FIRST STEPS IN STOVE DESIGN

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Individual cooking technologies exist to alleviate the effects of poverty.
But the results are mixed

Many fail
Some do not reach their full potential
Few Succeed
Why?
We do not perform an adequate assessment of local village contexts
The world is too diverse

Economically
Socially
Culturally
Geographically
Human Contexts

- Stove cannot cook my meal
- Harder to use than three stone fire
- I wouldn’t be seen with that in 100 years
- Cost!

Natural Contexts

- Fuel is in short supply
- Rain erodes stove

Built Contexts

- No infrastructure to transport replacement parts
- Lack of manufacturing tools
- No place available to keep fuel dry
We need an engineering methodology to link local village contexts to the stove *decision* process
If we start off in the wrong direction, how do we expect to reach our destination?
Assessing Local Contexts

Creating Specifications

Generating Functional Concepts
Assessing Local Contexts

Engineering Ethnography of Select Consumers
Quantitative Study of Market Region
Complete an Engineering Ethnography of Select Consumer Groups

- Build a consumer profile
- Identify distinguishing characteristics (demographic, occupation, …)
- Note absolute and relative amount of consumer type in the target population
- Create a “day in the life”
- Perform Task Analysis of activities
Construct a “Day in the Life”

**Typical Day for a Woman in Rural Mali**

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>5:30 AM</td>
<td>Wake up</td>
</tr>
<tr>
<td>5:30 AM 8:00 AM</td>
<td>Prepare and eat breakfast, wash dishes</td>
</tr>
<tr>
<td>8:00 AM 12:00 PM</td>
<td>Gardening, gathering wood, gathering water</td>
</tr>
<tr>
<td>12:00 PM 3:00 PM</td>
<td>Prepare and eat lunch, wash dishes</td>
</tr>
<tr>
<td>3:00 PM 4:00 PM</td>
<td>Bathing, washing clothes, cleaning</td>
</tr>
<tr>
<td>4:00 PM 6:00 PM</td>
<td>Misc duties, gathering wood</td>
</tr>
<tr>
<td>6:00 PM 8:00 PM</td>
<td>Prepare and eat dinner, wash dishes</td>
</tr>
<tr>
<td>8:00 PM 9:00 PM</td>
<td>Prepare grain for breakfast</td>
</tr>
<tr>
<td>9:30 PM</td>
<td>Go to bed</td>
</tr>
</tbody>
</table>
Generate a Hierarchy of Needs
Capture Data for Specific Needs using Task Analysis

Simple linear workflow (e.g., gathering water)

Linear workflow with parallel activities (e.g., cooking)

Cyclical workflow (e.g., farming)

Activity loop with exit criteria (e.g., washing clothes)
Capture Data for Specific Needs using Task Analysis

Focus on the task that best serves your purpose

Culinary chain*
(e.g, sanitation)

Food preparation → Cook food → Serving → Dining → Washing utensils → Drying utensils

Cooking
(e.g, air quality)

Pre-ignition → Ignition → Cooking → Extinguish → Clean-up

* See work by Maria Nyström
Benefits to Documentation and Communication

- Capture qualitative and quantitative data in standard format
- Common reference between you and user
- Creates a narrative of the user experience
Steps to Completing Task Analysis*

1. Determine scope of the activity
2. Identify people involved
3. Determine location(s) of the work
4. Determine time of each step
5. Identify technologies and resources in use
6. Determine procedures and habits
7. Determine relevant livelihood contexts

* See Slide 41 for more details
Examine Cooking Meals in Detail

The Stove Has to Cook

**Morning**
- **Cook pap**
  - 30-35 min
- **Boil chicken feet**
  - 15-20 min
- **Tea**
  - 8-10 min

**Break**
- **Heat water for bathing**
  - 20-45 min
- **Tea**
  - 8-10 min

**Noon**
- **Cook pap**
  - 30-35 min
- **Boil veg**
  - 15-20 min
- **Fry worms**
  - 8-10 min
- **Porridge**
  - 10-15 min

**Evening**
- **Cook pap**
  - 30-35 min
- **Boil veg**
  - 15-20 min
- **Cook eggs**
  - 10-15 min

*Heat water for bathing* 20-45 min

Can one design meet these needs?
Probe and Interview to Understand Qualitative Trade-offs in Each Task

Pre-ignition
Fuel storage, handling
Fuel procurement
Appliance storage

Ignition
Fuel loading
Easy of ignition
Time to start cooking

Cooking
Quick to cook
Safety and cleanliness
Adaptable to meal type
Comfort, ease of use
Heat regulation

Extinguish
Smoke & ash
Start/stop fire
Fuel conservation

Clean up
Black pots or person
Ash removal
Stove cleaning
Revisit with Questionnaires for Market Assessment

- Standard set of questions
- Section specific to cultural or regional requirements
Creating Specifications

Analyzing Consumer Data
Deciding What’s Important
Differentiate Need from Preference

- Participatory design
- Use Task Analysis for comparative analysis
- What are potential “show stoppers”?
- Bring other technologies for comparison
- Create mock-ups, draw concepts
Focus on *User-centered* Criteria and Constraints

What metrics do people use when making choices?

- ✓ Look / feel
- ✓ Upkeep and maintenance
- ✓ Hygiene and cleanliness
- ✓ Adaptable to meal varieties
- ✓ Cooks quickly
- ✓ Provides heat regulation
- ✓ Minimizes fuel use & waste

- ✓ Storage & mobility
- ✓ Method of loading fuel
- ✓ Ease of operation / versatility
- ✓ Ash disposal & clean-up
- ✓ Accessibility

- ✓ Health
- ✓ Safety
- ✓ Comfort

Aesthetics & Durability

Convenience

Performance

Personal well-being
Get Specific Consumer Requirements

Aesthetics & Durability
- Adaptable to meal varieties
  ✓ Adapts to vessel type
  ✓ Adapts to vessel size
  ✓ Heat focused to a point or dispersed

Personal well-being
- Cooks quickly
  ✓ Speed of ignition
  ✓ Produces high heat

Convenience
- Provides heat regulation
  ✓ Cooks over variety of heats
  ✓ Quick response time (fast change in heat level)
  ✓ Consistency and reproducible heat

Performance
- Minimizes fuel use & waste
  ✓ Dense fuel
  ✓ Pre-set amounts
  ✓ Ability to turn off
You Translate the Consumer’s Voice
Consumers Often Do Not Have the Same Set of Needs

- What size pot do you use?
  - 2L
  - 10L
  - 40L

- What if the result is…
  - 50% (small household)
  - 20% (large household)
  - 30% (cafeteria or cottage industry)
There are Many Options to Select the “Correct” Metric or Stove

- Plurality: choose the most accepted “winner takes all”
- Anti-plurality: remove the worst performing design
- Pair-wise comparison: select one out of two
- Borda Count: ranked order

You get one result, not effective for concept generation
No Market is Homogeneous

- Shape of stove
- Height of stove
- Length of cooking time
- Size of vessel
- ...

## Select Defining Specifications

<table>
<thead>
<tr>
<th>Fuel type</th>
<th>Mobility</th>
<th>Regulation &amp; smokelessness</th>
<th>Cooking surface</th>
<th>Fuel form / feed</th>
<th>Number &amp; style of hobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric</td>
<td>Portable</td>
<td>Natural draft</td>
<td>Griddle</td>
<td>Batch</td>
<td>Feet</td>
</tr>
<tr>
<td>Gas</td>
<td>Fixed</td>
<td>Forced draft</td>
<td>Sunken pot</td>
<td>Periodic</td>
<td>Rings</td>
</tr>
<tr>
<td>Liquid</td>
<td></td>
<td>Chimney assisted</td>
<td>Grill</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gel</td>
<td></td>
<td></td>
<td>Burner</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solid</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Fuel form / feed**: Briquettes, Pellets, Logs, Chips, Particles
- **Energy value performance**: $\rightarrow$ Convenient + competency
Document Consumer Requirements

- Many names
  - Quality Function Deployment
  - Six Sigma
  - House of Quality

- Used to **organize** and **document** information

- **Does not** translate consumer insights into design requirements
  - Metrics
  - Target Values
  - Single-consumer specific

Creating Functional Concepts

Specify Functions of the Stove
From Specifications into Conceptual Alternatives
There are Many Pathways to Design

Need

Strategy

Solution

Direct transfer of existing design

Trim down existing designs

Transfer design and adapt

Combine aspects of existing designs

Full product design
Group Specifications into Core and Adaptable Characteristics

Core specifications

Components that must be included in the design (social, cultural, environmental reasons)

And

The central functionality of the stove – what makes it cook
Group Specifications into Core and Adaptable Characteristics

Adaptable specifications

Those that can be modified on-ground for local user needs, material availability, and other factors
Why Categorize into Core and Adaptable?

- Match technical feasibility with user interest
- Shorten design time
- Part of your design may already exist
- Work may be partitioned between field and lab
Create Mock-ups
Revisit the Consumer

- Does the user understand your proposed engineering functions?
- Do you understand their preferences?

- Pre-ignition
- Ignition
- Cook food
- Extinguish
- Clean-up
Needs base extender
Additional Content

For instructions on completing task analysis see “First Steps in Confronting Poverty: Transforming Community Need Into Action”

http://www.ewb-usa.org/ConfProjWork09.php
Thank you

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