Multidisciplinary Senior Design
Project Readiness Package

Project Title:	Solar Assisted Low Energy Essential Oil Distiller
Project Number: (MSD will assign this)	P15484
Primary Customer: (provide name, phone number, and email)	Sarah Brownell
Sponsor(s): (provide name, phone number, email, and amount of support)	
Preferred Start Term:	Spring 2015
Faculty Champion: (provide name and email)	Sarah Brownell sabeie@rit.edu
Other Support:	
Project Guide: (MSD will assign this)	Sarah Brownell

Sarah Brownell — August 2014
Prepared By — Date

Received By — Date

Project Information

Overview:

Farmers in the Cooperative KGPB in Bornge, Haiti have requested help to develop methods to obtain more income from their agricultural products by transforming them for export or by implementing improved storage methods to reduce waste. This farmers group operates in one of the more impoverished and remote regions of Haiti. While food is generally available from farming, villagers lack access to cash for activities such as sending kids to school and paying for medications and clinic visits. They face difficulties in turning their agricultural products into cash. Good food often ends up spoiling before being sold despite the fact that there is a shortage of food in Haiti and much malnutrition. Infrastructure problems such as non-existent or poor roads, few ports, sparse electrical grid coverage, and high fuel costs inhibit perishable produce from getting to market safely and especially from reaching the more lucrative international markets. Multiple MSD teams will tackle different possible solutions for increasing the income and, therefore, the overall wellbeing of the cooperative families.

Essential oils are an agricultural product that the farmer's group could develop for export, because of the following advantages:

- The tropical climate is well suited for growing many types of plants that are commonly used for essential oil such as vetiver, lemongrass, basil, mint, eucalyptus, etc.
- Because so little oil can be obtained from each plant, the volume of the agricultural product is greatly reduced, facilitating transport.
- For similar reasons, the product is of high monetary value.
- Essential oils do not require refrigeration during transport and have long shelf lives.
- Essential oils can be used in non-food applications such as perfumes, air fresheners, laundry soap and bath products that may require less stringent regulations than food or therapeutic products. ("By far, the majority of essential oils produced today are for the perfume industry. This industry is able to produce a high volume of aromatic oils using high pressure, high temperatures, and chemical solvents because it does not require a therapeutic standard." http://www.family-essential-oils.com/essential-oil-distillation.html)
- Haiti is already a major producer of essential oil from vetiver from the southern coast. However, export of vetiver oil is controlled by a large company and little of the money reaches farmers.

Essential oils are traditionally produced by a steam distillation process (figure 1) where steam is passed over the plant materials in an, often pressurized, chamber. The steam is collected and condensed, and then the oil can be separated from the water by specific gravity. One challenge for extracting essential oils in the rural areas of Haiti is that costly fuel is required to generate steam for distillation. The goal of this MSD team will be to create an essential oil distiller which minimizes fuel requirements and costs and operates on the fuels available in rural Haiti (in order of cost: solar insolation, wood, charcoal, kerosene, propane). For this initial phase, the design focus will be on a home-scale distiller, but the team should consider scalability as they design. For testing the distillation process, the team can experiment with extracting oils from more locally available plants.

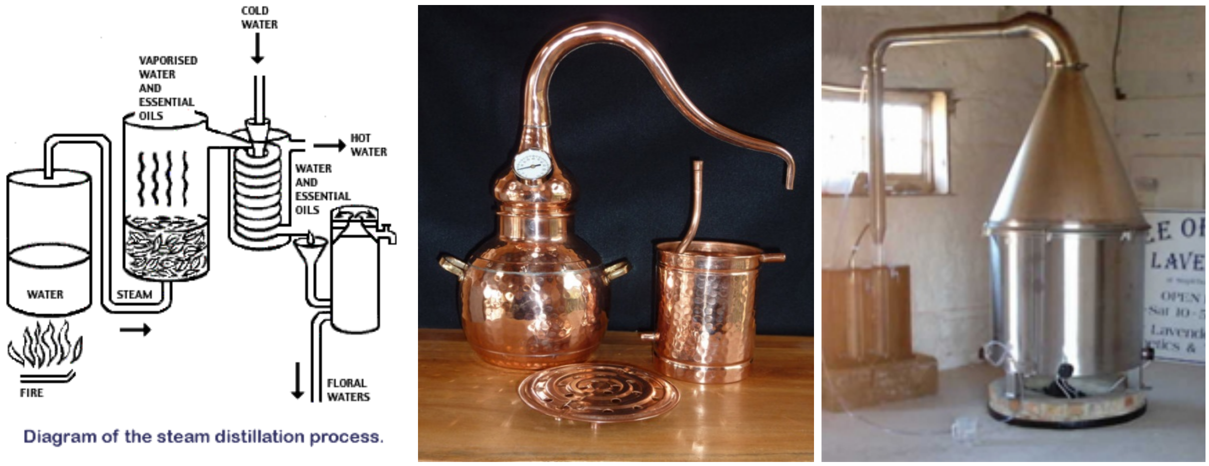

Figure 1: Process schematic, home-scale system, industrial scale system. From http://www.anandaapothecary.com/images3/distillation.gif , https://img0.etsystatic.com/000/0/6392254/il_570xN.281244758.jpg and http://gnltd.co.uk/distillation-equipment

Customer Requirements (CR):

- Maximizes fuel efficiency for purchased fuels.
- Minimizes fuel costs.
- Takes advantage of abundant solar energy available.
- Utilizes locally available fuels.
- Processes up to (at least) 1 lb of plant material at a time (ie. 4-5 basil plants).
- Allows pressure (and thus steam temperature) to be adjusted for various plant types
- Directs steam past the plant materials.
- Prevents chemical reactions with the plant materials that could contaminate the oil.
- Protects quality of the oil from too high temperatures and pressures.
- Condenses steam and collects it.
- Allows easy separation of oils from floral waters.
- Recovers oil at a rate comparable with other home products on the market.
- Minimizes breakable (ie. glass) parts.
- Easy to operate.
- Easy to repair.

Functional Decomposition (will not be given to the students, but will be provided to the team's guide for reference):

- Hold plants
- Provide heat
- Provide pressure
- Heat water
- Generate steam
- Pass steam by plants
- Condense steam
- Reclaim condensate heat

- Separate oil from floral waters

Constraints:

- Utilizes locally available fuels
- Minimizes fuel costs
- Maximizes energy efficiency

Project Deliverables:

Minimum requirements:

- Working household scale prototype
- Design drawing package
- Bill of Materials
- Assembly manual
- User Manual
- Test plan and results
- Complete Edge site
- Poster
- Paper
- Final presentation materials

Budget Information:

Estimated $800 for prototyping

Intellectual Property:

N/A

Project Resources

Required Resources (besides student staffing):
Describe the resources necessary for successful project completion. When the resource is secured, the responsible person should initial and date to acknowledge that they have agreed to provide this support. We assume that all teams with ME/ISE students will have access to the ME Machine Shop and all teams with EE students will have access to the EE Senior Design Lab, so it is not necessary to list these! Limit this list to specialized expertise, space, equipment, and materials

Faculty list individuals and their area of expertise (people who can provide specialized knowledge unique to your project, e.g., faculty you will need to consult for more than a basic technical question during office hours)	**Initial/ date**
Environment (e.g., a specific lab with specialized equipment/facilities, space for very large or oily/greasy projects, space for projects that generate airborne debris or hazardous gases, specific electrical requirements such as 3-phase power)	**Initial/ date**
May need outdoor testing, depending on choice of fuel	
Equipment (specific computing, test, measurement, or construction equipment that the team will need to borrow, e.g., CMM, SEM,)	**Initial/ date**
Temperature & pressure sensors	
Materials (materials that will be consumed during the course of the project, e.g., test samples from customer, specialized raw material for construction, chemicals that must be purchased and stored)	**Initial/ date**
Stainless or tinned copper, maybe aluminum (but research required to rule out interactions)	
Other	**Initial/ date**

Anticipated Staffing By Discipline:
Indicate the requested staffing for each discipline, along with a brief explanation of the associated activities. "Other" includes students from any department on campus besides those explicitly listed. For example, we have done projects with students from Industrial Design, Business, Software Engineering, Civil Engineering Technology, and Information Technology. **If you have recruited students to work on this project (including student-initiated projects), include their names here, as well!**

Disc.	# Req.	Expected Activities
ISE	1	Sustainability/efficiency, engineering economy, safety, usability, process control
ME	4	Solar pre-heating of water and/or heat exchange with condensate 2) steam generation 3) containing plants for extraction and 4) collecting and re-condensing steam. Heat transfer, fluids, machining, material selection

Skills Checklist:

Indicate the sills or knowledge that will be needed by students working on this project. Please use the following scale:

1=must have

2=helpful, but not essential

3=either a very small part of the project, or relates to a "bonus" feature

blank = not applicable to this project

Mechanical Engineering

	ME Core Knowledge		**ME Elective Knowledge**
2	3D CAD		Finite element analysis
	Matlab programming	1	Heat transfer
3	Basic machining		Modeling of electromechanical & fluid systems
3	2D stress analysis		Fatigue and static failure criteria
3	2D static/dynamic analysis		Machine elements
1	Thermodynamics		Aerodynamics
1	Fluid dynamics (CV)		Computational fluid dynamics
	LabView		Biomaterials
	Statistics		Vibrations
1	Materials selection		IC Engines
			GD&T
			Linear Controls
			Composites
			Robotics
			Other (specify)

Electrical Engineering

n/a

Industrial & Systems Engineering

	ISE Core Knowledge		**ISE Elective Knowledge**
	Statistical analysis of data: regression		Design of Experiment
2	Materials science		Systems design – product/process design
	Materials processing, machining lab		Data analysis, data mining
	Facilities planning: layout, mat'l handling		Manufacturing engineering
1	Production systems design: cycle time, throughput, assembly line design, manufacturing process design	1	DFx: manufacturing, assembly, environment, sustainability
1	Ergonomics: interface of people and equipment (procedures, training, maintenance)		Rapid prototyping
	Math modeling: OR (linear programming, simulation)	2	Safety engineering
2	Project management		Other (specify)
1	Engineering economy: Return on Investment		
	Quality tools: SPC		
	Production control: scheduling		
	Shop floor IE: methods, time studies		
	Computer tools: Excel, Access, AutoCAD		
	Programming (C++)		

Biomedical Engineering
n/a

Computer Engineering
n/a