The Tiny Oat Collider version 2

Stage:
02/10/2022 V2 - Ready to Build

Description:
Revised instructions for making a small oat dehuller - nicknamed the “tiny oat collider”. The dehuller is a semi-vertical shaft impact dehuller.

Project Overview:
The original version 1 of this open source design was funded by the Gaia Foundation seed sovereignty project. A presentation outlining the v1 design development and prototype development is available here:-
https://www.seedsovereignty.info/events/seed-gathering-2021/
https://player.vimeo.com/video/641850070?h=e2e2ed9d1f

The subsequent testing and version 2 development of this open source design was jointly funded by the Gaia Foundation seed sovereignty project and the Pebble Trust.

V2 Improvements
The version 1 design was put through a period of testing to identify areas for improvement. The below table illustrates the key changes in four categories:-

Category	**V1 Evaluation**	**V2 Improvement**
Cost	The version 1 dehuller raw material cost was ~£1102.89 but featured some complex components with a high cost / time to manufacture such as the original impeller and drive train shaft. In testing, it became apparent speed control was largely unused, with the machine operating at full speed.	The version 2 dehuller has removed the drive train in favor of a fixed speed motor. The complex components have been reduced to one (the rotor hub). The raw material cost has significantly reduced to ~£600.
Safety	The version 1 dehuller was relatively safe to use, but had no safety switch on the lid preventing	The version 2 dehuller has no exposed belts, and a safety switch and motor

Category	V1 Evaluation	V2 Improvement
	operation with the lid open, had no motor control/protection, and had exposed belts which posed a finger trap. It was also heavy and cumbersome to lift (approx 20kg)	controller. The motor controller has been downsized. It is made of lighter plywood, split into two pieces (approx 5-10kg each) and lighter/easier to carry.
Ease of Build	The version 1 dehuller had little design for manufacture, with components requiring manual machining, and medium skills/medium tooling in order to successfully assemble.	The version 2 dehuller is designed from the ground up for CNC routing of all timber parts, with assembly now being a low skills/low tooling operation.
Performance	The version 1 dehuller had a steel impact ring which through testing was shown not to be the optimum material. It had several flaws in the enclosure design which led to either trapped grain or escaped grain. It had no hopper requiring manual feeding. The impeller was a 10 vane design.	The version 2 dehuller has a polyurethane impact ring which through testing was shown to be the optimum material for dehulling oats. It has a hopper with feedgate and has no areas for trapped or escaped grain. The impeller is now a 12 vane design.

Documentation:
A full set of CAD drawings is appended as follows:-

Dwg No	Dwg Name
DH_V2_001_r0	General Assembly
DH_V2_002_r0	Impeller Sub-Assembly
DH_V2_003_r0	Enclosure Sub-Assembly
DH_V2_004_r0	Hopper Sub-Assembly
DH_V2_005_r0	Impact Ring
DH_V2_006_r0	Rotor Hub

Dwg No	Dwg Name
DH_V2_007_r0	Single Line Diagram
DH_V2_008_r0	Rotor Hub Washer

CAD Files

The v2 dehuller was designed and modeled in Autodesk Inventor. A full export of the CAD assembly is appended as follows:-

IGES	Dehuller V2.igs
STEP	Dehuller V2.stp

CAM Files

The v2 dehuller was designed for manufacture in Autodesk Fusion 360. A full export of the parts designed for CAM is appended as follows:-

Enclosure	All enclosure timber parts exported as fusion 360 archive files
Hopper	All hopper timber parts exported as fusion 360 archive files
Impeller	All impeller timber parts exported as fusion 360 archive files
Nested Sheets	9 nested sheets numbered 1-9 suitable for a small bed CNC router[1]

Sourcing Components

The full bill of quantities is located on the general assembly drawing. Suggestions on where to procure the parts (in the United Kingdom) is available in the below table:-

Drive Motor	https://www.mmengservices.co.uk
Polyurethene Resin - impact ring	https://www.easycomposites.co.uk/polyurethane-resin

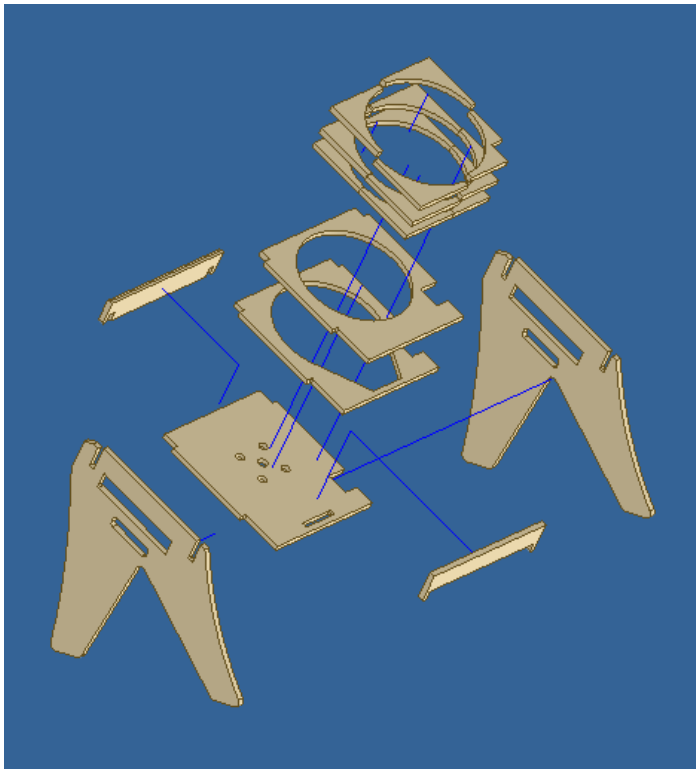
[1] Nested CAM files are machine specific, and all toolpaths/setups should be simulated, checked and post-processed to the match the specific machine being employed.

Machine Hardware - internal circlips, bolts, and nuts	https://www.spaldingfasteners.co.uk/
Custom metal components - rotor hub and rotor hub washer	Search for “precision machining” service in your local area https://www.yell.com
Custom wooden components - Enclosure sub assembly, hopper sub assembly and impeller sub-assembly	Search for “CNC wood routing” service in your local area https://www.yell.com

Build

The following points should provide a guide for building the version 2 dehuller:-

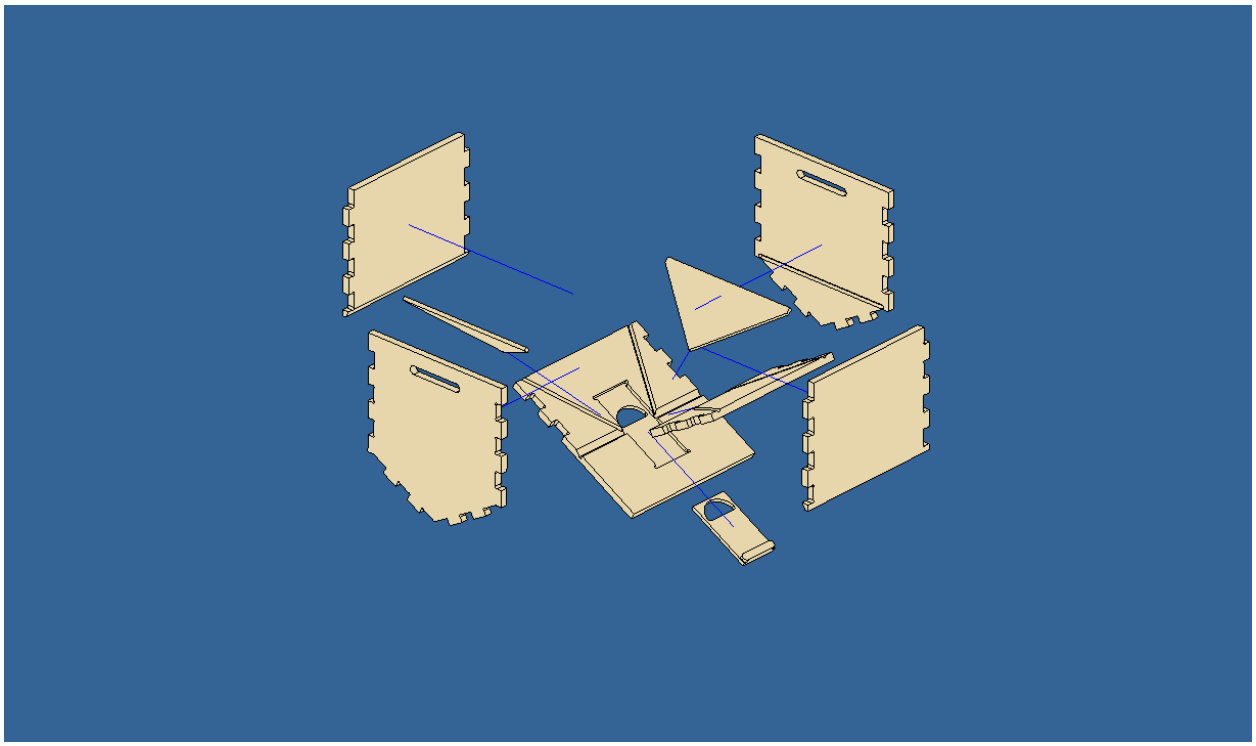
Enclosure Sub Assembly



1. Refer to dwg DH_V2_003 Enclosure Sub-Assembly
2. The parts can be assembled with or without glue. Ensure all parts are clean and any sharp edges from the CNC router removed.
3. Stack 3 components - the enclosure floor, enclosure floor guide, enclosure impact ring floor.
4. Insert the stack of three components into the slot in enclosure side (2 off)
5. Interlock structure by installing enclosure cross piece and enclosure cross piece front.

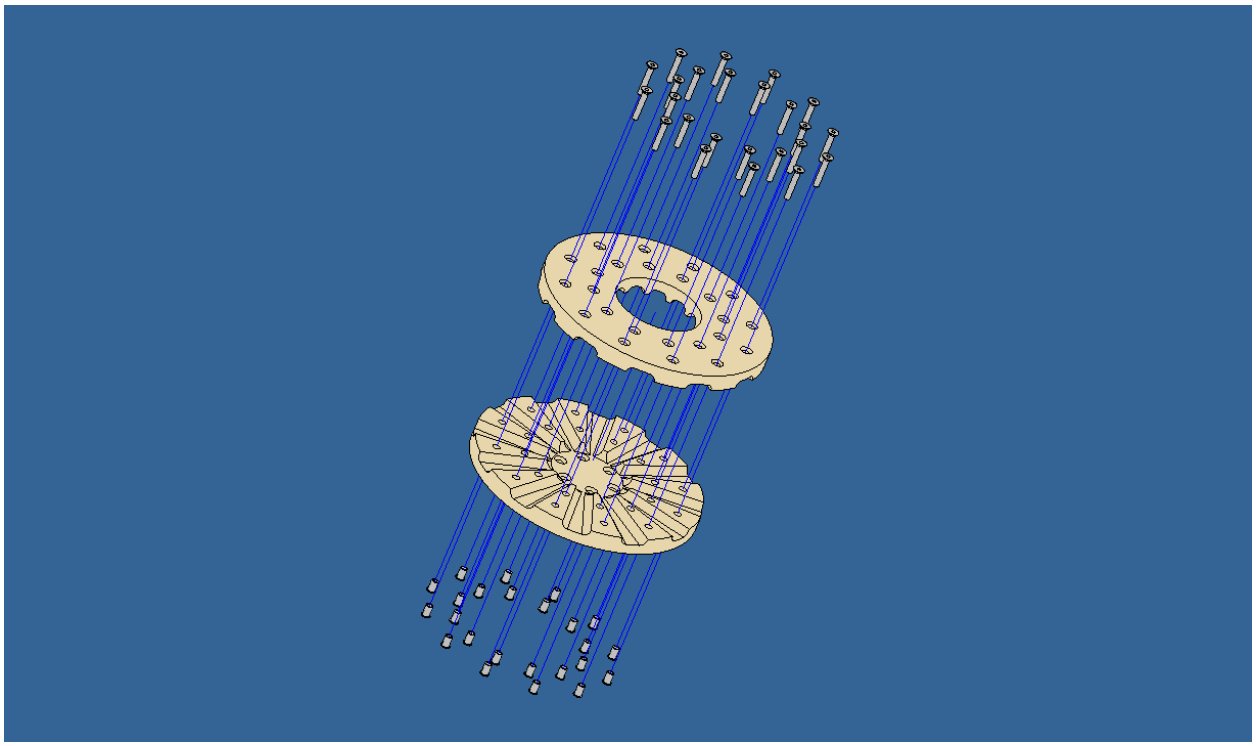
6. Install impact ring backers (9 off) and impact ring safety backers (3 off).
7. The enclosure is now complete. Optionally screw the structure together at strategic points and/or coat with a polyurethane sealer.

Hopper Sub Assembly



1. Refer to DH_V2_004 Hopper Sub-Assembly
2. The parts can be assembled with or without glue. Ensure all parts are clean and any sharp edges from the CNC router removed.
3. Install the hopper gate into the hopper base rear. Ensure it remains captive for the remainder of the assembly and does not fall out.
4. Insert hopper base rear into hopper side.
5. Add hopper front (2 off) and hopper base front
6. Complete assembly by adding remaining hopper side.
7. The hopper is now complete. Optionally screw the structure together at strategic points and/or coat with a polyurethane sealer.

Impeller Sub Assembly



1. Refer to DH_V2_002 Impeller Sub-Assembly
2. The parts can be assembled with or without glue. Ensure all parts are clean and any sharp edges from the CNC router removed.
3. Install 24 No M5 insert nuts into the impeller bottom plate.
4. Align the impeller top plate and install 24 No M5 socket head countersunk screws. To prevent vibration loosening, it is recommended the screws are installed with a threadlocker. Screws should be torqued evenly.
5. The impeller is now complete. Optionally coat with a polyurethane sealer.

Impact Ring

1. Refer to DH_V2_005 - Impact Ring
2. The round impact ring can most easily be manufactured as a flat item, by pouring a PU90 polyurethane casting resin into a rectangular mold.
3. The mold internal dimensions should measure 45mm x 970mm x 5mm, made out of timber or similar, in order to produce a flat polyurethane strip of shore 90 hardness.
4. Follow the casting resin instructions at all times. Once cured, test fit the strip into the enclosure, and trim to final length, ensuring a tight fit to the impact ring backers and impact ring floor.

Final Assembly

1. Refer to DH_V2_001 - General Assembly
2. Screw the safety switch into position on the enclosure. Temporarily lift the impact ring safety backers as required. Double check safety switch vertical position, by trial fitting the hopper assembly atop the enclosure to ensure it interacts correctly with safety switch armature.
3. Bolt the motor to the enclosure using 4 No M10 countersunk screws and machine nuts. Torque evenly.
4. Install two internal circlips into the rotor hub. Slide the rotor hub onto the motor shaft. Install firstly the rotor hub washer and then secure the rotor hub with the M4 socket cap screw. Ensure all connections are tight. To prevent vibration loosening, it is recommended the screws are installed with a threadlocker.
5. Install the impeller to the rotor hub using 6 No M6 countersunk screws. To prevent vibration loosening, it is recommended the screws are installed with a threadlocker.
6. Install the impact ring into the enclosure, ensuring a tight fit to the impact ring backers and impact ring floor.
7. Install a suitably rated motor controller/protective device on the enclosure side.
8. The general assembly is now complete. The motor, safety switch and control should now be wired by a competent electrician.

Electrical disclaimer

In addition to the disclaimer of warranties and limitation of Liability inherent in the creative commons Attribution 4.0 International license, note this open source design requires electrical components connected in a safe and appropriate manner. As such it is recommended to use an electrician who is a member of a registered competent person's scheme and therefore experienced and qualified to connect the components in a safe manner and ensure compliance with the relevant electrical safety regulations where the equipment is located.

Operating Advice:

The following points should provide a good starting point for your own dehulling adventures:-

1. Clean and grade your seed (by winnowing/screening) into a clean seed of consistent grain size & weight.
2. Check the moisture content of the grain - condition to 16%.
3. Calculate the thousand kernel weight (tkw) of your grain, to establish input rate.

4. The number of vanes (12no) and rpm of the impeller (approx 3000rpm) will dictate the optimum infeed rate. Based on a 40g tkw the following input rate to ensure each grain strikes the impact ring is 1500g/min.
5. Fill the hopper with grain. Ensure the hopper lid is securely in place, and the safety switch made. Turn on the machine. Slowly open the feed gate to allow grain to pass through the dehuller.
6. Winnow and screen the grain between passes, and if possible screen off hulled grains to prevent damage.
7. Typically it requires 3-6 passes to achieve high ~ 90% dehulling rates

Suggested Adaptations:

This open source design licensed under the creative commons license allows others to continue to adapt, remix, transform and build upon the design. Some suggested adaptations are outlined below:-

Variations for Impeller Speed Control

- The handholes in the enclosure sides would allow a belted design with either fixed diameter pulleys or variable speed pulleys..
- Three phase motor & VFD - the design could be adapted for three phase motor & variable frequency drive (VFD).

Variations for Power Source

- The power source could be changed to human powered (either hand cranked or pedal/treadle powered, with the addition of a suitable gear train & linkage.
- The power source could be changed to tractor power take off (PTO), with the addition of a suitable linkage or drive pulley. It would likely require the enclosure to be substantially changed and constructed as a fabricated steel weldment.

Variations for computer aided manufacture (CAM)

- All timber parts could be nested on a single 1200 x 2400mm plywood sheet for a large bed CNC router.