

# Parabolic Solar Pizza Oven

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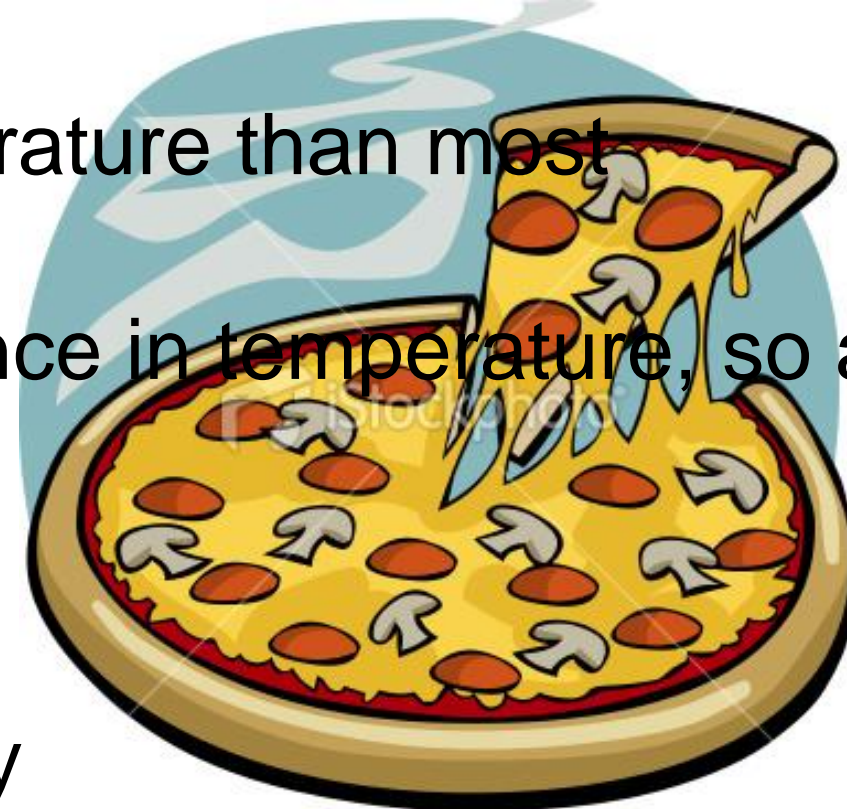
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## Goal Statement:

- Our goal is to build a solar pizza oven, constructed from a microwave communication dish, bricks, and mortar.
- Our oven should be able to reach  $>400^{\circ}\text{F}$  during the day, and retain heat for at least a few hours after the sunset, to continue cooking into the evening.
- Our oven should be made with readily available, inexpensive, and recycled materials.
- Our oven should be portable so it can be taken to local events to demonstrate and promote renewable energy.

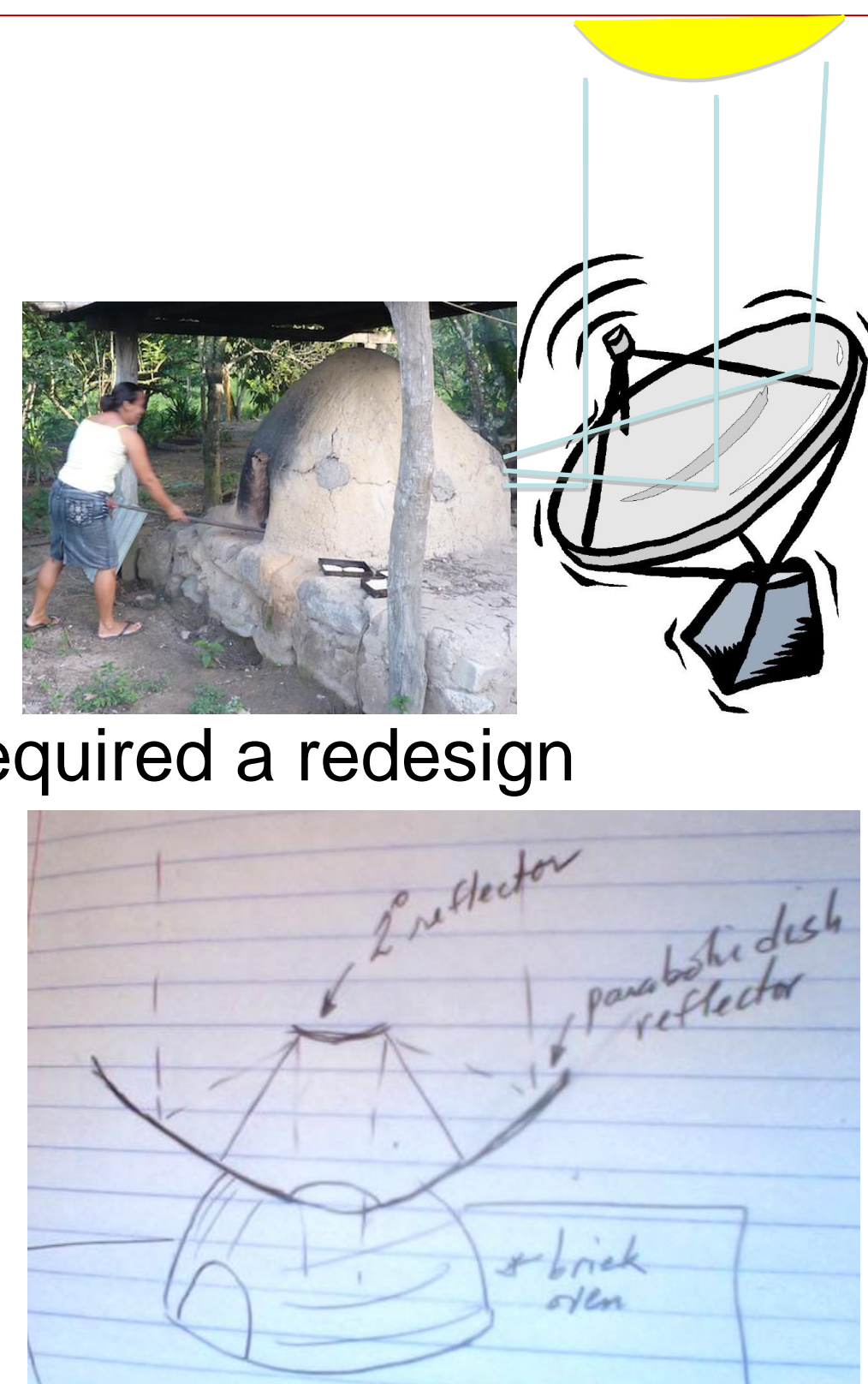
## Basic Principles:

- Cooking pizza requires a higher temperature than most common foods.
- Heat flow is proportional to the difference in temperature, so a pizza oven needs
  - great insulation
  - large heat capacity
  - a large concentrator of solar energy
- As opposed to a solar stove, a solar oven should get hotter and store heat for a longer period of time.



## Initial concepts:

- Parabolic concentrators can focus solar energy into a small aperture of the oven. How can we convert a surplus microwave communication dish into an efficient solar concentrator?
- The short focal length of our dish required a redesign
- A Cassegrain design requires two reflective surfaces and
  - Is compatible with the short focal length
  - Provides a roof for the oven
  - Keeps bright (dangerous) reflections out of people's eyes



- *The oven we built is essential apparatus to research solar concentrator design and performance.*
- Initial tests suggested it would be difficult to focus all the light through a small hole, and furthermore, the dish put the entire oven in the shade.

## Materials and cost:

The solar concentrator was a surplus microwave dish, and a recycled dual glazed window was also acquired for free. The total cost of materials was thus  $\sim \$1100$ .

Description	Cost
Flatbed trailer	\$800
500 lbs mortar	\$40
150 bricks	\$40
Paint, foam, steel, hardware	\$150
Aluminized Mylar	\$40

## Methods:



- The flatbed trailer was covered with two layers of  $\frac{3}{4}$ " plywood.
- The 5" base of the oven was anchored to the plywood with bolts and hardware cloth.



- The oven walls were stacked bricks wrapped inside and outside with hardware cloth (and wired together).
- Mortar covered the inside and outside.



- An 8' dish was cut in half, sanded, and strips of aluminized Mylar were glued to its surface.
- A dual-pane window was glued to the oven with expansive foam.
- The concentrator was supported by a Unistrut frame

**References:** <http://solarpizza.pbworks.com> is our project Wiki. We welcome your comments and participation at that site.

## Theoretical considerations:

- A 6' and 8' dish can concentrate  $\sim 4\text{kW}$  &  $8\text{kW}$  of power.
- An 8' dish should heat 500 lbs of brick to  $300^{\circ}\text{F}$  in 1 hour.
- The oven can collect  $\sim 1\text{kW}$  of energy if not shaded by the dish.
- The  $2^{\circ}$  mirror may not focus all the light through a small  $1^{\circ}$  aperture, especially when the sun is off the parabolic mirror axis.
- This led to our **third design**, using half an 8' dish without a secondary mirror. This design is:
  - Relatively simple and inexpensive
  - Allows construction of two ovens from one dish
  - Collects more energy than possible with flat concentrators

## Results:

- In overcast weather, the oven reached  $130^{\circ}\text{F}$  without the concentrator.
- Large thermal mass makes the oven heat (and cool) very slowly.
- The  $\frac{1}{2}$  dish ignited newspaper at its focus in 1-2 seconds at 5:30pm.
- Additional reflectors around the oven may increase heating.
- Lots of concentrated heat is reflected off the glass.



## Lessons learned:

- A parabola reflects axial rays to a focal point, but non-axial parallel rays spread out in more complex foci. It may take us some time to understand how best to orient and focus the dish.
- We applied science and technology to navigate a myriad of challenges, uncertainties, decisions, and constraints, to turn an idea into a reality.
- We explored a diversity of materials, tools, and scientific principles from saws and drills to heat equations, aluminized Mylar to brick and mortar.
- Engineering and design involve a plethora of trade-offs and compromises. Ergonomics, cost, safety, ease of use, heat-up speed vs. cool-down speed, etc. are factored together in any design.
- Achieving high temperatures in a massive oven is not trivial.