



What is LooLoo? LooLoo is a revolutionary mobile toilet for maximum UX! It's got 1 kW solar power. Cell phone charging ports. Commercial-Off-The-Shelf materials. No special skills, materials or tools to construct. Ultraviolet germicidal irradiation (UVGI). LED lighting. Hand sanitizer. Powered ventilation. Financial incentives to use wisely. Unprecedented!

The goal of this project is to build a four-season, innovative structure that collects human waste. But wait! It does so much more! It is envisioned as a temporary not a permanent structure. It is maintained by local community people. And it provides financial incentives for caretakers on a rotating basis using electronic transfer funds (ETF). What's not to like?

See the slide show, download the proposal and other documents at:
<http://www.thehomeshelter.org>

I contacted California Governor Gavin Newsom, the American Red Cross, universities, designforthehomeless, US Interagency Council on Homeless, even the National Park Foundation for interest, ideas, critical assessment, funding or a grant application. No responses. No feedback. Nothing. So, I thought I'd try crowdsourcing. I not sure where this will go but I thought I'd throw it out there. Research, design, build, and test one yourself. Good luck!

OBJECTIVES

- **DESIGN A HUMAN WASTE CONTAINMENT SYSTEM COMPLETE WITH POWER AND ELECTRONICS FOR LIGHTING AND CELL PHONE CHARGING, FINANCIAL INCENTIVES FOR MAINTENANCE AND HOMELESS COMMUNITY INVOLVEMENT**
- **LIMITED LIFE INSTALLATION, ONE YEAR MAXIMUM**
- **FOUR SEASON DURABLE.**
- **MAXIMIZES PREASSEMBLY TO MINIMIZE TOOLS AND FASTENERS ON SITE.**
- **PORTABLE FOR TWO PEOPLE TO ASSEMBLE / DISASSEMBLE.**
- **ATTRACTIVE TO LOOK AT AND ENJOYABLE TO USE.**
- **MAXIMIZE SANITATION METHODS TO MINIMIZE PATHOGENS**
- **ENCOURAGE MALES TO SIT RATHER THAN STAND TO PREVENT SPILLAGE.**

LooLoo objectives are simple and straightforward. It's extremely low cost (less than \$1000 for all materials), low maintenance and simple construction for easy assembly and disassembly by two people is a huge advantage over expensive public toilets. It uses splines, pressure fittings and a limited number of fasteners rather than welded steel seams, plastic or rivets. It uses readily available cleansers and disinfectants to reduce pathogens. It's designed for four season use. The target weight is less than 500 lbs. with each panel weighing less than 60 lbs. It reduces maintenance and increases cleanliness by strongly encouraging males to sit rather than stand. Its electronic feature allows users to charge their cell phones which are a lifeline for people living rough. And the external surface treatments make it attractive and part of the environment.

SIMPLE

- **LOOLOO BUILT FROM COMMERCIAL GRADE ACX PRESSURE TREATED WOOD**
- **USES SPLINES TO CONNECT PANELS**
- **REQUIRES LIMITED HARDWARE TO BUILD**
- **USES TWO HALVES OF A 55-GALLON DRUM AS WASTE CANS**
- **ASSEMBLED ON-SITE OR TRANSPORTED ON A PALLET**
- **2-HOUR ASSEMBLY**
- **USES PASSIVE AND ACTIVE VENTILATION**



Richard Davids, Sponsor. Aerospace Human Factors Engineer.
rcdavids1@verizon.net

9 APRIL 2013

The entire structure could be constructed using eight (8) sheets of 0.5-inch-thick pressure treated 4 feet x 8 feet ACX plywood sheets. Each sheet weighs about 60 lbs. so the entire structure might weigh about 500 lbs. Its sheer weight discourages tipping or removal. Each sheet costs about \$40 at Home Depot. Since it is constructed with splines as shown above and limited fasteners, it is easy to assemble and disassemble with portable power tools. The pallet base enables forklift transportation. Splines provide more contact surface between panels. It includes a 'power cap' as designed for the HOME Shelter, its predecessor. The nearly inaccessible power cap contains the electronic components. Watch a video of its features and construction at <http://www.thehomeshelter.org>

INNOVATIVE

9 APRIL 2020

- Physical design encourages users to sit rather than stand.
- Sitting posture reduces spill, odor, cleanup and maintenance
- Includes a 'power cap' for lighting, electronics and phone charging.
- Power cap is inaccessible to users
- Looloo system includes financial incentives for a caretaker.
- Caretaker is in the local community.
- Users take responsibility, not city or town.
- Caretakers reimbursed via ETF.

Richard Davids, Sponsor. Aerospace Human Factors Engineer. rcdavidst1@verizon.net

LooLoo is innovative in several ways compared to other outdoor toilets. To start with its structure encourages users to sit rather than stand. Sitting reduces overspill and splashing. LooLoo's power cap combination of solar panel, battery, and inverter enable charging your phone. Electronics are enclosed in a solid wood structure to discourage vandalism. LooLoo's financial incentive arrangement with a local charity or credit union reinforce community involvement. The caretaker is responsible for encouraging best use and not abuse by users. Users take responsibility for cleaning and maintaining LooLoo, not the municipal government.

**CARETAKER
– GLUE
HOLDING
LOOLOO
TOGETHER**

9 APRIL 2020

- Local community member
- Reimbursed with cashless transfer via Zelle or comparable service.
- Rotated responsibility
- Replenishes paper and yeast.
- Cleans seat and floor
- Contacts septic pumpers
- Coordinates with social worker
- Encourages users to use not abuse

Richard Davids, Sponsor. Aerospace Human Factors Engineer. rcdavidst1@verizon.net 5

The role of the caretaker is an important distinction from all other public toilets. LooLoo involves the local user community. The caretaker is given financial, maintenance and social responsibility to maintain LooLoo for a year. It's to their advantage to maintain the facility and encourage users in the local community. Most encampments are cooperative with local community enforcement. Read about it in the documents section. And the financial benefits and responsibilities are rotated around the community so everyone who wants an opportunity can have one. In a sense, members of the local community are on a payroll setup through a local bank or credit union or charity. This is unprecedented in humanitarian community projects.

APPROACH - DESIGN, BUILD, INNOVATE

Engineering
Research
Design
Build
Test

Business
Research
Marketing
Management
Logistics
ETF accounts

LooLoo

Arts and Sciences
Research
Art and Digital Design
Environmental Science

Richard Davids, Sponsor, Aerospace Human Factors Engineer, rcdavids1@verizon.net

9 APRIL 2020 6

One approach is for a university or college to adopt LooLoo as a Capstone or Senior Design project. This project requires innovative civil and environmental engineering plus additional substantial inputs and cooperation from the college of business and college of arts and sciences. I believe this project will improve with input from the College of Arts and Science, namely, Art and Art History and Environmental Sciences and College of Business, Marketing or Management. The departments of civil and environmental engineering need to investigate and estimate structural loads, ventilation, effects of composting, electronic power supply, durability and effects of temperature (freezing poop). The college of arts and science will investigate artistic effects, application of trompe l'oeil, and digital design. The college of business will develop a business plan for municipalities, electronic fund transfers via cell phone, marketing and management of LooLoo at the city level.

ELEMENTS OF LOOLOO

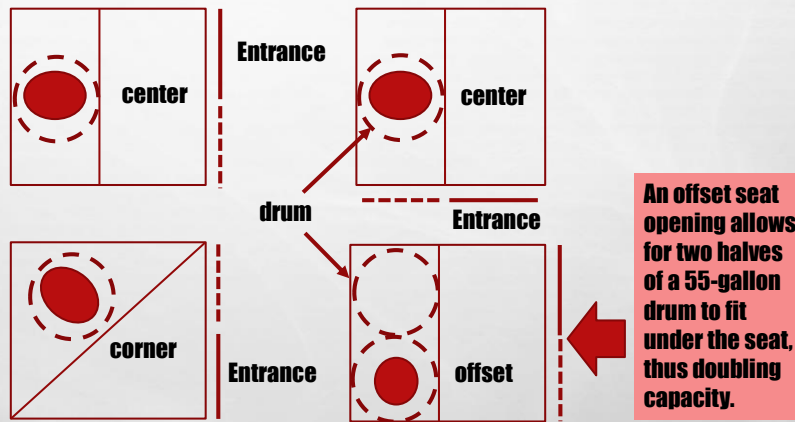


Richard Davids, Sponsor. Aerospace Human Factors Engineer. rcdavids1@verizon.net

9 APRIL 2020 **7**

Here's a more detailed look at the operational elements of LooLoo. You have the limited life structure, private contractor or municipal septic pumping, volunteer or city employed social workers to assist the caretaker, the caretaker and consumables like paper, cleanser, sanitizer. It's important to remember that LooLoo is a system not just a structure. It actively involves members of the local community. That's why most other attempts have failed; waste management involves the local community, financial incentives, ensuring usability for an optimal experience, and allowing the user additional incentives like charging a cell phone while using LooLoo. LooLoo is a total system concept.

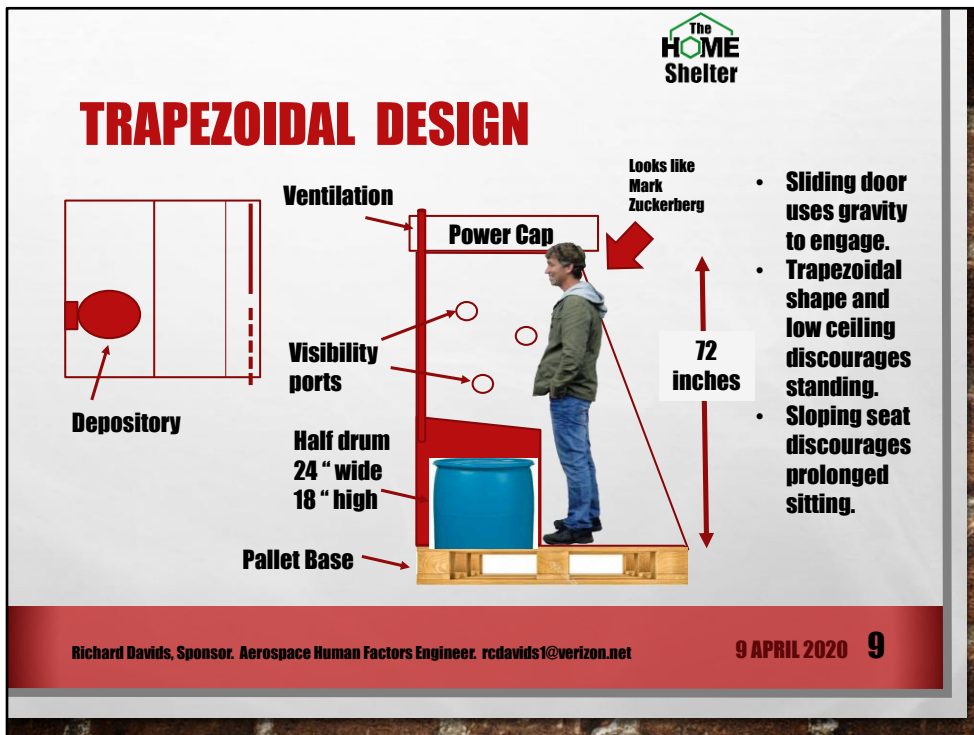
STRUCTURAL – SEVERAL OPTIONS



Richard Davids, Sponsor, Aerospace Human Factors Engineer, rcdavids1@verizon.net

9 APRIL 2020 8

There are several options for the physical or structural layout. LooLoo could have a center, corner, or offset seat. The entrance can be on either on the front or side of the structure depending on your viewpoint. There is a distinction between 'door' and entrance. A door implies a hinged panel that swings left or right. Suppose we think of the opening as an entrance. Think of a way to allow someone to enter and exit a structure. If you don't think of a door, then how you exit and enter is wide open. Pun intended.... Considerations include sizing for 95th percentile male, including accessories like a backpack or heavy clothing, large bag, etc. The offset seat allows for placing extra items next to the user without dropping them on the floor. All other restrooms use a center seat. A center seat restricts horizontal storage space. Perhaps an offset seat is better? Since the concept uses a split 55-gallon plastic drum as storage, how do you minimize moving the drum around if the seat is fixed and still use both halves?



A trapezoidal design like this one encourages the user (Mark Zuckerberg, as shown) to sit rather than stand to avoid bumping the head. If the height of the ceiling is reduced to 72 inches, this vertical dimension further restricts standing and encourages sitting. There's another advantage to a lower ceiling. Lowering the ceiling from 8 to 6 feet saves 1 4 x 8 sheet of plywood. The ripped 2-foot long pieces from 3 sides can be used for the seat and riser.

A pallet base could provide more stability and transportability. Most are 48 inches x 40 inches. A 48-inch x 48-inch will work here since the notional design uses 4-foot x 8-foot plywood. Two-inch diameter holes drilled in the sides and rear allow visibility inside from outside and vice versa. No other restroom considers visibility for users and a caretaker to ensure safety.

See the slide show, download the proposal and other documents at:
<http://www.thehomeshelter.org>

I'm not sure where this will go but I thought I'd throw it out there. Research, design, build, and test one yourself. Good luck!

The HOME Shelter

HOW ABOUT A LOWER CEILING?

- Most users have a cell phone.
- Phones need charging. Charger encourages sitting.
- Sloped seat discourages prolonged use.

Richard Davids, Sponsor. Aerospace Human Factors Engineer. rcdavids1@verizon.net 9 APRIL 2020 10

LooLoo has an off-center seat as shown. There are two features of this design that encourages users to sit rather than stand: one – a lowered 6-foot ceiling and two – a pedestal with a charging station. A lowered ceiling risks bumping your head if you stand up. Lowering the ceiling from 8 to 6 feet saves 1 4 x 8 sheet of plywood since the ripped 2-foot long pieces are used for the seat and riser. The pedestal stand is wired for charging a cell phone. The charger allows the user to sit and charge a cell phone while reading messages or sending a message. The seat is sloped to discourage prolonged sitting. The half drum container is accessed from the rear via a pop-out panel. A pallet base could provide more stability and transportability. A 48-inch x 48-inch pallet will work here since the notional design uses 4-foot wide x 8-foot high plywood . Two-inch diameter holes drilled in the sides and rear allow visibility inside from outside and vice versa. No other restroom considers visibility for users and a caretaker to ensure safety.

See the slide show, download the proposal and other documents at:
<http://www.thehomeshelter.org>

I not sure where this will go but I thought I'd throw it out there. Research, design, build, and test one yourself. Good luck!

9 APRIL 2020

ATTRACTIVE

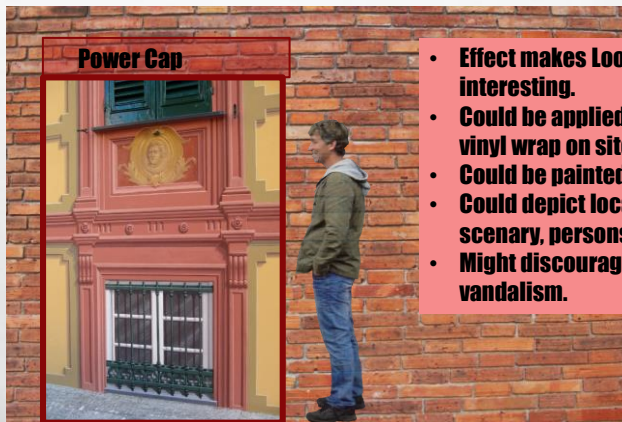
- USES TROMPE L'OEIL TO MAKE LOOLOO NOT LOOK LIKE A LOO.
- TROMPE L'OEIL MEANS TO 'FOOL THE EYE'.
- DEPICTED SURFACE APPEARS AS 3 DIMENSIONAL
- COULD BE A MURAL PAINTED OR APPLIED VINYL COATING
- MIGHT DISCOURAGE GRAFFITI AND VANDALISM.

Richard Davids, Sponsor. Aerospace Human Factors Engineer. rcdavids1@verizon.net



The external outside appearance is extremely important. It's part of the UX. Suppose you used trompe l'oeil to disguise the appearance? Of course, you still know it's a toilet but if it looks like part of the environment rather than a big blue box isn't that more pleasing and interesting? The outside of LooLoo might look like a wall or a shrub or a brick wall. Color and design might be applied on the site by a local artist or at a pre-fab shop using vinyl coating like you see on the side of a bus. High school students even grammar school students could paint one. The possibilities are endless. Although trompe l'oeil is a 3D effect, the outside design might be any kind of painting.

ART – TROMPE L'OEIL EFFECT



- Effect makes LooLoo interesting.
- Could be applied using vinyl wrap on site.
- Could be painted in shop.
- Could depict local scenery, persons, location.
- Might discourage vandalism.

Richard Davids, Sponsor. Aerospace Human Factors Engineer. rcdavids1@verizon.net

9 APRIL 2020 12

A trompe l'oeil effect would make LooLoo appear more interesting and appealing. If the effect is mass produced on vinyl, then it could be applied before assembly. Or a mural could be painted or applied on site that would match the surrounding landscape like a building or not.

PORTLAND LOO

PERMANENT PUBLIC TOILET

\$100K - \$250K TO INSTALL AND MAINTAIN

STAINLESS STEEL CONSTRUCTION

RICHARD DAVIDS, SPONSOR. AEROSPACE HUMAN FACTORS ENGINEER.
RCDAVIDS1@VERIZON.NET

9 APRIL 2020

Many attempts were made in the past 10 years to design and build a public toilet. About 20 cities have public toilets. The most successful is the 2012 Portland public toilet called 'Portland Loo.' It costs about \$100,000 per unit to construct and install. Some estimates are as high as \$250,000 per toilet. In New York City, public toilet installation and maintenance can top \$1,000,000. The Portland Loo is popular in Oregon, but its design is not suitable for harsh environments with winter and snow and sleet. A driving rain with blow right through it. And the cost is rather high considering it must include hooking up to city sewers and water. While it is designed for public use including moms with kids and students with backpacks and bicycles, it does place a maintenance burden on the community for years. Public toilets like the Portland Loo are designed for last 10 – 20 years. They're constructed of welded ¼ stainless steel panels with special powder coatings. LooLoo is designed to be a consumable item, something that might last one season or a year at most.

PORTA POTTY

- **MOST POPULAR PORTABLE RESTROOM.**
- **MADE OF PLASTIC, LONG LIFE ITEM.**
- **40 INCHES X 48 INCHES**
- **\$300 PER POTTY PER WEEKEND OR**
- **\$500 RENTAL PER MONTH PER POTTY**
- **ONE-YEAR COST = \$6,000 PLUS CLEANING**
- **HOLDS 60 GALLONS; LOOLOO HOLDS 55 GALLONS**



Richard Davids, Sponsor. Aerospace Human Factors Engineer.
rcdavids1@verizon.net

9 APRIL 2014

Notice that the common Porta Potty prevents users and caretaker to see out or inside. This lack of visibility can be threatening for personnel safety. While it is easy to clean the plastic surfaces, the Porta Potty is extremely sterile and encourages users to place items on the floor which is dubious. By encouraging sitting through good design, LooLoo eliminates the extra urinal you see attached to the side wall plus any interfaces to the waste tank.

LOOLOO VS. PORTLAND LOO VS. PORTA POTTY

9 APRIL 2020

Item	Loo Loo	Portland Loo	Porta Potty
Only one person inside	Yes	Yes	Yes
No mirror	Yes	Yes	Yes
No running water inside	Yes	Yes	Yes
Visibility inside	Yes	Yes	No
No flush button	Yes	Yes	Yes
Graffiti resistant	N/A	Yes	Yes
Damage repairable	Yes	Yes	Yes
Hand sanitizer	Yes	Yes	No
Lighting	Yes	Yes	No
ADA compliant	N/A	Yes	Yes
Stainless steel	No	Yes	No
Charging station	Yes	No	No
UVGI	Yes	No	No
Four (4) season use	Yes	No	Yes

Richard Davids, Sponsor. Aerospace Human Factors Engineer. rcdavidst1@verizon.net

This table compares LooLoo with Porta Potty and Portland Loo against 14 criteria from research on toilet design. Porta Potty scores six (6) NO features. Portland Loo scores three (3) NO features. LooLoo scores only one (1) NO feature. While Portland Loo and Porta Potty might be graffiti resistant, LooLoo encourages external surface treatments which might be construed as graffiti. LooLoo is not ADA compliant but the argument is that LooLoo is not a true public toilet. It is designed for a specific user community on a temporary basis. No other toilet has a charging station or the extensive use of solar power. And it can be designed to be a four-season structure at a reasonable cost.

STRUCTURAL - CONSTRUCTION

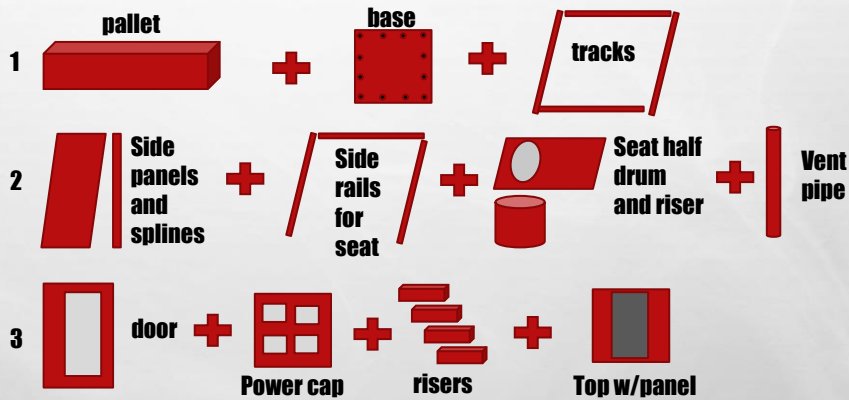
Watch a video at:
<http://www.thehomeshelter.org>

RICHARD DAVIDS, SPONSOR, AEROSPACE
HUMAN FACTORS ENGINEER,
RCDAVIDST@VERIZON.NET



The basic structure is held together with splines, tracks and screws. The sliding door is captive between a bottom and top track. There are no hinges or hardware that can break. Cutouts in the sliding panel act as door handles. You do not need a doorknob or handle. The door measures about 24 inches wide; the minimum for door width. The door is captive to the structure. Door is set in a standard 4-foot x 8-foot ACX sheet of plywood. This 2-foot wide door allows a 95th percentile person to enter and exit sideways. Watch a video at: <http://www.thehomeshelter.org>.

SOME PREASSEMBLY REQUIRED



Richard Davids, Sponsor, Aerospace Human Factors Engineer.
 rcdavids1@verizon.net

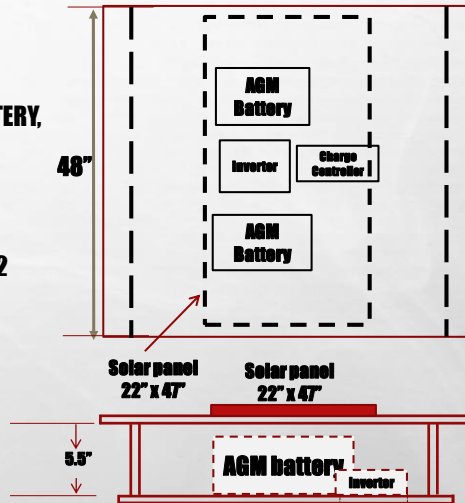
9 APRIL 2020 17

This pictograph shows the basic assembly sequence. You start from the bottom and work up to the top. Some preassembly is done in a workshop. Preassembled units are delivered to the installation site. For instance, the electronics can be preassembled in the power cap including wiring and then sealed. Tracks, side panels and the door can be precut in a workshop. The seat openings are cut and fit-checked for the vent pipe. The charging station is preassembled, also. Total assembly in the field might take about 4 hours.

POWER CAP - ARRANGEMENT

COMPONENTS: SOLAR PANEL, BATTERY, CHARGE CONTROLLER, INVERTER, CHARGERS, WIRING.

- MOUNTED IN/ON 'POWER CAP'
- 'POWER CAP' CONSTRUCTED OF 2 PIECES OF 0.5" PLYWOOD
- HOUSES ELECTRONICS
- SOLAR PANEL ON TOP
- BOTTOM PANEL IS 40 X 48; TOP PANEL IS 48 X 48 INCHES.



Power is stored in one or two 12 Volt, Absorbed Glass Mat (AGM) batteries which can be placed in any position and has no risk for spilling. That's an important feature of AGM batteries for both users, local community, and the environment. The final components selected for the electrical system include a solar panel with built-in voltage regulator, a separate charge controller, and a separate power inverter.

POWER CAP – WEIGHT

POWER CAP WEIGHT ANALYSIS:

- **PLYWOOD (4' X 4' X .5") = 50 LBS.**
- **2" X 6" X 36" LUMBER**
- **SOLAR PANEL = 16 LBS.**
- **AGM BATTERY (2) = 20 LBS.**
- **CHARGE CONTROLLER AND INVERTER = 2 LBS.**
- **WIRING = 0 LB.**
- **TOTAL ESTIMATED MAX WEIGHT = 90 LBS.**

The power cap contains the electronic components in a sealed compartment. The cap is most likely pre-assembled and installed on site. It might weigh about 95 lbs. so two people can lift it into place. It might be painted or sealed in some way to keep out mice and moisture.

POWER
SUBSYSTEM –
REQUIREMENTS

RICHARD DAVIDS, SPONSOR, AEROSPACE
HUMAN FACTORS ENGINEER,
RCDAVIDST@VERIZON.NET

Power Consumption of Typical Devices:

Cell phones (2) @ 3.5 V x 24 hr @ 125mA or (2 x 0.5 Watts/hr x 5 hr / day)	5 Watt-hours
Cell phone charger	5 Watt-hours
LED string x 4.8 Watts @ / string (35 lights per string) x 4 hrs / day	10 Watt-hours
UVGI light fixture	35 Watt-hours
Small ventilation fan	5 Watt-hours
TOTAL	60 Watt-hours

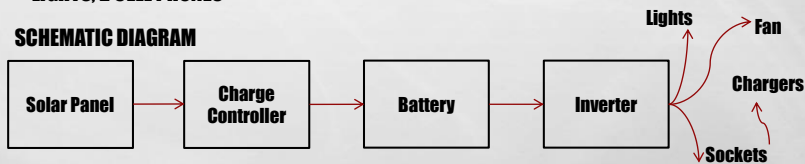
There are components that require electricity – (1) electrical outlets, (2) interior lighting and (3) USB charging sockets. Having 1 string of LED 5 mm light strings ‘ON’ for 4 hours a day consumes almost as much power as using a tablet for 4 hours per day. Cell phones require very little relative to the other items. Plus, you can have a UVGI lamp to kill germs and bacteria. A small ventilation fan in the vent stack will remove odor from the waste tank or drum. These power requirements are estimates. A more extensive power load analysis is required.

POWER SUBSYSTEM – SCHEMATIC

REQUIREMENTS

- PROVIDE 50 – 100 WATTS
- DESIGN INCLUDES BATTERY OR BATTERIES, CHARGE CONTROLLER, POWER INVERTER PLUS USB CONNECTORS (A, B, C, MINI, AND MICRO)
- ALLOWS INTERMITTENT USE AND CHARGING OF LOW WATTAGE SMALL ELECTRONICS, LIKE LED LIGHTS, 2 CELL PHONES

SCHEMATIC DIAGRAM



Here is a simple schematic of LooLoo electronics. One solar panel could provide 50 – 100 Watts. A single flat panel minimizes cost and complexity compared to small panels used by hikers and backpackers. Peripheral electronics like the LED lighting, fan, and cell phone chargers plug into sockets built into the inverter.

POWER SUBSYSTEM – POWER ANALYSIS

- ASSUMES 4 HRS. / DAY SUN EXPOSURE
 - SIMILAR TO ATLANTA, GA

Wattage and Charge Controller Requirements	
For 100 Watt hours / day	Optimum level
Total wattage of solar panels must =	36 Watts
LooLoo has room for 1 panel:	
Number of Watts per panel =	50 - 100 Watts
Charge controller =	9 amps ?

We assume only 4 hours per day of sun exposure to charge the battery. More analysis is needed to specify the requirements for the electronic components based on certain cell phone charging assumptions.

POWER SUBSYSTEM – SOLAR PANEL

SOLAR PANEL

- **GRAPE SOLAR GS-S-100-TS 100-WATT MONOCRYSTALLINE PV SOLAR PANEL**
- **PANEL DIMENSIONS: 40.8-INCHES X 20.7-INCHES X 1.38-INCHES, WEIGHS 16.3-POUNDS**
- **TRUE MODULE EFFICIENCY RATING OF 18%**
- **PULL IN 2-3 AMPS ON CLOUDY DAYS**
- **"POSITIVE GROUND" PANELS; POTENTIAL PROBLEM**
- **"POSITIVE GROUND" IS NO LONGER REQUIRED IF A "PULSE WIDTH MODULATED DIGITAL REGULATOR" USED.**
- **\$109 AT AMAZON.**



Richard Davids, Sponsor. Aerospace Human Factors Engineer. rcdavids1@verizon.net

9 APRIL 2020 23

Here is a good candidate for the solar panel component. It is a mono crystalline Grape Solar 100-watt panel readily available from HOME Depot, Costco and Amazon. It is small enough to fit on top of the power cap. It would be bolted, and glued in place to discourage vandalism. Monocrystalline panels are 20% efficient, at best.

POWER SUBSYSTEM - BATTERY

- **BATTERY - BASICS**
 - **FUNCTION: STORES POWER CHARGE**
 - **CAN BE USED INDOORS, I.E.,**
 - **NO SPILLAGE**
 - **DOES NOT NEED PERIODIC WATERING**
 - **DOES NOT EMIT NO CORROSIVE FUMES**
 - **ELECTROLYTE WILL NOT STRATIFY**
 - **NO EQUALIZATION CHARGING IS REQUIRED.**
 - **DIMENSIONS = FITS IN A SPACE 5.5 INCHES HEIGHT**

Richard Davids, Sponsor. Aerospace Human Factors Engineer. rcdavids1@verizon.net

9 APRIL 2020 24

There are a few types of lead acid deep cycle batteries: flooded, sealed gelled, or sealed AGM. For most situations a sealed **AGM (Absorbed Glass Mat)** is the safest and best option. AGM batteries require little maintenance. There is no need for ventilation and they will not spill. Flooded batteries have the advantage of being significantly less expensive, but they require adequate ventilation, maintenance, and also have the potential liability of tipping or spilling. AGM batteries are typically lighter and less expensive per amp-hour compared to gel.

Chargers designed for long term charging of flooded cell (or AGM) batteries will frequently have a remote temperature sensor (battery charging voltage is temperature sensitive) and 2-3+ charging stages- with the last stage a "float" voltage setting (backs charging voltage back to around 12.7-13.6 volts to prevent boiling a battery dry) and/or an automatic or manual equalize setting (which can be turned off/adjusted for AGM/sealed batteries).

Flooded Lead acid are constant current charged at the C/10 rate until they reach 2.45 Vpc. Gel are constant current charged at the C/20 until they reach 2.35 Vpc. AGM are constant current charged at as high as C/5 until they reach 2.35 Vpc

Morningstar [SunSaver 15 Amp MPPT](#) has jumper and switches for 4 battery types, including AGM. Major name brand, trusted. You don't worry about it like the \$30 version from ebay. if it's too pricey at \$250, you can hunt through the rest of the [Morningstar line](#), or others, and view the manuals, before you buy. If your solar panel Vpmax is under 20v or so, you don't NEED a MPPT, but the old school PWM will work well too. If your PV Vpmax is over 20V, you will see increased performance with MPPT.

Operating Temperature: -10 ~ 55 °C

Storage Temperature: -25 ~ 55 °C

Humidity Requirements: ≤ 90% , no condensation

POWER SUBSYSTEM - BATTERY

ONE AGM NEEDED FOR 26 AH

'UNIVERSAL' BATTERY

\$64.00



UPG No:	D5747
Product Type:	Battery
Model No:	UB12260
Chemistry:	Sealed Lead Acid / AGM
PHYSICAL SPECIFICATIONS	
Length (in.):	6.50
Width (in.):	6.86
Height (in.):	4.94
Weight (lb.):	18.05
ELECTRICAL SPECIFICATIONS	
Nominal Voltage:	12
Terminal:	B1
20 hr @ 0.9A	26A

Richard Davids, Sponsor. Aerospace Human Factors Engineer. rcdavids1@verizon.net

9 APRIL 2020 25

AGM batteries are not the best choice for all applications - they are rather expensive compared to flooded batteries. However, their safety and design features make them the battery of choice for many applications, such as:

Where you cannot have fumes or hydrogen, such as in poorly ventilated areas, or where fumes may cause corrosion to electronics, such as repeater and cell phone sites.

Where resistance to shock and vibration is important.

Where spilled acid from leaking, tipped, or broken batteries cannot be tolerated.

When installed in a location where maintenance would be difficult or expensive, such as remote communications sites.

Where the batteries may be subject to freezing (-40 degrees F or lower).

Anyplace where you need a reliable totally sealed battery for safety or environmental reasons - wheelchairs, medical standby power, inside RV's, computer room UPS systems, or in enclosed spaces in boats.

POWER SUBSYSTEM - CONTROLLER

CHARGE CONTROLLER - BASICS

- **FUNCTION: REGULATES THE CHARGE TO THE BATTERIES PREVENTING ANY OVER CHARGING.**
- **INSTALLATION: INSTALLED BETWEEN THE SOLAR PANEL ARRAY AND THE BATTERY WHERE IT AUTOMATICALLY MAINTAINS THE CHARGE ON THE BATTERIES USING A 3-STAGE CHARGE CYCLE.**

Richard Davids, Sponsor, Aerospace Human Factors Engineer, rcdavids1@verizon.net

9 APRIL 2020 26

Charge Controllers

The primary function of a solar PV charge controller is to prevent the solar battery from being overcharged by the photovoltaic array and constantly monitors battery voltage. Solar PV charge controllers are a necessary component in every solar power energy system. When the batteries are fully charged, the controller will stop or decrease the amount of current flowing from the photovoltaic array into the battery. When the batteries are being discharged to a low level, many controllers will shut off the current flowing from the battery to the DC load(s). Solar PV charge controllers come in a variety of sizes from a just a few amps to as many as 80 amps. A wide range of quality PV charge controllers from such quality manufacturers as Steca, Morningstar, Xantrex and many others.

For example, you may have appliances in your house powered by solar energy. As you use the various appliances, the battery gets drained and depleted. If you leave for an extended period of time—say for a vacation—the batteries will continue to charge. Ideally speaking, you do not want your battery to get topped off and have the solar panels continue to charge after it is at capacity. The solar charge controller will prevent this. When the batteries are fully charged, the controller will stop or decrease the amount of current flowing from the photovoltaic array into the battery. When the batteries are being discharged to a low level, many controllers will shut off the current flowing from the battery to the DC load(s). All solar charge controllers are for off grid solar energy systems.

Terms such as “charge controller” and “solar charge controller” are interchangeable. Ones used for solar cells or solar panels can also be used for other purposes including wind power charge controller. Solarblvd sells three types of solar charge controllers: 1. **PWM solar charge controller**: this type of solar cell charge controller can only go from the same voltage to the same voltage, for instance from 24v to 24v, for 100% efficiency. If you use a PWM solar charge controller to go from a 24v panel to a 12v panel, you will lose about 50% of efficiency from your solar panel. PWM solar charge controllers tend to be lower in price for this reason, and are for use in smaller footprint situations such as on boats or RVs. 2. **MPPT solar charge controller**: recently becoming quite popular as homes continue to integrate solar panels in a drive to move off the grid. MPPT (Maximum Power Point Tracking) allows you to have a 24v panel and want to charge a 12v battery bank. The MPPT solar charge controller would regulate the battery and drop it to 12v without losing any efficiency in the panel. MPPT charge controllers will give you the most out of your solar energy system; 100w out of a 100w solar panel. MPPT charge controllers are big and bulky, thus more suited for a home or cabin environment. 3. **Lighting control** is a timer similar to a sprinkler system. It works as a solar charge controller and also controls your lights on/off schedule.

These controllers actually detect the optimum operating voltage and amperage of the solar panel array and match that with the battery bank. The result is additional 15-30% more power out of your solar array versus a PWM solar controller. Although the MPPT solar charge controller is more expensive than its PWM counterpart, it is generally worth the investment for any solar electric system over 200 watts.

POWER SUBSYSTEM - CONTROLLERS

PULSE WIDTH MODULATION OK FOR 100-WATT SYSTEMS.



PWM Blue Sky Charge Controller \$152



PWM Morningstar Charge Controller \$40



PWM Morningside Pro Star \$95.00

Richard Davids, Sponsor. Aerospace Human Factors Engineer. rcdavids1@verizon.net

9 APRIL 2020 27

REQUIREMENTS - 10 Amp Charge Controller:

- Helps prevent the overcharging and discharging of 12-volt batteries
- Keeps 12-volt batteries in a fully charged state to maintain voltage
- For use with 12-volt solar panels and batteries only
- Handles up to 150 watts of solar power
- Handles up to 10 amps of array current
- Small and compact for added convenience
- Maintenance free protection of your solar panels and batteries
- LCD digital display continuously shows battery voltage
- LED indicator shows when charging and when system is over voltage

Technical Information for 12V Systems:

- Rated solar input: 10A/20A
- Rated Load: 10A/20A
- 25% Overload: 1 minute
- Load disconnect: 11.1V

SPECIFICATIONS:

- Load reconnect: 12.6V
- Equalization voltage (30 minutes): 14.6v
- Boost voltage (30 minutes): 14.4v
- Float voltage: 13.6v
- Temp Comp. (mV/C°):-30mV
- Temperature: -35°C to +55°C
- For wire sizes to 6mm²

POWER SUBSYSTEM - INVERTERS

- **FUNCTION: MAKES 120 VOLTS AC FROM THE 12 VOLTS DC STORED IN THE BATTERY**

- **XANTREX PROWATT SW600**

- **PURE SINE WAVE**
- **600 WATT**
- **6.5 LBS.**
- **\$155**



- **SAMLEX**

- **PURE SINE WAVE**
- **600 WATT**
- **\$150**



Richard Davids, Sponsor, Aerospace Human Factors Engineer, rcdavids1@verizon.net

9 APRIL 2020 28

With a two-year manufacturer's warranty, this item provides 600 continuous watts and 1200 surge watts of energy. Two easily accessed AC outlets allow for charging two items simultaneously. The fact that it's a true sine wave inverter means that there's less harmonic distortion in the DC to AC conversion, so it can be used to power sensitive electronic devices. It also features Dual GFCI AC receptacles and USB power connection facility, both of which are invaluable.

Product Features:

600/1000/2000 watts maximum, 1200/2000/3000-watt surge capability

Built-in digital display for DC volts and output power

Built-in USB port

Dual GFCI AC receptacles for safe operation

Heavy duty terminals for trouble-free battery connection

Available ON/OFF remote switch (with ignition lockout)

Two year warranty

Protection Features:

Low voltage shutdown (10.5 Vdc)

Low voltage alarm (11.0 Vdc)

Over voltage protection (15.5 Vdc)

Overload shutdown

Over temperature shutdown

GFCI protection

ELECTRICAL COMPONENTS – COST ESTIMATE

Component	Cost
AIMS Power 100 Watt panel	\$109.00
Charge Controller (PWM)	\$40.00
12 V Deep Cycle AGM Battery (2)	\$80.00
LED String lights (2)	\$12.00
Inverter w/ GFI outlets (2)	\$150.00
Wiring	~ \$20.00
TOTAL	\$411.00

Richard Davids, Sponsor, Aerospace Human Factors Engineer, rcdavids1@verizon.net

9 APRIL 2020 29

The suggested power components are single Grape Solar panel, two (2) Universal Batteries (12 v AGM), Morningstar charge controller and Xantrex PRO Watt power inverter. These cost estimates are retail. The pendant cell phone charger cables are replaceable.



COST – PER WEEK ; PER YEAR

Item	Non-recurring vs Weekly	Estimated Cost
Wood, barrel, pipe, fasteners, paint	Non-recurring	\$575.00
Electronics	Non-recurring	\$411.00
Subtotal		\$986.00
Caretaker	weekly	\$105.00
Pumping	weekly	\$175.00
Consumables	weekly	\$30.00
Subtotal		\$310.00

- **NON-RECURRING = LESS THAN \$1000.**
- **COMPARABLE TO THE COST OF ONE PORTA POTTY.**
- **ANNUAL COST IS 1/10 OF A SINGLE TYPICAL PORTLAND LOO.**

Richard Davids, Sponsor. Aerospace Human Factors Engineer. rcdavids1@verizon.net

9 APRIL 2020 **30**

Here are the estimated non-recurring and recurring costs. Non-recurring cost is approximately \$1,000. However, you have recurring costs for consumables, the caretaker salary, and waste pumping. Basically, you can build and maintain ten LooLoos for every Portland Loo. The cost of one LooLoo is comparable to a Porta Potty. However, a porta potty does not offer interior lighting or cell phone charging or active ventilation.

REMAINING ISSUES

- **ACTIVE OR PASSIVE VENTILATION. POWER CONSUMPTION. WATERPROOF. LANYARDS FOR CELL PHONE CHARGERS. BUSINESS PLAN. COMMUNITY INVOLVEMENT. STABILITY. EFFECTIVENESS OF ART AND MURALS. SANITATION. DURABILITY OF ART AND MURALS. ACCEPTANCE. USABILITY. CARETAKER INVOLVEMENT. VANDALISM. SPONSORS. FINANCIAL SUSTAINMENT. HAZARDOUS WASTE. SOLID / LIQUID SEPARATION. FREEZING POOP AND PEE. SLIDING DOOR HANG-UP. 'JUICE HACKING'.**

There are many issues to research and analyze prior to building a LooLoo. A 3D model would help. A more thorough electronic load analysis is needed. Ensuring that the structure can be assembled, and waterproofed is critical.