

Peanut Oil Press Redesign for Developing Countries

by

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Submitted to the Department of Mechanical Engineering
in Partial Fulfillment of the Requirements for the Degree of

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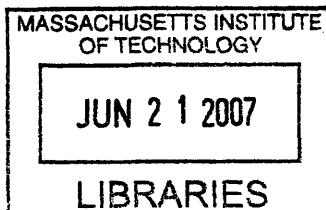
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ABSTRACT

One of the causes of malnutrition among the rural inhabitants of Sub-Saharan Africa is the high cost of dietary fats that are necessary to maintain normal body functions. Though the Food and Agriculture Organization of the UN recommends an annual intake of 9.6 liters of dietary fats a year per person, some areas of Africa consume only about 1.5 liters annually. Many members of these communities lack the resources to purchase imported edible oils; locally produced peanut oil would provide a cheaper alternative. In addition, peanut production is particularly beneficial to farmers, as peanut plants enrich the soil they grow in.

Once they have a steady supply of peanuts, the problem facing farmers is the inability to efficiently extract the oil from the nuts. The current design for human-powered rapid extraction is the Bielenberg ram press, which uses a lever to generate the required pressure needed to extract the oil. However, this design is not optimal for two reasons: it requires significant upper body strength to operate, and also, incorrect operation of the lever leads to only a fraction of the peanuts' oil content being extracted.

For these reasons, this thesis focuses on a design modification originally proposed by a team in D-Lab Spring 2006. While the oil extracting mechanism was kept intact, the lever was replaced by a cam-and-follower system driven by treadles. By moving the driving motion from the upper body to the lower body of the user, the new design aims to address the ergonomics issue present in the Bielenberg ram press. The cam also allows optimization of the pressure profile for the peanuts. Research performed by Ravi Patel in 2007 has shown that a rapid buildup followed by a long period of followed by a gradual advancing of the piston will create the desired pressure characteristics to maximize output.

An earlier attempt to convert the Bielenberg ram press into a treadle design yielded several insights into how the design could be improved. These insights have led to many design modifications, which are incorporated into the proposed redesign. This redesign is aimed at improving performance, reducing cost, and increasing the manufacturability of the press.

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I would also like to acknowledge the work of the Peanut Press Team of D-Lab II: 2006 for their proof of concept model that really helped develop the basis for what the press is now. In particular, I would like to thank Vivian Li for sharing her invaluable insights and experiences with me during the early design phase.

During the fabrication phase, I was helped by Mark Belanger of the Edgerton Student Shop, Ken Stone of the MIT Hobby Shop, the members of the Pappalardo Machine Shop staff, and instructors Toby Bashaw and Michael Tarkanian of the MIT Foundry. They were always helpful and eager to share their vast knowledge of machine design and assembly. Despite my best efforts to put as many insurmountable obstacles as possible into the design, these machinists and instructors were there every step of the way to make sure that the job got done in spite of me.

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1. Introduction

According to the World Health Organization (WHO), one third of people in developing countries suffer from some form of malnutrition¹. One cause of malnutrition is the lack of oils in their diet. While the recommended annual consumption is 9.6 liters of oils per year, people of communities in sub-Sahara Africa consume as little as 1.5 liters². The majority are either too far removed from a reliable source of imported oil or the expense of it is just too great. To address this issue, this thesis focuses on the modification of the Bielenberg ram press, which is currently deployed in the field as the means for farmers to extract oil from oilseed crops by hand. The crop chosen for this application, peanuts, is high in essential proteins and fatty acids³ and has the additional benefit of enriching the soil it is grown in through a process called nitrogen fixation⁴.

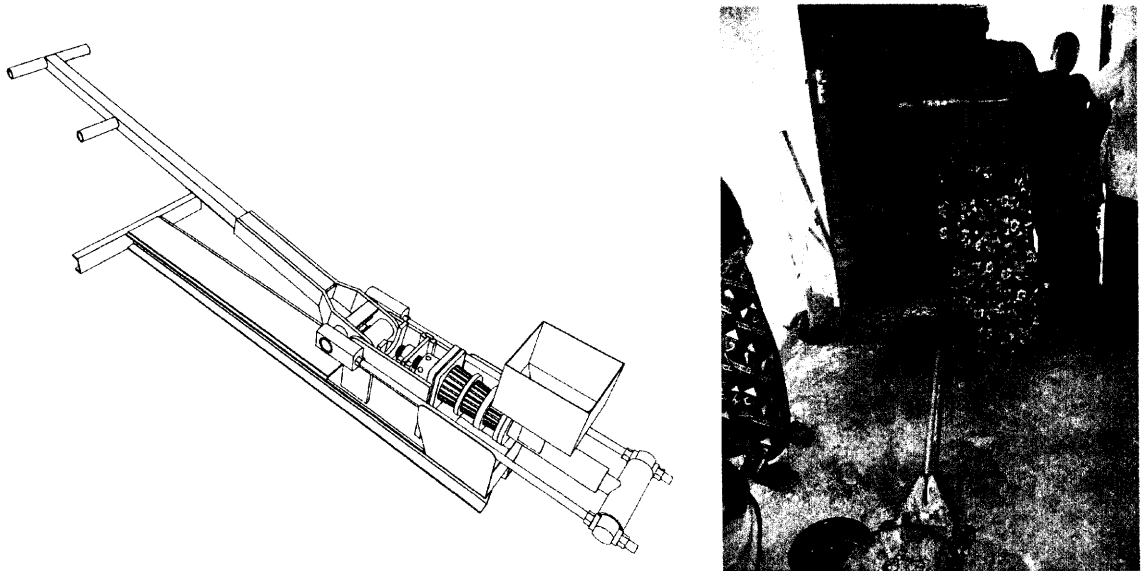


Figure 1: Schematic view of the Bielenberg press⁵ on the left, and a model being used in Zambia⁶ on the right.

The Bielenberg ram press, first developed by Carl Bielenberg, was developed in 1985 as part of the efforts of the Arusha Village Sunflower Project. The goal of this

¹ World Health Organization, 1.

² Hynd, Alison and Smith, Amy. "Meeting a Pressing Need." pp. 1

³ National Institute of Health, Essential Fatty Acid Education.

⁴ Sainju, U.M., Terrill, T.H., Gelaye, S., Singh, B.P. "Soil Aggregation and Carbon and Nitrogen Pools under Rhizoma Peanut and Perennial Weeds". pp. 146

⁵ Bielenberg, Carl. "Bielenberg Ram Press."

⁶ Photo provided by Amy Smith.

project was to press oil from sunflower seeds, and originally called for the use of scissor-jack seed presses to be deployed to Tanzania. However, after a few units were deployed, it was found that scissor-jack presses were unsuitable because they were expensive because of the extensive amount of labor required in production. They also found that the scissor-jack was susceptible to breakdowns, and the scale of production was too large to be used in micro-enterprises⁷. In designing his press, Bielenberg drew inspiration from the existing batch and screw press, which both used cages in which seeds were crushed. However, both required some form of motorized assistance to operate. By scaling down the size of the piston, Bielenberg was able to reduce the required energy such that the press could be manually driven using a long lever arm⁸.

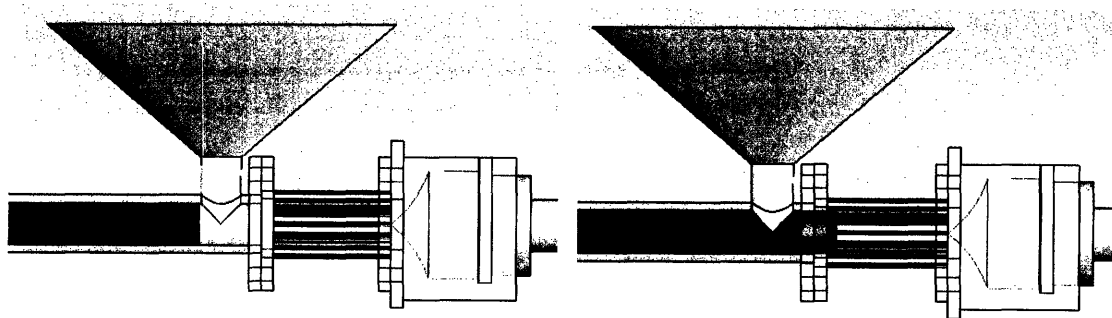


Figure 2: In the back position (left), the hopper is open. As the piston advances, the hopper closes off the peanut supply.

Bielenberg’s design, as seen in Figure 1, is constructed entirely from steel components that are locally available. Peanuts are loaded into a hopper that is attached to a cylinder that houses a piston. As shown in Figure 2, the peanuts are pushed into the expelling cage as the piston advances, where they are compressed. The thin slots in the cage allow the oil that is being pressed out of the seeds to drip from the press. As the piston moves back to its original position, the hopper is opened again, and more peanuts fall into the cylinder to be crushed. In order to extract the seed cake, a cone-shaped plug is used to partially cover the back of the expelling cage. This creates the back-pressure that is necessary to press oil out of the seedcake. The lever is attached to a pivot and to the piston through rods arranged in a class II arrangement. This allows the user to

⁷ Hyman, Eric. “Local Agro-Processing with Sustainable Technology: Sunflower seed Oil in Tanzania”. p 4.

⁸ Hynd, Alison and Smith, Amy. “Meeting a Pressing Need”. p. 2

increase the force exerted by the piston to create sufficient pressure within the expelling cage.

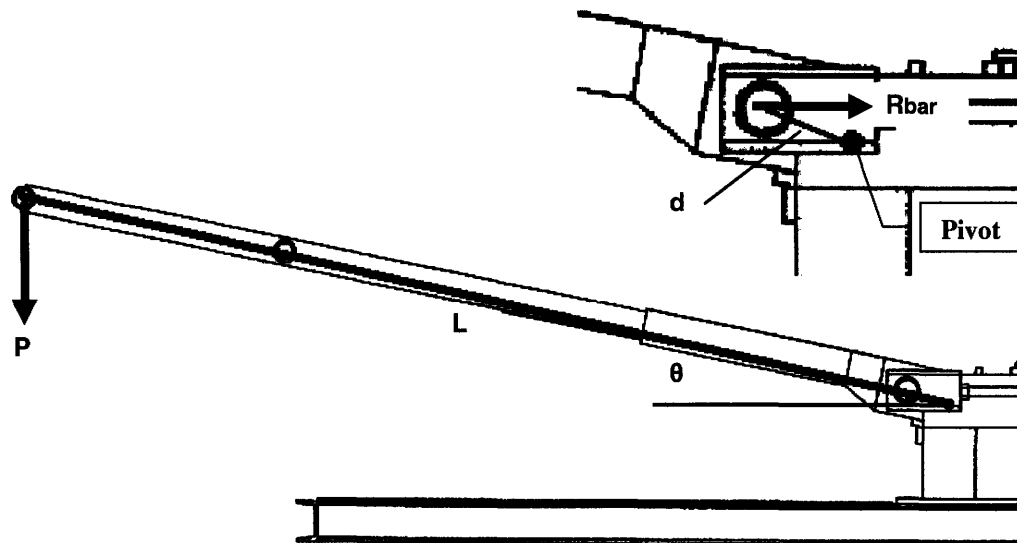


Figure 3: Class II lever multiplies the input force, relative to the ratio of the lever length and the distance between the pivot and the piston rods⁹.

$$\sum M_{pivot} = PL \cos \theta - R_{bar} d \sin \theta$$

$$\therefore R_{bar} = \frac{L \cos \theta}{d \sin \theta} P \quad (1)$$

The lever length, L , in Bielenbergs drawings is 1.718 meters and the distance between the pivot and the pin is 0.076 meters. This lever arm arrangement allows the user to achieve at least a mechanical advantage 22.6 times the input force. One of the pitfalls with using the lever to drive the piston in the press, however, is that an inexperience user oftens operate the mechanism incorrectly. It is necessary to dwell at the bottom of the stroke to maximize the amount of oil extracted. In sunflower seeds, which contain between 40-43% oil content by weight¹⁰, the Bielenberg press leaves up to 25% of this oil in the oilseed cake¹¹.

⁹ Bielenberg, Carl. "The Bielenberg Oilpress".

¹⁰ Khan, L.M., Hanna, M.A. "Expression of Oil from Oilseeds – A Review". p. 1

¹¹ Food and Agriculture Organization of the UN. "Small Scale Food Processing – A Guide for Appropriate equipment." 1992. Percentage taken from sunflower seeds.

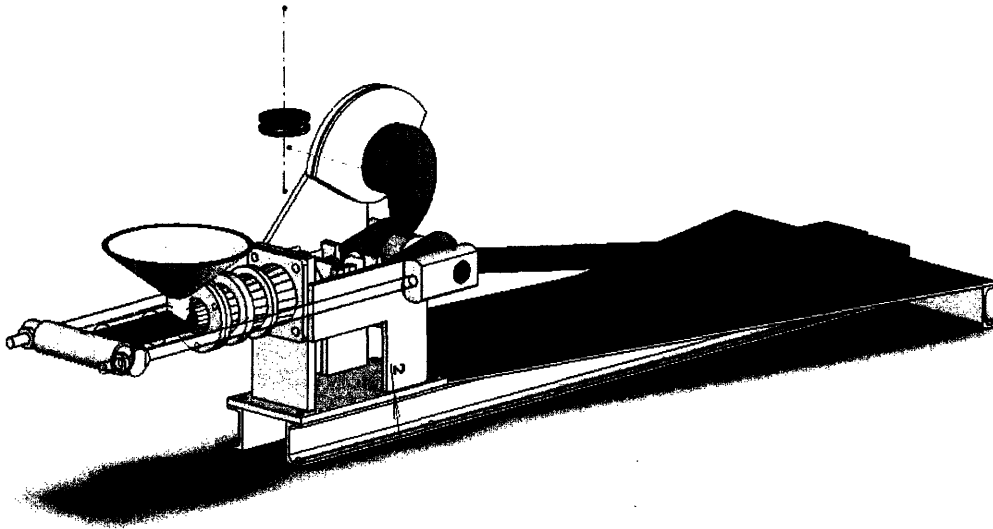


Figure 4: Design concept for D-Lab II Spring 2006 design team. Concept shows the initial use of a cam and treadles¹².

The solution proposed by a team working on the design concept in D-Lab II in Spring 2006 was a system that utilized treadles to drive a cam. Bicycle freewheels were used as ratchets and allowed the treadles to engage on the down-strokes and slip when the user's weight was on the other treadle. The cam pushed down on an oscillating follower, which in turn, rotated about a pivot. The horizontal displacement of the follower forced the piston to advance inside of the cage, generating the pressure needed to produce oil. The incorporation of the cam into the system gives the designer control over the displacement profile of the piston within the cylinder, which in turn determines the pressure profile within the cage. According to research by Ravi Patel, the cam profile should include a rapid period of compression, followed by a small, constant, increase in displacement¹³.

2. D-Lab Treadle Ram Press: Lessons Learned

While the mock-up made by the 2006 D-Lab II design team demonstrated the feasibility of driving the press using a cam system, the first attempt at constructing a full-scale prototype resulted in a non-functional press. After a few modifications, the

¹² D-Lab Spring 2006. "Oil Press Design Review". Power Point Presentation. April, 2006. Provided by Vivian Li.

¹³ Patel, Ravi. "Maximization of oil output of a treadle-powered peanut oil press". MIT Mechanical Engineering, 2007.

prototype would indeed press oil, but neither as easily the design specifications called for, nor in sufficient quantities. However, several observations were made on how to improve upon the design, and these are discussed below.

2.1. Piston

After studying Bielenberg's original design, the piston head diameter was reduced from 1.75in to 1.25in. This change reduced the force needed to generate the required pressure within the expelling cage, which is a function of the cross-sectional area of the piston.



Figure 5: Because the seed cake forms a wall that closes off the expelling cage from the cylinder, the extracted oil is left with no path to flow out of the press.

The second modification to the piston is in regards to its length. Original drawings of the Bielenberg ram press shows that the piston does not travel into the expelling cage. However, the piston travel is lengthened in this design so that at the maximum displacement, the piston is inside the cage. This modification is prompted by the buildup of oil inside of the piston cylinder, as seen in the figure above. Because the travel only extends to the entrance of the cage, a dense wall of seed cake builds up, closing the path for the oil to escape through the slots. By moving the seed cake wall

further into the cage, a portion of the slots will be left open as a path for the oil to flow out of the press.

2.2. Cam and Follower

In the original design, the cam was cut from a single one-inch thick steel plate, at an expense of over \$300. If the peanut press is to be deployed in the field, the cost of the cam must be significantly reduced. One method is to replace the steel with a local hardwood. To test the durability of a wooden cam, a duplicate cam was made, and the press was drive through ten cycles. There was noticeable deformation along the edges of the cam that contacted the follower. Along with that, there was a slight change in the cam's dimensions, suggesting that over long-term usage, the cam would wear down quickly and become inadequate at driving the piston.



Figure 6: The steel, wood, and wood with steel band cams, in clockwise order (left). Deformation of the edges proved the wooden cam cannot take the contact pressure.

The solution that was first proposed by Gwyn Jones was to take the wooden cam and attach a thin steel band to the outside. This allowed the cam to ride over the steel, which distributed the load more evenly across the cam surface. After running the cam through multiple cycles, the cam showed no noticeable deformation.

2.3. Expelling Cage

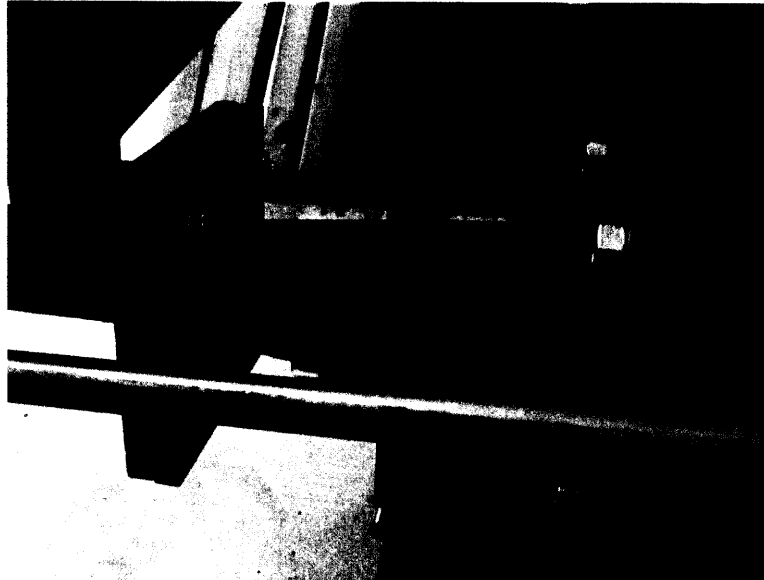


Figure 7: Cone-shaped expelling cage.

In Bielenberg's drawings, the expelling cage was cone-shaped, made by welding several strips of steel on a jig to form the necessary slots. We tried to make a cage of a similar shape by cutting V-notches along the length of a steel pipe and then bending it into a cone shape. The bent end was then gathered into a circle and held in place by a steel plate, which was then welded into place.

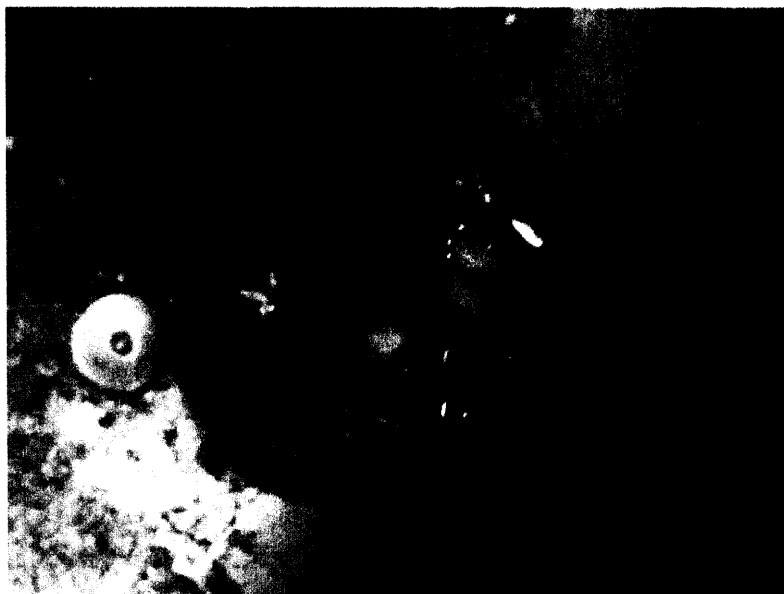


Figure 8: Nuts that are being pushed back between the piston and the cylinder prevent the press from being filled with more peanuts.

While this formed a cage similar to the shape called for by Bielenberg's drawings, this cage shape has a few challenges. Because the acute angle is in the piston side, the back pressure formed when the piston moves forward actually pushes the seed cake out in between the piston and the cylinder rather than towards the back plug. Since the path of least resistance for the seed cake is out from the piston end, the back plug end of the cage experiences very little compression. This region of the cage ended up containing whole peanuts that were too large to pass through the back plug, and created a permanent block, resulting in oil buildup inside of the cylinder. The design solution that we will incorporate into the next generation is a straight section of pipe with slots cut out of it. The cage will also be shorter, so that seed cake all along its length will experience compression.

2.4. Frame

The frame of the current version of the treadle press is made from 0.5 inch steel plate that was cut with a water jet to the correct dimensions. This fabrication technique also enabled us to cut holes in the proper locations for the shafts. However, while this created a strong structure after the two sides were welded to steel plate spacers, there were several issues with this process that increased production time. The plates that were ordered arrived slightly bowed, resulting in decreased precision in the cutting of critical dimensions, such as the location of the shaft bearings. The warping also led to further misalignments after the two side plates were welded. During the testing phase of the press, we discovered that the back plug area, where the seed cake accumulated after the oil had been extracted, was enclosed by the frame walls. The original treadle press design had not had this problem because the side walls of the frame were not a single plate.

To address these issues, the frame in the next version will be made from welded angle iron. While welding does not control tolerances well during assembly, it enables the manufacture to measure dimensions and adjust cuts as necessary throughout the process. Angle iron also allows easy access to the back plug and inside of the frame for easier cleaning and maintenance. The choice of using angle iron will also be an effective

means of reducing the overall cost of building a treadle-powered press. Because the aim of the first version was to achieve functionality rather than design for cost and manufacturability, the expense of the process was acceptable. In addition to significantly decreasing the cost of the press, using angle iron also reduces the overall weight and the amount of material used.

2.5. Treadles

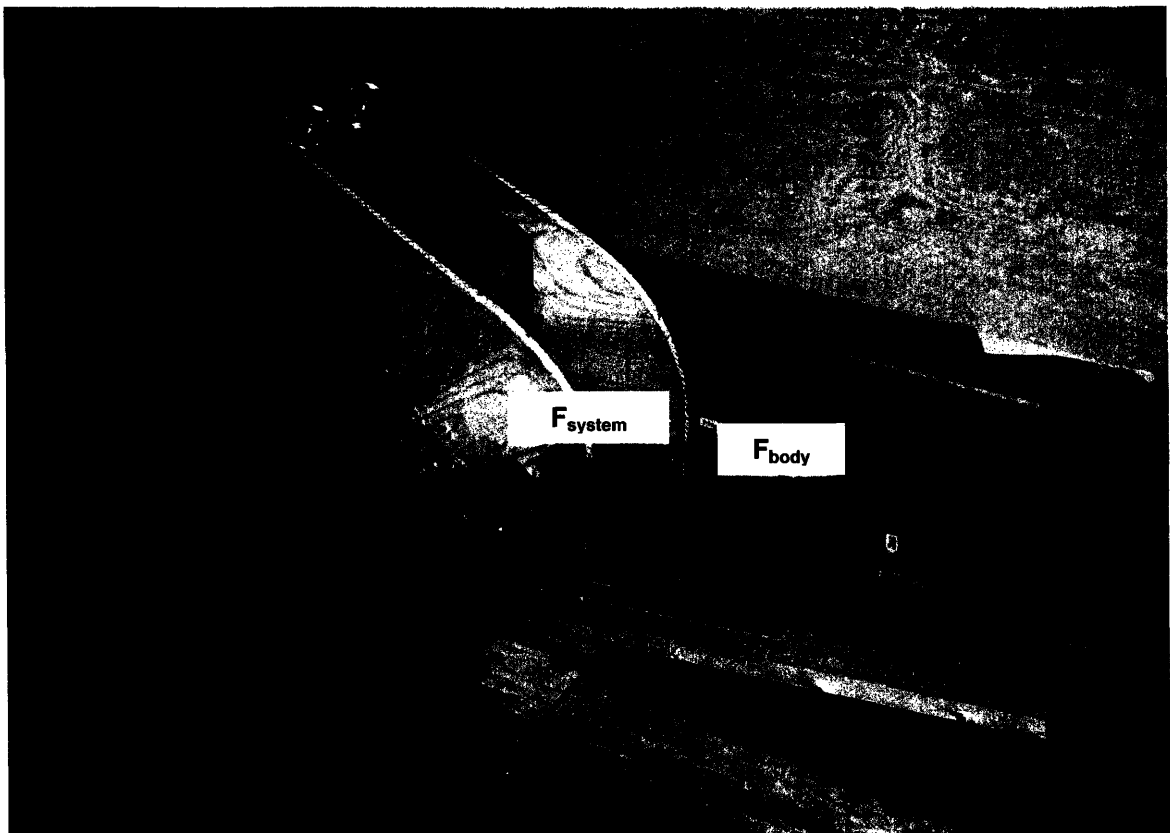
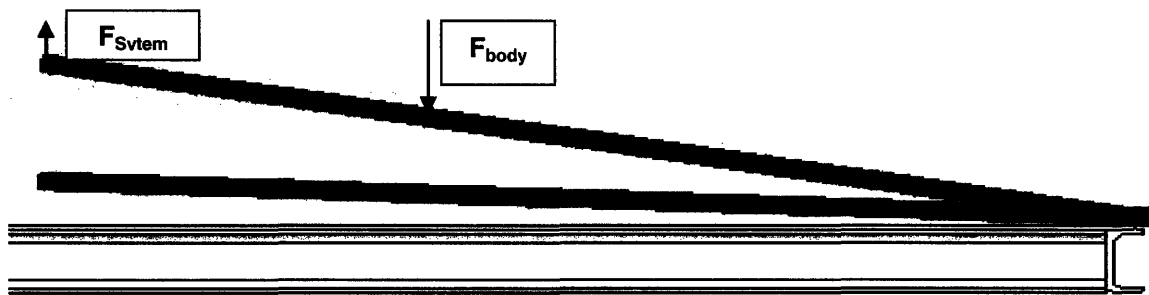


Figure 9: While the original treadles (top) were hinged from the back, the user gains mechanical advantage by hinging from the front (bottom).

The treadle and base configuration was modified during the testing phase, and the changes made will be carried over to the next generation of the press as well. Originally, the treadles were hinged from the back, but during testing, we found that this method of transmitting the necessary torque was not efficient. The lever arm actually acted to decrease the force instead of magnifying the user's weight. While this increased the rope displacement of each cycle and reduced the number of steps the user took to rotate the cam, the forces being put into the system was insufficient to drive the piston. As a result, the treadle hinge was moved to the front of the press, and the user is then free to step behind where the treadle is attached to the sectors. The mechanical advantage that is gained from this configuration significantly improved the overall performance and ease of use of the first press.

The treadles in the first version were connected across a system of two pulleys by a rope, which allowed the downwards step of one treadle to bring the treadle on the other side to the 'up' position. However, this results in the user's legs to simultaneously move in opposing directions, rapidly transferring weight from one treadle to the other. Because this does not mimic the natural walking behavior, each treadle on the redesigned treadle-powered press is independent of the other. They are each attached using rigid members

2.6. Ratchets

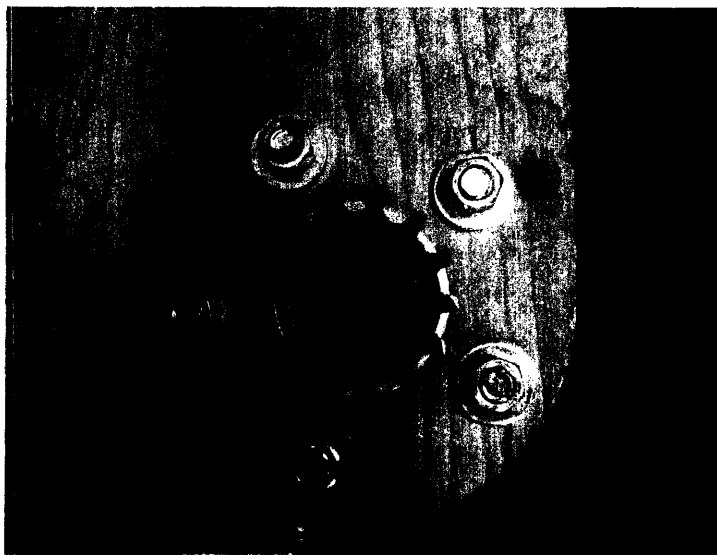


Figure 10: Bicycle freewheels could not withstand the loads exerted on them (left). The proposed ratchet and pawl system engages entire surfaces (right).

In the first version of the treadle-powered press, bicycle freewheels were used to provide the ratchet mechanism for the cam shaft. In order to rotate the cam in a single direction, ratchets are necessary so that the treadle only engages the shaft on the down-stroke, and slips on the up-stroke. Because bicycles are used extensively in developing countries, utilizing bicycle parts in the design of the treadle-powered press was a plausible alternative to designing a ratcheting mechanism. However, while these bicycle ratchets worked enough on the proof-of-concept model, they were not robust enough to handle the loads that were placed on them during testing. Because the loads were deforming and shearing the ball bearings used in the bicycle freewheel, it was clear that a more robustly engineered ratchet mechanism was needed. The engagement mechanism for the ratchet and pawl arrangement utilized in the redesigned treadle-powered press transfers normal forces across planes.

2.7. Elastics

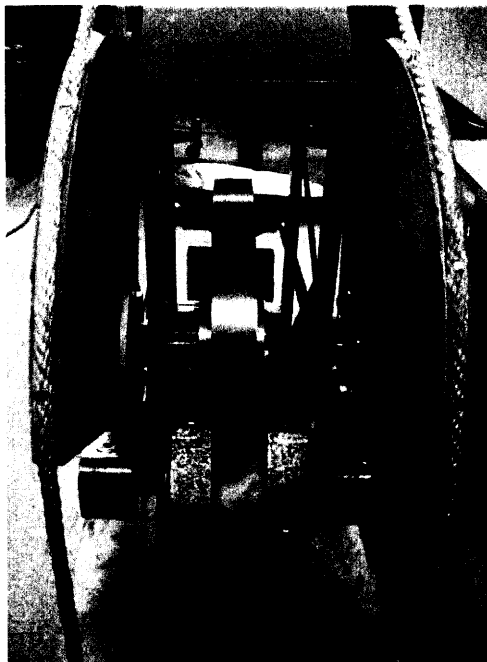


Figure 11: Red elastic cords hold the follower shaft against the cam.

In the first version of the treadle design, the follower shaft that was connected to the piston guide shafts was located beneath the follower. I believe this design choice was made so that the cam and follower configuration would match the class 2 lever configuration in the lever-powered press. However, this design requires the use of

elastics to oppose the weight of the follower shaft, and hold it against the cam. Upon testing, this method was not very effective, as bungee cords that were being used did not have the necessary spring coefficient to keep the follower in continuous contact with the cam.

To address this issue in the redesign, the follower assembly was moved above the cam. In this configuration, the weight of the follower assembly and drawbar assembly will keep the follower pressed down against the cam. The constant contact this creates eliminates the need for elastic cords.

3. Manufacturability

One of the primary considerations in designing for the developing world is the manufacturing capability in the country where the product is to be deployed. In most developing countries, it is difficult to incorporate parts that are made using advanced fabrication techniques because the same parts cannot always be reproduced by local metal workers. Therefore, the redesign focuses on designing specifically for the techniques that are available to the local manufacturers.

3.1. Materials Selection

The primary material used in the press' construction is mild steel. While heavy, steel offers considerable durability and is readily available throughout the developing world. Though the difficulty in machining steel limits the fabrication techniques that can be employed, steel is weldable, and facilitates assembly. The availability of skilled craftsman in developing countries enables manufactures to hold reasonably high tolerances across parts and assemblies. Its availability in different forms also reduces the overall production cost of the press.

Table 1: Steel components made from commonly available geometries.

Stock	Assemblies
Angle Iron	Frame
Rod	Various Shafts in Frame, Draw Bars, Piston, Back Plug, Treadles
Plate	Back Plug, Cylinder, Expelling Cage, Frame Bands, Base, Ratchet, Treadle
Pipe	Expelling Cage, Piston, Cylinder, Cam, Treadles
Sheet metal	Follower, Cam, Ratchet
Square Tubing	Treadles

While steel is the primary material used in the treadle-powered oil press, hardwood is also an important element in this design. Hardwood is readily available throughout the developing world¹⁴, and should only be a small factor in the overall cost. This material was chosen for use in the cam because it represented a cheaper alternative to thick steel plate and also much easier to make into the cam. While wood in itself was not sufficiently strong to transmit the loads from the follower without deformation, a steel band bent around the perimeter helped to distribute the forces across the surface. Hard wood encased in a similar manner is used as the follower arm, because it provides a natural bearing surface against the pivot and the cam follower shaft. This was done because as the lever rotates, the pivot and follower shafts are at once rotating with respect to the follower arm. Wood will be used primarily in the construction of the treadle and base.

3.2. Fabrication Technologies

Because it is desirable to produce the press in developing countries, the design must include parts that can be made using the manufacturing facilities within these countries. While fabrication technologies can vary from area to area, the design incorporates basic tools found in most machine shops¹⁵. It is important to note that while the lack of advanced fabrication technologies relegates the metal workers to time and

¹⁴ Conversation with Gwyn Jones.

¹⁵ This and the succeeding sections on machining capabilities of developing countries from conversation with Peter Haas.

labor intensive processes, these are the most plentiful resources available in developing countries today and the skills of these artisans are considerable.

3.2.1. Cutting

The vast majority of cutting of angle iron, pipe, rod, and plate will be performed by hand using a hacksaw. Some shops may have a vertical band saw, which would greatly decrease the production time, but this equipment is not necessary for production. The majority of the piece, will be angle iron and steel plate, and will not exceed thicknesses of 0.5 inches, making them relatively easy to cut. The most difficult piece to cut will be the expelling cage, where 8-10 slots running nearly the length of the pipe will be cut to allow oil to flow through. However ever this can be achieved using a jig that guides the blade along a straight line.

The cutting of wooden parts will prove to be an even easier task. One of the motivations for moving from steel to wood for the cam was to increase the manufacturability within developing countries. In order to cut a cam that had a relatively smooth edge surface, the steel was cut with a water jet. While this profile could be obtained by cutting, grinding, and polishing the steel surface, the time consumed in this operation makes it impractical. However, a wooden cam could be roughly cut using either a band saw or a hand saw, and desired edge could be obtained through sanding.

3.2.2. Drilling

In order to use bolts to join the cylinder, expelling cage, and back plug assemblies, it is necessary to drill holes in the some of the steel parts. Drill presses are rare, but most metal workers will be equipped with hand drills. There are a few holes of large diameters in plates connecting the cylinder, expelling cage, and back plug assemblies that are machined but because these are to be welded, they do not have to be of fine tolerance and can be cut with a cutting torch by a skilled welder. The largest holes that were in the side plates of the first version were used as bearing surfaces for the cam and follower shafts. Because the finish from a cutting torch is very coarse and unsuited for a bearing surface, this method would not work. Instead, we solve this problem by using press-fitted bronze bushings in steel pipe that are welded to the frame.

There are a total of 40 holes ranging from 0.25 – 0.5 inches in diameter to drill in this design of the peanut press, but because several are bolts running through mating pieces, the hole locations are the same. This will enable manufacturers to save time by drilling through several plates at once to ensure alignment.

3.2.3. Welding

The majority of the joints in the peanut press will be welded. Extensive welding in the angle iron of the frame as well as in the assembly of the back plug is necessary. Welding is also required to attach the follower to the piston shaft, and allows for the proper spacing and alignment of the cam by holding the alignment plates located on the cam shaft. Welding technology in developing countries is more than adequate for the purposes of this design. Stick or MIG welding is the faster form available to us, but oxy-acetylene is another option for areas that do not have access to a reliable source of electricity.

4. Design Requirements

The success of the treadle design can be better assessed by quantifying certain requirements and goals that they hope to achieve. The factors that are most critical to the design – weight, manufacturability, and the user interface – are discussed in more detail below.

4.1. Weight Requirement

The weight of the redesign is important because while it doesn't take into account the cost of fabrication, it serves as a good indicator of the material cost of the press. The redesign focused heavily on reducing the weight of the treadle-powered press, in an effort to make it more affordable to the user. The initial design weight was approximately 250 pounds, with a significant portion of the weight consumed in the frame. In the proposed redesign, the projected weight of the treadle-powered press is approximately 150 pounds¹⁶.

¹⁶ Numbers obtained from the "mass properties" function in SolidWorks. Each part was assigned a material of known density, and based on geometry, the mass could be calculated for each assembly.

4.2. Manufacturability Requirement

The treadle powered press must be designed for manufacturing using only the fabrication techniques outlined in section 3. By limiting the design to commonly available techniques, it is possible to make the entire treadle-press within the country it is deployed in. This is advantageous because it allows the country to use its indigenous labor resources rather than paying to have parts and shipped from different parts of the world. Fabrication within the country also means that replacement parts and skilled craftsman familiar with the press design will be available. The benefit of having those resources nearby means that presses will not experience lengthy down-time, and expert repairs will give units longer life expectancies.

4.3. User Considerations

The primary consideration for the user is the force needed to actuate the press mechanism. For this design, the user must have a body weight of at least 100 pounds to generate the pressures needed to extract oil from the peanuts. Because the people of the developing world, where the treadle-powered oil press is targeted, are especially at risk for malnutrition, this weight specification is intentionally low. The low requirement needed to drive the piston also means that women and children are able to use the treadle-powered press.

The rate at which the user operated the treadle was also considered important, especially if the press were to be used in a commercial application. While maximizing oil output for the user is important, the throughput of the treadle-powered peanut oil press must be comparable to the throughput of the Bielenberg press. 10 steps over the course of 20 seconds for a throughput rate of 3 cycles per minute was identified as both sustainable and fast enough to appeal to oil press users.

5. Final Design

5.1. Frame Assembly

As discussed in sections above, the main changes for the frame assembly will be its construction from angle iron rather than steel plate. This drastically reduces the weight of the frame, and cuts down on the cost of manufacturing. Additionally, the height was reduced by 8.5 inches, due to the redesigned treadle system. The older version used a rope and pulley system to attach the two treadles together, and pulleys were mounted at the top plate to align with wooden sectors of the side. By making the treadles operate independently of one another, the pulleys were no longer necessary. Another feature of the frame is the sections of pipe that serve as the bearing surfaces for the cam and follower shafts. In order to achieve better alignment, a single section of pipe will be laid across the angle iron frame and welded into place. After the pipe has cooled, it can be cut near each side, leaving only the welded ring behind¹⁷.

5.2. Cam and Follower Assembly

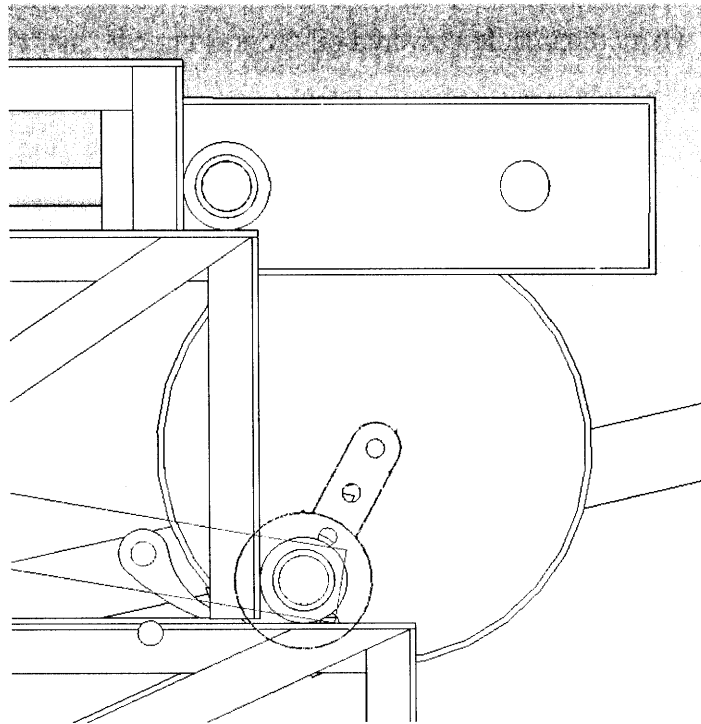


Figure 12: The follower now rests on top of the cam.

¹⁷ This method of alignment was first suggested by Amy Smith, April, 2007.

The follower and cam assembly has changed so that the follower now sits above the cam. This modification uses the 25 pounds of the follower and drawbar assemblies to hold the follower in contact with the cam surface. In the first version, this was accomplished by using elastic cords to lift the follower shaft up to the cam. However, this method was often ineffective because the combination of weight of the follower and the friction within the bearings of the follower arm would cause the follower to 'stick' in the horizontal position. The follower would have to be lifted up manually in order to move the piston back to the opened position. As seen in Figure 12, a collar around the cam will keep it fixed to the rotation of the cam shaft. In the drawing, this collar extends to the center, to provide a solid member where forces being transmitted from the follower to the cam.

5.3. Piston Assembly

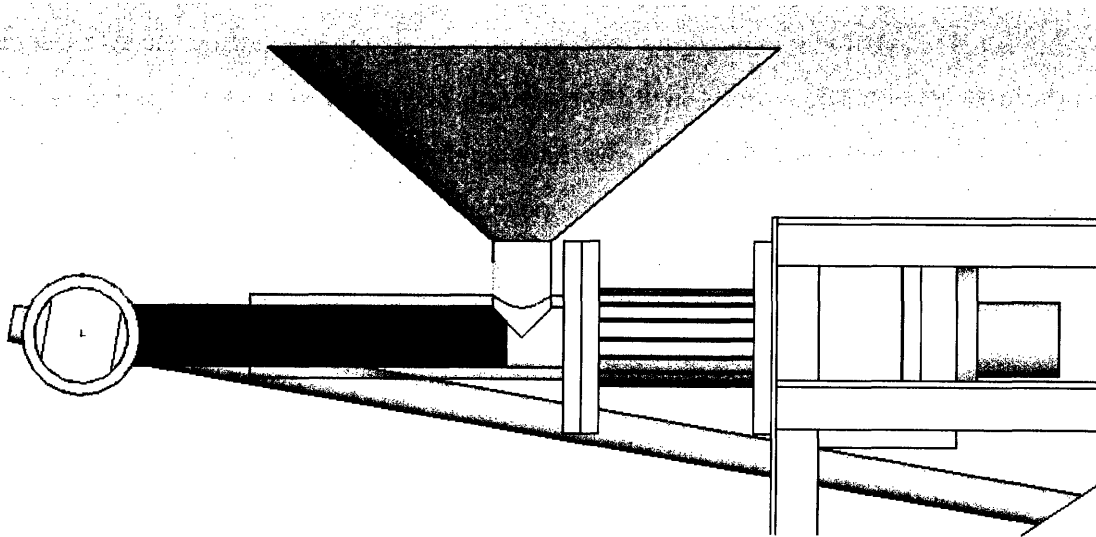


Figure 13: Piston head diameter has been reduced and the cylinder has been shortened.

The piston assembly is very similar to the assembly in the first version. The one major difference is the change in diameter of the piston head and cylinder. This was done so the piston could create more pressure inside of the cage using the same force by reducing the cross-sectional area.

5.4. Expelling Cage Assembly

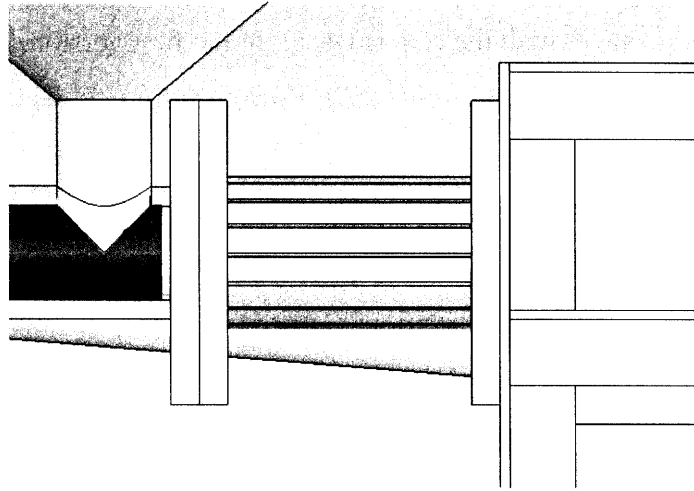


Figure 14: The new expelling cage is made from a single section of pipe with slots cut through and welded on both sides.

Major changes have been introduced to the expelling cage. The original drawings called for the cage to be tapered and welded on a jig. However, during the construction of the first version, the cage was cut from a single section of pipe. V-shaped slots were cut out on the water jet, and the ends were then gathered and closed, creating a tight arrangement of slots. However, while the peanuts were being crushed, the oilseed cake formed a tight wall, and the oil was trapped inside of the expelling cage. Because of the angle of the cone, the path of least resistance for the oil is around the piston. When the piston is displaced, the pressure pushes the oil in between the piston and the cylinder, resulting in the oil leaking from the piston end of the press rather than through the cage. For these reasons, the redesign will incorporate a straight section of pipe with slots cut into it. This method should make fabrication much easier, and the shorter barrel length ensures that all of the nuts in the cage are under pressure.

5.5. Treadle and Base Assembly

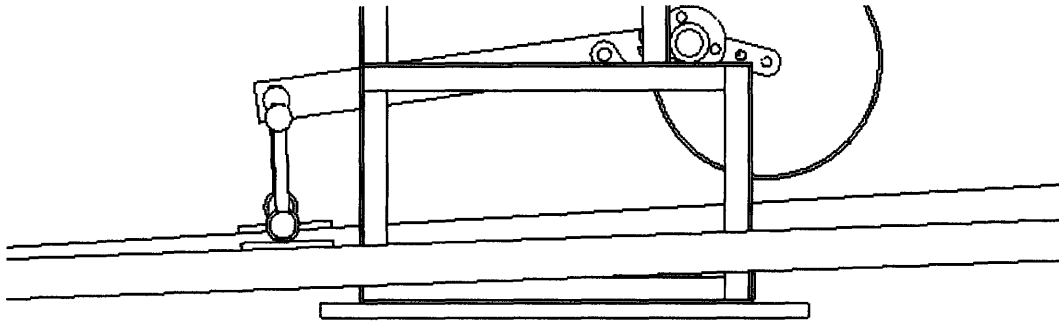


Figure 15: The treadles are now uncoupled, and act independently, allowing the user to mimic the natural motion of walking

The treadles in the first version were connected across a system of two pulleys by a rope, which allowed the down-step of one treadle to bring the treadle on the other side to the 'up' position. However, this results in the user's legs to simultaneously move in opposing directions, rapidly transferring weight from one treadle to the other. Because this does not mimic the natural walking behavior, the treadles on the redesigned press are independent of the other. The users feet will be attached to the treadles through straps. They are each attached to the cam shaft using rigid members, so that as the user's leg is lifted, the ratchet slips to the 'up' position, and is ready to engage the cam.

6. Discussion

In comparing the proposed redesign to the first version of the treadle-powered peanut oil press, the new generation incorporates several desirable features. The angle iron frame and better materials management resulted in a 100-pound reduction in the weight of the press. This prototype also eliminates the need to cut parts using the waterjet, which was a major tool in the fabrication of the first treadle press. While the press contains only a few pieces of steel that would ideally be milled, the manufactures could get by using a cutting torch, making the press viable for local production. After analyzing data from Ravi Patel, the system of levers and treadles were arranged such that a 100-pound person could to exert sufficient force on the piston such that the pressure within the expelling cage reached 1900psi (13 MPa) which is the required pressure for

extracting oil. One aspect that did fail to meet the design criteria, however, was the rate requirement. While the press was originally meant to undergo 3 cycles per minutes, the current configuration requires twenty steps per cycle, which is approximately 1.5 cycles per minute.

7. Future Recommendations

The challenge facing the proposed design of the treadle-powered peanut press is the matter of rate of oil production. If the press cannot compete with the original Bielenberg ram press, then it is highly unlikely that it will be put to use on a commercial level. For the purposes of disseminating to local entrepreneurs, as was the model that the Bielenberg press used in Tanzania¹⁸, the press must first match high output with high efficiency. This problem may be resolve through further investigation of the treadle arrangement.

Another issue facing the press is the expansion and contraction of the wood components from heat and moistures. Because of this, the cam in particular cannot be fully enclosed within a band of sheet steel. Suggestions proposed by Gwyn Jones centers around the idea of cutting a groove into the cam that the band will rest in. By attaching the band at one point along the edge and allowing the rest of the band to slide inside the groove, the cam is allowed unrestricted expansion and contraction.

The angle iron frame on which the press is built may also need to be redesigned. The frame itself is not joined in the most efficient manner, and the order of the welding could be changed. There are also no cross supports spanning the longer sections of angle iron, and this could buckle under heavy loads. Another method of preventing failure in the members of the frame is to construct it using wider and thicker angle iron. Though the design calls for 1 x 1 inch angle iron that is 1/8 inch thick, moving to 1.5 x 1.5 x 0.5 inch angle iron would not significantly alter the geometry of the press.

In further reviewing the design, advisor Amy Smith expressed concern about the wall thickness of cam shaft hole. Though the cam shaft is 2 inch in length, the wall thickness at the weakest point is 0.75 inch. Relocating the cam shaft in future designs

¹⁸ Smillie, Ian. Mastering the Machine Revisited: Poverty, Aid, and Technology.

will allow this wall thickness to be larger, alleviating any concern with cracking in the hardwood.

Finally in manufacturing the expelling cage, it is possible to band saw vertically along the length of the pipe, rotate a certain angle, and then perform the cutting operation again. This method of manufacturing future expelling cages is both time and cost effective.

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