DECISION MAKING PROCESS

PROBLEM SPACE

LIFECYCLE ANALYSIS

FUNCTIONAL ANALYSIS

MATERIAL CONSIDERATIONS AND FUTURE ITERATIONS

FINAL DESIGN DRAWING

BADMINTON

BACK – SAVER

SYDE – GROUP 5

[DESIGN PROBLEM]

Constantly bending over to retrieve large amounts of birdies after repetitive badminton training contributes to **health problems** and puts significant **strain on the lower back**.

[TARGET USERS]

The target users of the Badminton Back Saver are any people who may have to clean up a large amount of birdies scattered across an indoor court.

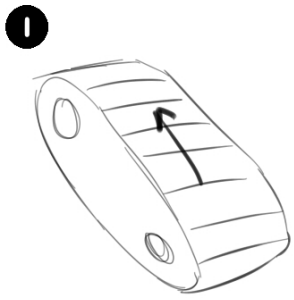
This primarily includes:

- Badminton Players (who perform repetitive training)
- Badminton Coaches
- Gym Attendants

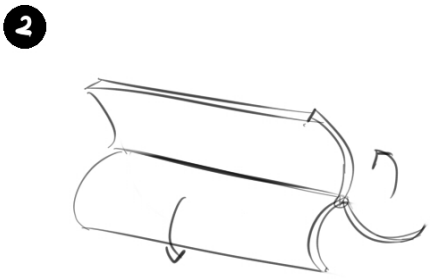
[SITUATION IMPACT STATEMENT]

"Design a device to be used by badminton players and gym attendants to collect badminton shuttlecocks from a gymnasium floor and deposit them in a catch basket that: operates effectively when pushed between the upper and lower limits of an average person's walking speed (three and six kilometres per hour), damages fewer than 1% of the shuttlecocks that it handles, and is able to collect a minimum of 35 shuttlecocks per minute (rate derived from average person's practice repetition rate)."

During the design process, we investigated 3 different designs:



Conveyor Belt



Rotating Scoop

Archimedes Screw

[QFD]

Using a Quality Function Deployment (QFD) Chart, we compared these designs against each other and against competitors to see how well they satisfied user and engineering specifications.

[CDM]

Using a Computational Decision Making (CDM) Chart, narrowed down our comparison scope to the three most important engineering specifications:

- ➔ **Pickup Fail Rate (%)**
- ➔ **Ease of Operation (normative analysis)**
- ➔ **Speed of Internal Operation (m/s)**
- ➔ **Damage to Birdies (%)**

[PROTOTYPING]

{Medium fidelity prototype}

- ➔ Demonstrated the form of our final design, but had minimal functionality.
- ➔ From user testing, we found several design problems and made changes, resulting in our high fidelity prototype.

{High fidelity prototype}

More compact, with the catch basket placed under the conveyor belt rather than on the back.

- ➔ Wheels were replaced with swivel wheels to expedite turning during operation of the machine.
- ➔ Handle was made to be telescopic to fit a wider range of body sizes.

User testing was completed to determine which features of our Medium Fidelity Prototype and High Fidelity Prototype needed to be changed.

- Users pushed the device around to get a feel for how the device is operated.

[AREAS OF IMPROVEMENT]

Based on feedback, the following areas of improvement were identified:

1) **"Hard to navigate."** ← *issues with mobility; difficult to turn*
2) **"Handle height too low/high."** ← *handle height not adjustable*
3) **"Birdies get stuck."** ← *birdies had difficulty transitioning from brush to conveyor belt*
4) **"Catch basket badly positioned."** ← Catch basket too small, not removable

[SOLUTIONS]

1) SWIVEL WHEELS

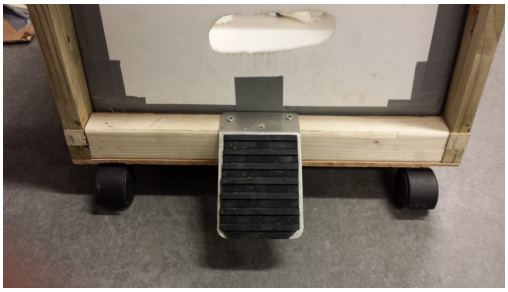
   The back wheels for the HFP were changed to swivel wheels to improve maneuverability
2) TELESCOPIC HANDLES

   Adjustable handles were implemented in the HFP to allow users to change the handle height
3) SIDE GUARDS

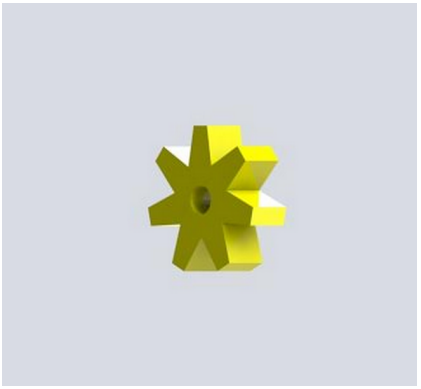
   Additional guides were added on the sides of the conveyor belt to improve the transition up conveyor belt
4) REMOVABLE CATCH BASKET

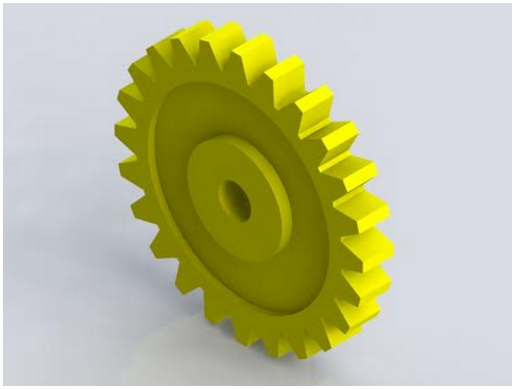
   removable catch basket implemented so that birdies can be easily retrieve



[MATERIALS AND PROTOTYPING]





3D printing has been crucial to our prototyping process, as it allows us to quickly and cheaply fabricate specialized parts. Consequently, the highest priority area for improvement in future iterations is *selecting the materials for our design*, balancing the need for them to be lightweight with their cost.

[FOCUS AREAS FOR FUTURE ITERATION CYCLES]

- Select optimal materials
- Minimize component count
- Re-design of transition between brush and conveyor belt
- Optimize design for assembly

IN SUMMARY:

The current Badminton Back Saver promotes sustainability through its usage of **recyclables** in the **transportation stage**.

However, in the other stages, it risks a large **negative impact** on the environment by contributing to **CO^2 & greenhouse gas emissions and hazardous waste**.

To reduce these negative impacts, the Badminton Back Saver should be produced using **recyclable materials** and that its **power source should be changed** to something more sustainable.

Life Cycle Stage	Inputs	Outputs	Analysis of Impact	Level of Impact	Possible Improvement
Material Acquisition	- wood - metal - pre-built electric motor - rubber - cardboard - batteries - plastic - fibres - buckets	- CO^2 from trees - Greenhouse gases from machinery in factories - Depleted of earth - Polluted Water - Air pollutants - Oil for rubber	- Deforestation contributes to greenhouse gases while reducing foliage. - Mining destroys the land, reducing ecological diversity, produces waste water and contributes more greenhouse gasses - Drilling for oil produces greenhouse gases	Deforestation: **Very Negative (- -)** Greenhouse gas emissions: **Very Negative (- -)** Mining and Oil Drilling: **Very Negative (- -)**	- build own conveyor belts using recycled material - try to source plastics from recycled sources - ensure recyclable metals are used in materials
Production	- coal - oil - energy	- CO^2 emissions	- The CO^2 emissions are harmful to the environment, as they contribute to global warming	CO^2 emissions : **Very Negative (- -)**	- Outsource our energy to a clean source such as Bullfrog power
Transportation	Transportation: - diesel oil - coal (train) Shipping Materials: - wooden pallets - Styrofoam - metal (nails) - plastic - cardboard boxes	- CO^2 emissions - Recyclables - Styrofoam - plastic - wooden pallets - cardboard boxes	- The CO^2 emissions are harmful to the environment, as they contribute to global warming - The recyclables would be considered positive as they are being reused and will continuously be put to use	CO^2 emissions : **Very Negative (- -)** Recyclables: **Positive (+)**	- Change to design to be collapsible; that would allow more units to be loaded per truck and ultimately reduce the CO^2 emissions
Product Use	- batteries -aluminum -lithium -electricity	-Hazardous waste (dead batteries) -metals & heavy metals - CO^2 from burning coal - nuclear waste from nuclear energy	- batteries contain heavy metals and toxic materials which may have negative effects on the environment if not disposed of properly	Hazardous waste: **Very Negative (- -)** CO^2 emissions: **Very Negative (- -)**	- Change design to not require batteries, and rather function based off of the rotation of the wheels when the user pushes the device
End of Life	-fuel to power machines which transport and dispose of the non-reusable materials - battery disposal	- CO^2 emmisions - hazardous waste - plastic, scrap metal, wood	- Contributes to global warming Hazardous waste needs to be disposed in complicated ways	CO^2 emmisions: **Very Negative (- -)** Hazardous waste : **Very Negative (- -)**	- Change design to use rechargeable batteries to eliminate the need to dispose of them