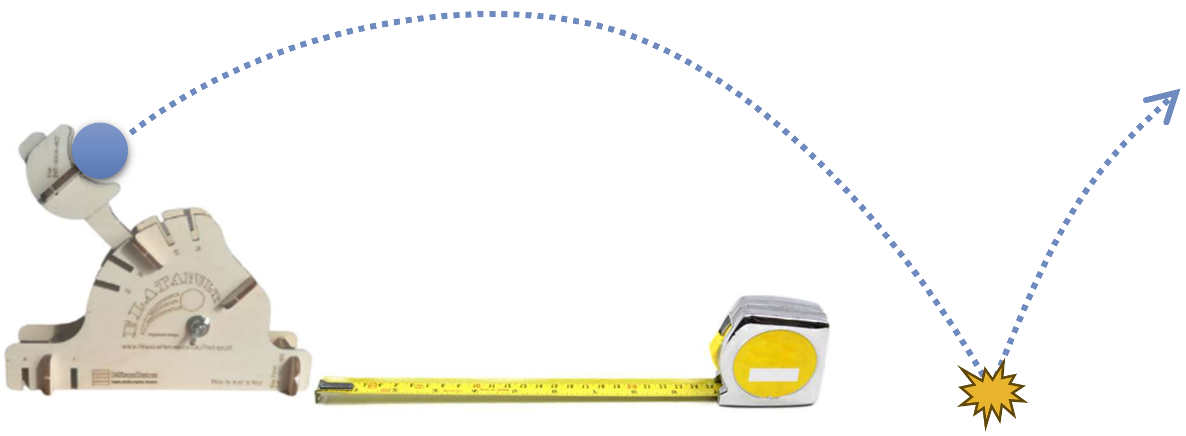
Seek immediate advice from your trainer if any equipment becomes damaged during your training exercise.

Measuring Performance of your Flatapult®

There are different aspects of the Flatapult® performance which could be measured and studied. The selection of performance measure will depend on the objectives of your study, typical measures being:

- Shot distance
- Number of shots fired
- Time between shots
- Set-up or change-over time

How you develop and analyse your measurement system will be an important part of many learning exercises. You should give careful consideration to the accuracy and precision of measurement systems that you develop. To help get things started, here is an example of a measurement approach:



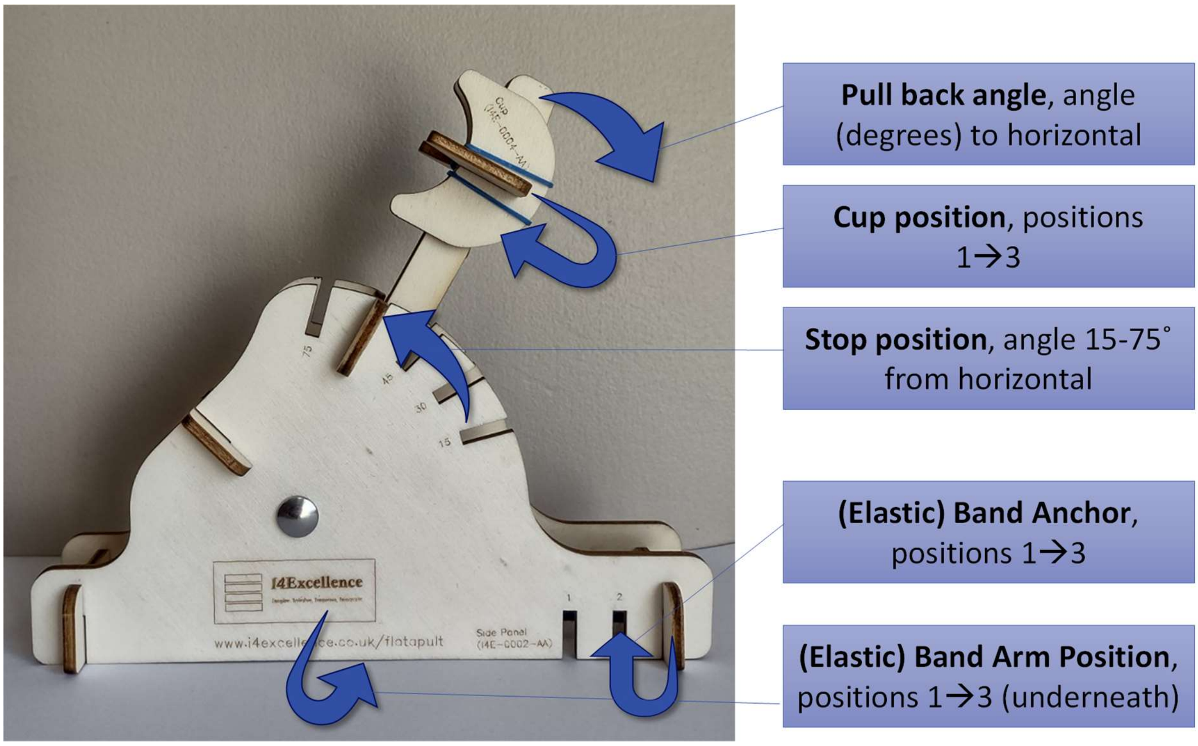
Measure distance from the Flatapult® to the mark.

Surface is marked as the projectile lands.

Changing the Performance of your Flatapult®

There are five equipment parameters that can be adjusted to change the performance of the Flatapult®. Changing these offers an opportunity to study the effect of different parameters on the performance of the Flatapult®.

Equipment Parameters:



Sources of Variability

There are many other sources of variability which affect Flatapult® performance – discovering these is what makes the learning exercises so engaging. When you have identified and controlled key sources of variability, you're on your way to Flatapult® mastery.

Available Exercises

Accompanying the Flatapult® equipment, we provide access to a suite of exercises captured as individual 'exercise brief' documents. The latest versions are available through the I4Excellence Flatapult web page at www.i4excellence.co.uk/flatapult.

The 'First steps' exercises are included in this user guide for your convenience.

First-steps - Understanding variability:

1. Experiencing variability.
2. Gaining stability – 'Standard Operating Procedure'

Measurement Systems:

3. Define a 'Standard Operating Procedure' for measuring Flatapult performance.
4. Measurement System Analysis.
   a. Attribute (Pass/Fail)
   b. Variable (Shot distance)

Process Stability:

5. Review the time-series stability of the Flatapult® process using Control Charts.

Applied Data Analysis:

6. Capability Analysis.
7. Comparisons.
8. Relationships – Regression.
9. Conduct a Design of Experiments…
   a. 2/3-level full factorial.
   b. Multi-factor 2-level fractional factorial.
   c. 2/Level with mid-points for check of curvature.
   d. Optimisation DoE – Multi-level.

Lean Process Analysis:

10. Standardisation (Assembly / Change-over Process).
11. Single-piece flow assembly of multiple units.
12. Line balancing.
13. Change-over time reduction / SMED.
14. Maintenance planning / TPM.

Process Simulation:

15. Build a monte-carlo simulation to analyse performance of a multi-stage Flatapult® process.
16. Build a discrete event simulation to analyse performance of a multi-stage process.

Failure-Mode Avoidance:

17. Significant & Critical Characteristics.
18. PFMEA – Assembly & Change-over.
19. DFMEA / ESA – Systems Engineering & FMA Analysis.

Problem Solving & Improvement Methods Consolidation:

20. Full team-based consolidation exercise using a structured framework for problem-solving & improvement e.g. DMAIC.
21. Team-based problem-solving and improvement exercise for a multi-stage Flatapult® process – simulates leadership of a portfolio of improvement and optimisation activities.

Exercise 1.

Getting Started - Studying variability

Step 1: Correctly assemble and set-up the Flatapult® and establish a way of measuring shot distance.

Step 2: Launch and measure 20 consecutive shots from the Flatapult®

Step 3: Change Flatapult® operators, then launch and measure 20 more shots.

Note: The data recorded from shot distance measures should then be gathered in a column of a spreadsheet using Excel® or equivalent software.

Step 4: Identify observations from the data, e.g. longest and shortest shot fired, the range.

Step 5: Calculate statistics from the data, including the mean, median, mode and the standard deviation.

Step 6: Plot the data as a run-chart (line chart in Excel®) and look for patterns in the data.

Step 7: Plot the data as a histogram to review the data distribution.

You could: Compare the distribution of data between the two different operators working the Flatapult®.

Reflect: What have you noticed about...

- Multiple 'events' (Flatapult shots) in the process?
- The nature of the variability observed?
- Things that may contribute to variability?
- How this understanding may be useful?

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Exercise 2.

Gaining Stability – Standard Operating Procedures

Step 1: Consider the best approach for capturing the 'one best way' of operating the Flatapult®.

Step 2: Define and document a "Standard Operating Procedure" (SOP) for operating the Flatapult®.

Reflect: What do you think about…

- The potential benefits of documenting the Flatapult® SOP?
- The likely effectiveness of an SOP?
- Other activities which may be needed to support an SOP?
- The potential need to update the SOP in the future?