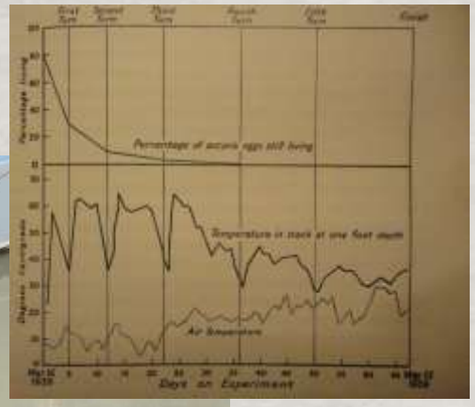
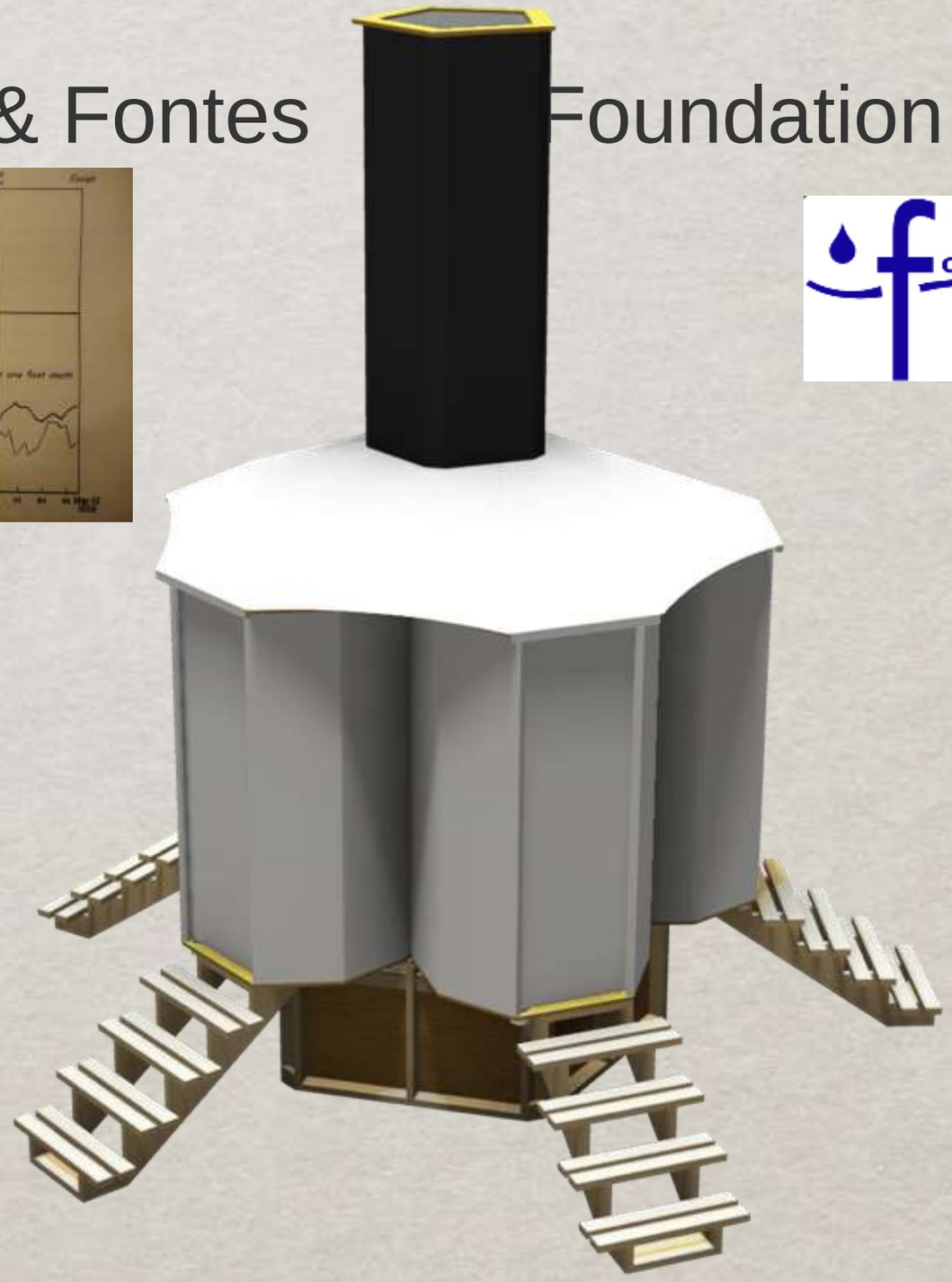
Low-Cost Sanitation Solutions

A report on progress in Post-Earthquake Haiti

Andrew Larsen & Fontes Foundation





FSM 2 Conference

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Drawings by Cameron Whetten

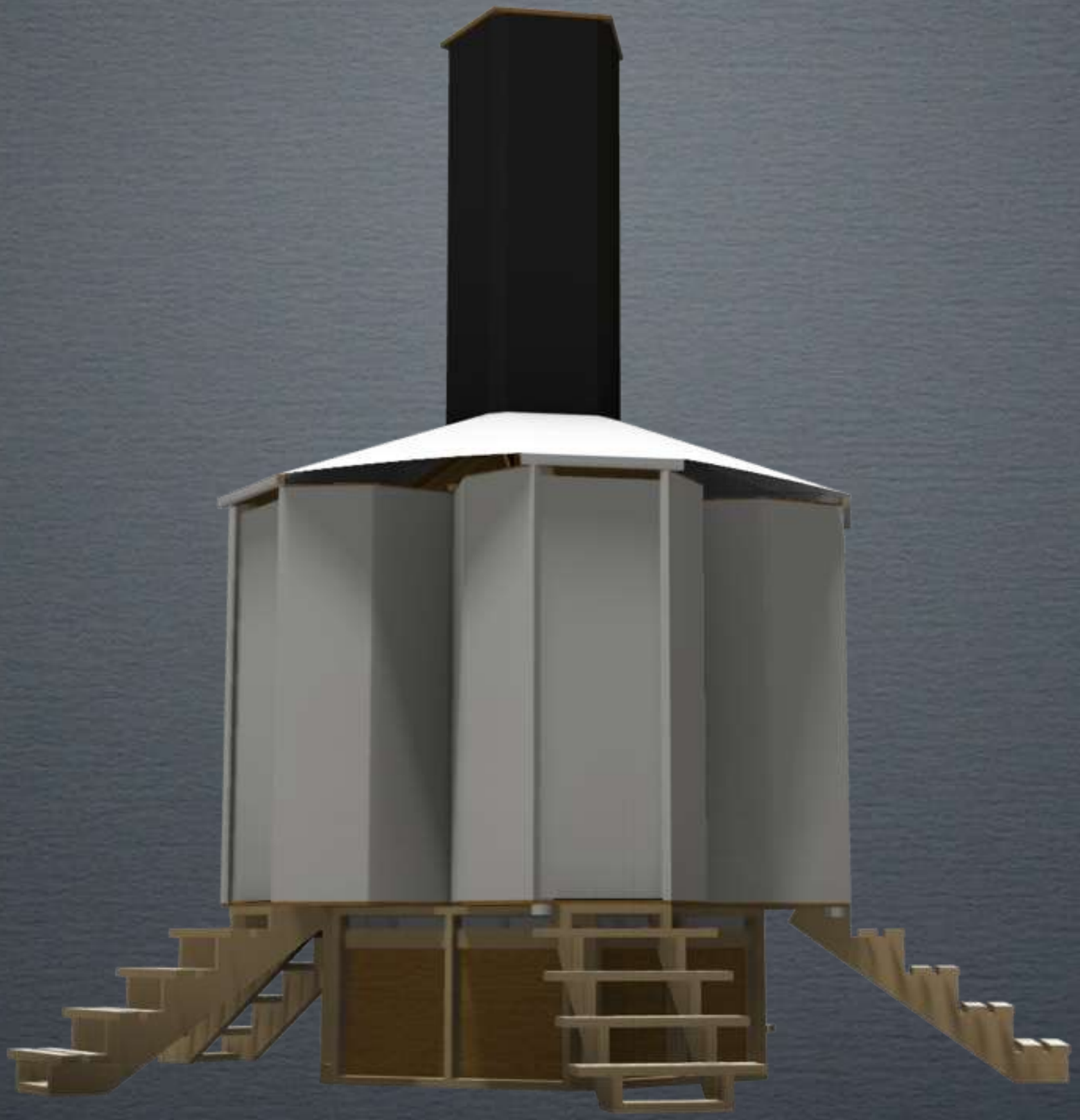
Port-au-Prince, Haiti

Common graffiti in Port-au-Prince, January 2010

Notice they don't ask for toilets...

Ongoing cholera epidemic
Over half a million cases
Over 7,000 deaths so far
High density populations without sanitation are extremely vulnerable to excreta-borne disease

Public/Private Toilet System



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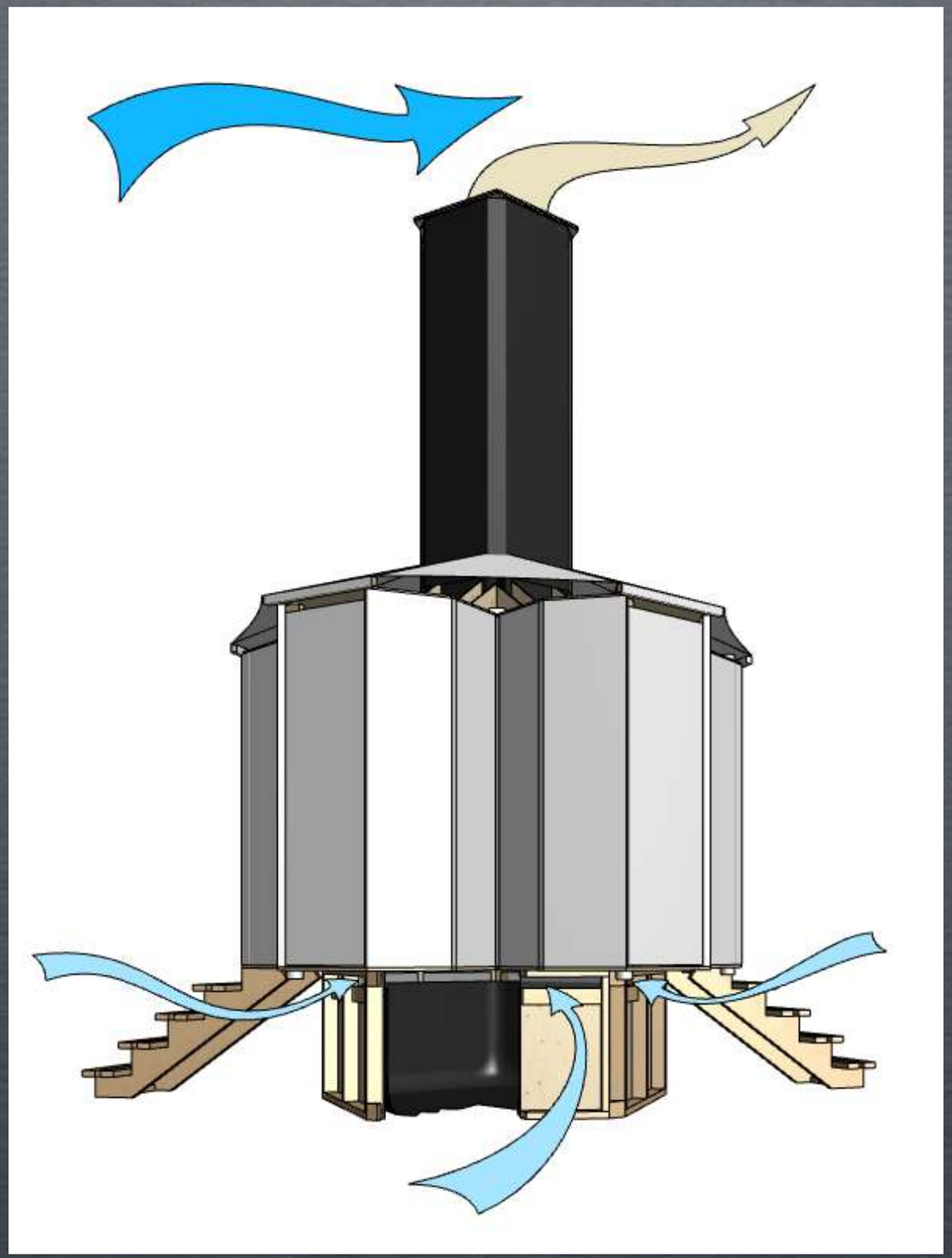


Overall Goals

Innovative, bold ideas

Design for emergencies

Low-cost, robust, and weatherproof structure

Flooded and high-water table areas

No excreta contact with the ground

Integration *with* and input *from* the community to be served

Key Design Features

Reused billboard vinyl: tensioned-fabric building method

Inexpensive structure allows for design innovation

Passive ventilation using large central plenum

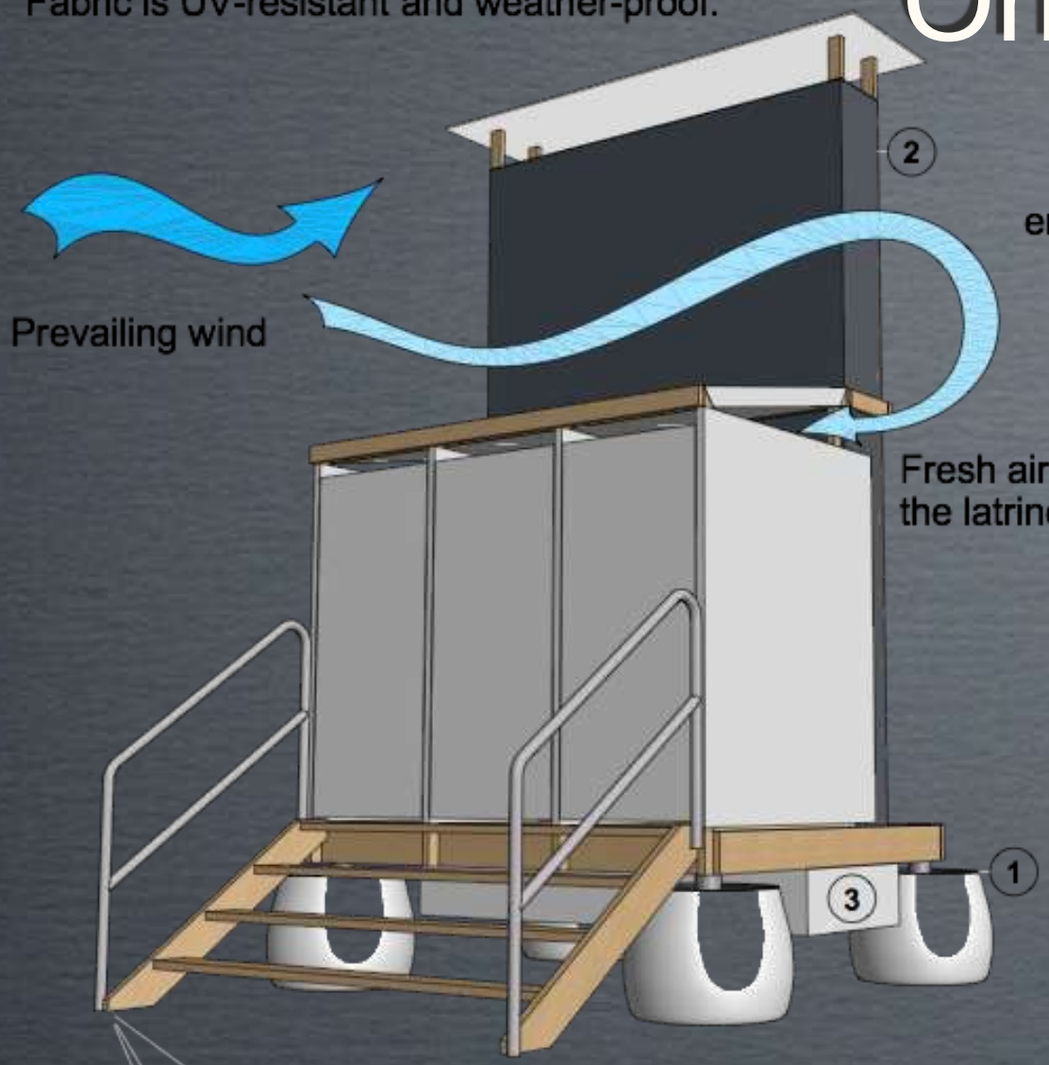
Much larger air flow than VIP toilets

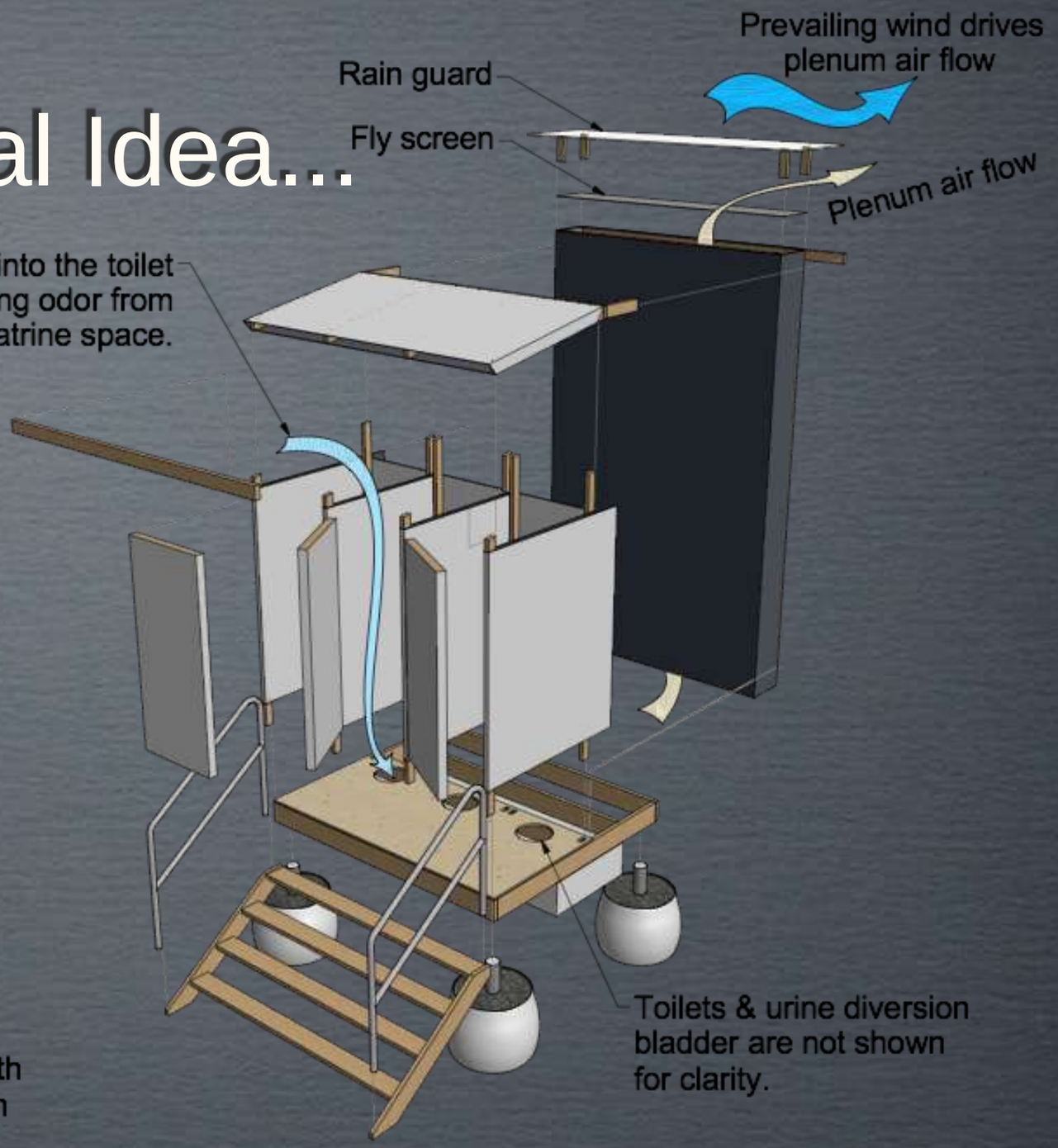
Externally stabilized toilet array

Process can be UD or “everything-in-together”

Original Idea...

Walls, roof, doors, ballasted supports, and plenum made from tensioned fabric stretched around wood supports. Fabric is UV-resistant and weather-proof.





1. Ballasted supports use tensioned fabric in combination with rubble from site, est. 350 lbs per support; deployable on uneven surfaces and in flooded areas.
2. Enhanced ventilation using solar thermal and wind-induced air flow.
3. Solids cartridge for collection and micro-composting of feces is removable for further thermophilic composting. Enhanced ventilation promotes desiccation, keeping solids accumulation low.

Pre-fabricated components enable quick and easy field assembly.

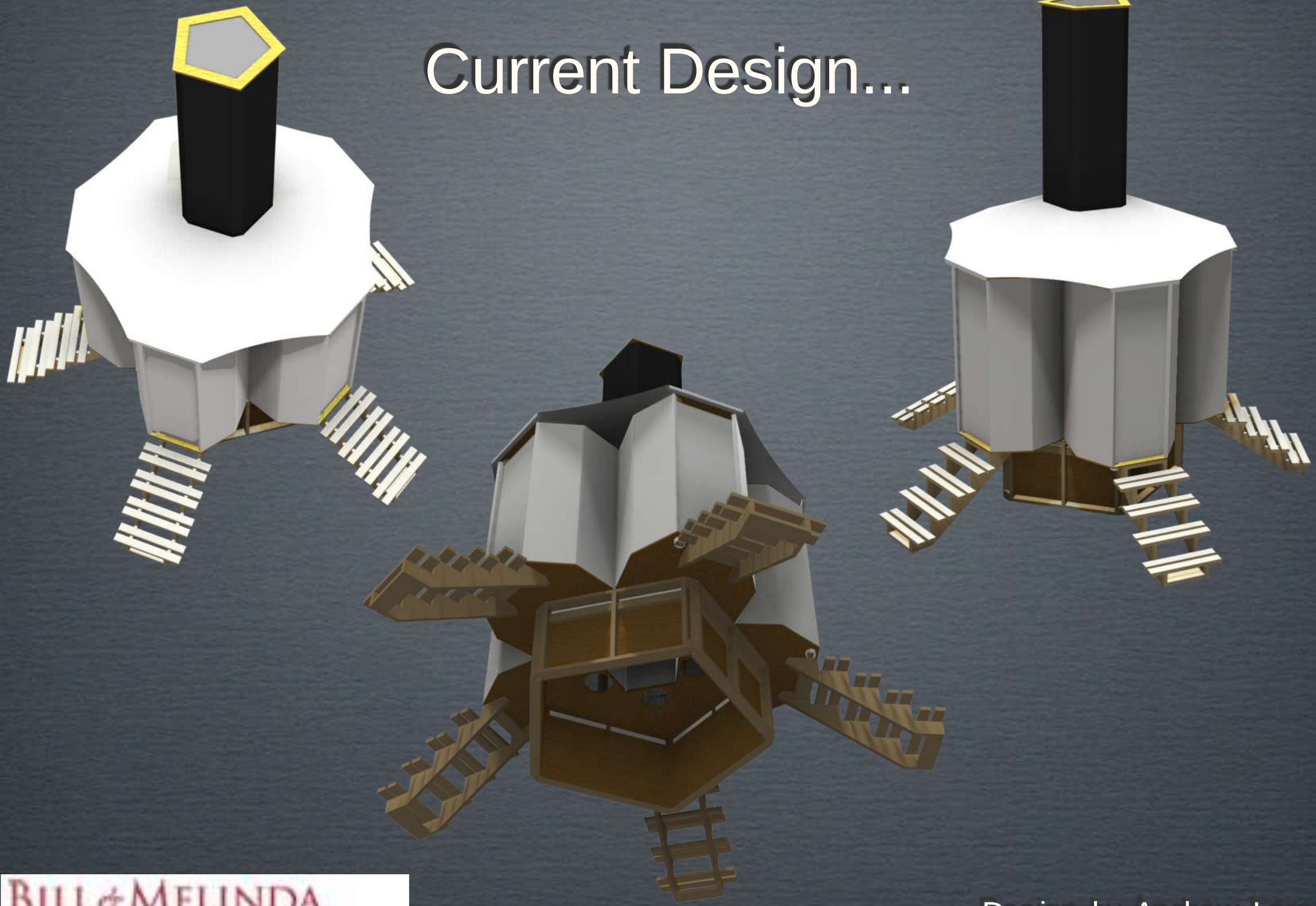
BILL & MELINDA GATES foundation

Design by Andrew Larsen
Drawings by Cameron Whetten

Original Idea...

Prototypes in Utah and Norway

Current Design...



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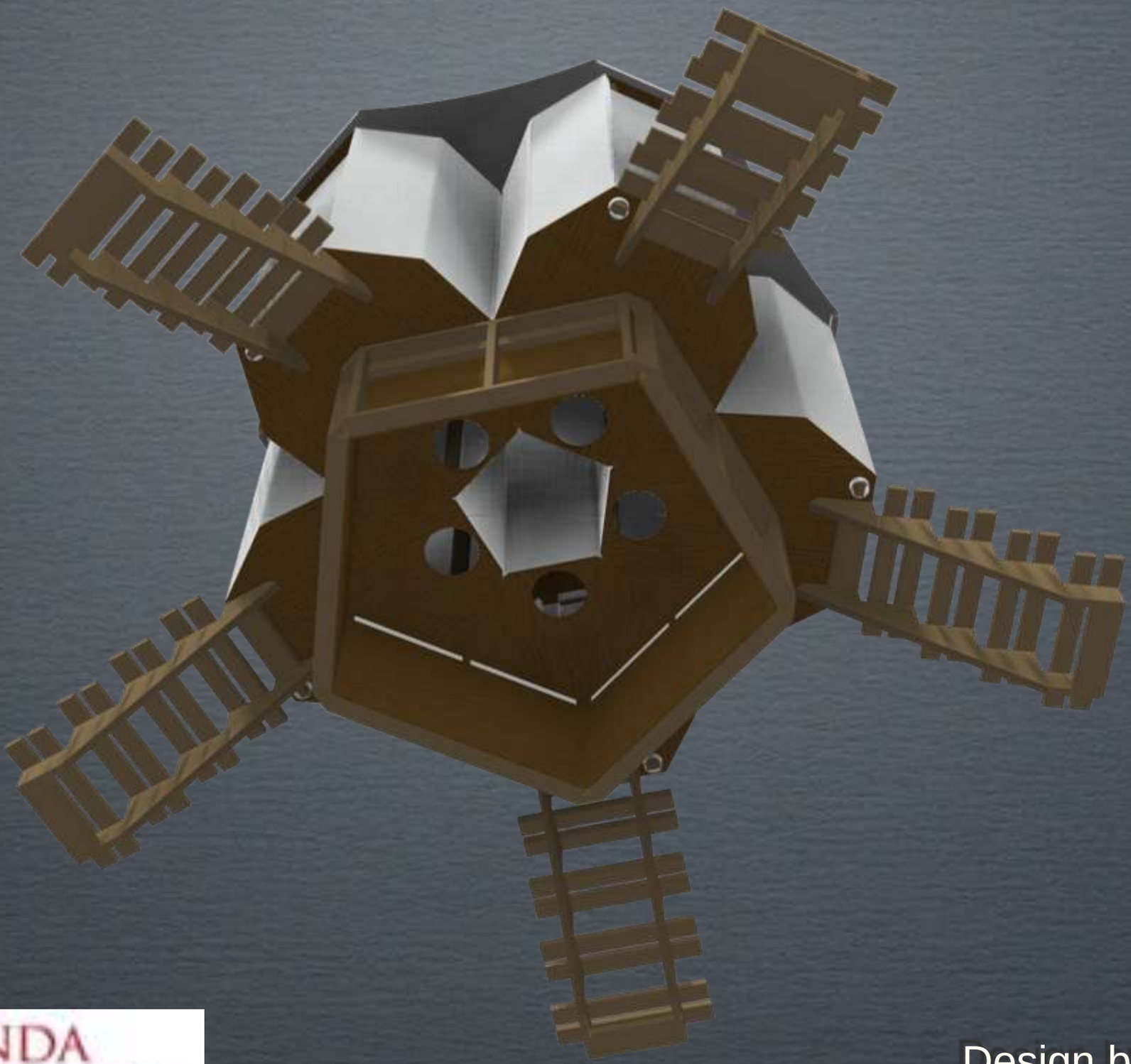
Current Design...



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Current Design...

Vodrey, Cite Soleil, Haiti

Six Factors in Compost

Carbon

Compost substrate--sugar cane bagasse, straw, etc.

Nitrogen

Feces, urine, food refuse

Oxygen

Air from interstitial spaces as well as from turning

Water

Addition of water during turning process

Thermophilic microorganisms

Already there, just need to be encouraged

Minimum volume

About one cubic meter

Compost: Hygienic and Mature

WHO Guidelines(2006)--50 C for one week for pathogen destruction

Achieving high temperature not a problem in properly constructed compost piles

Edge effects are an issue and need to be studied more

Compost hygienization has to do with its safety for people

Compost maturation has to do with its safety for the soil

Still a lot of controversy about composting human excreta

Importance of Historical Records

George Vivian Poore--Essays on Rural Hygiene, 1893

F.H. King-- Farmers of Forty Centuries, 1911

Sir Albert Howard--The Waste Products of Agriculture, 1931, Agricultural Testament, 1940

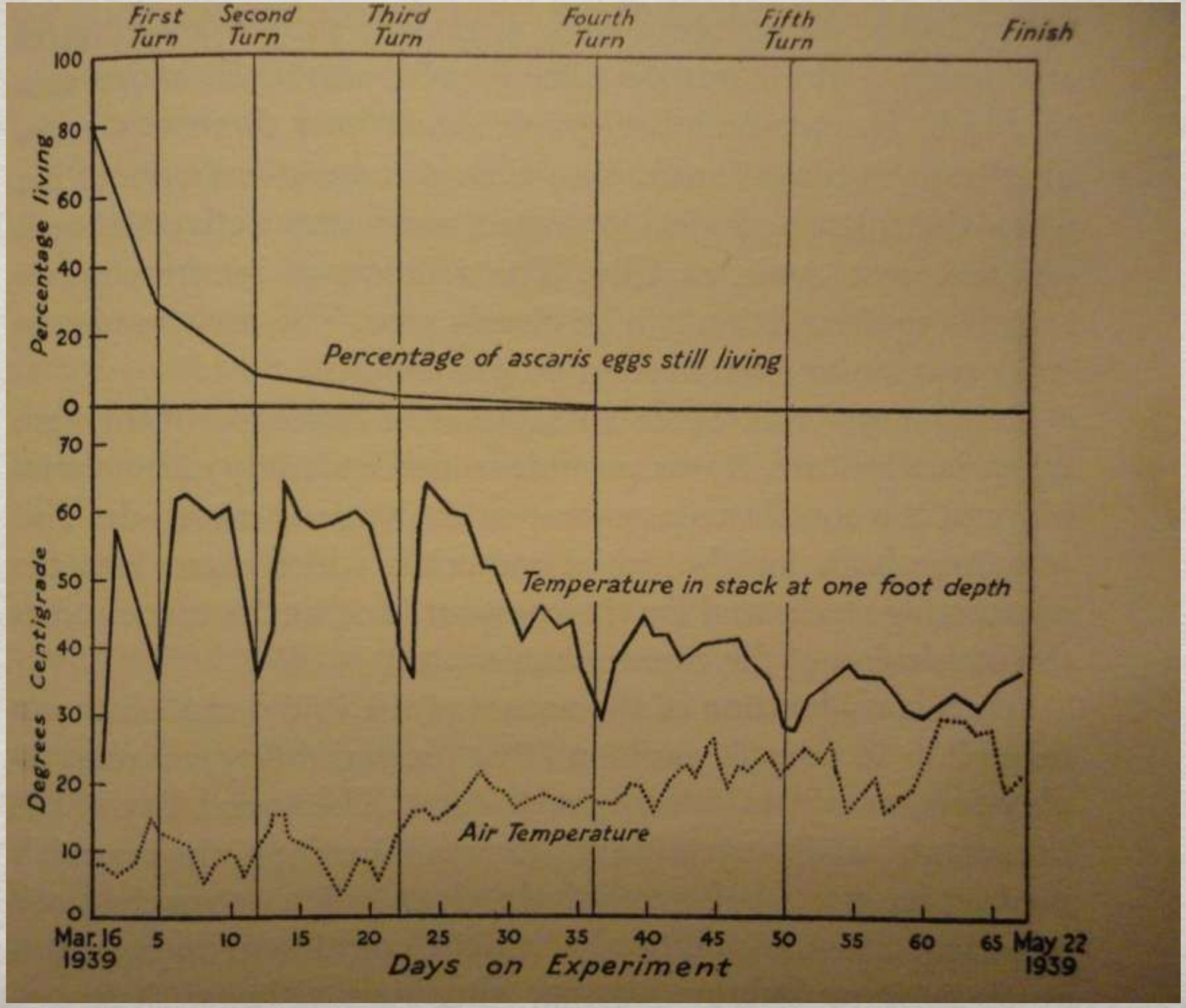
G.T. Wrench--Wheel of Health, 1938

Dr. Gerald Winfield--China: the Land and the People, 1948

James Cameron Scott--Health and Agriculture in China, 1952

Joseph Jenkins--The Humanure Handbook, 2005

Importance of Historical Records



Results So Far

Achieving up to 71 degrees C

Regularly achieving 65 degrees C

We turn when the temperature gets too high

Temperature drops, then climbs back up within two days

All parts of the pile are exposed to high temperatures after several turns

We can turn every three days

Thermophilic Composting in Haiti

WHO guidelines specify 50 C or greater for one week for composting
Confirmed this with Dr. Jamie Bartram, WHO
Toilet materials never exposed to the outside environment
No odors, no flies, no kidding! :)

Composting in Peri-urban Port-au-Prince

Compost experiments at our shop
One pile is sugarcane bagasse and cow manure
One pile is sugarcane bagasse and bucket-latrine contents
Active turning of both piles

After Tropical Storm Isaac

Toilet blocks withstood winds estimated at 50-60 mph
Plantain and banana trees mostly lost
Toilets had been well-maintained throughout
Toilets stayed dry through the storm

After Tropical Storm Isaac

Users add bagasse
Families maintain the toilet cubicle
Paid workers maintain the toilet system and compost
Families are happy to pay 100 HTG ($2.50 USD) per month

Current Design--Ways Forward

Trying to reduce the amount of lumber
Fabric costs about $140 USD including shipping
Fabric as a floor covering works better than expected

Current Design--Ways Forward

Small pit for the support structure
Pit is lined the same way as the support bin--billboard fabric bag
Lower lumber costs
No need for stairs or handrail

Current Design...

Current Design...

Community of Vodrey, Cite Soleil, Haiti

Social Innovation

Awareness-raising in a disaster affected community in Haiti
Social message created by theater troup for display to the community
Attention! Shit is the source of a lot of sickness, protect your health, don't defecate in the open, shit in a toilet, respect hygiene rules

Community of Vodrey, Cite Soleil, Haiti

Social Innovation

Mike Cloutier and Andrew Larsen using the Solvita® Compost Test Kit

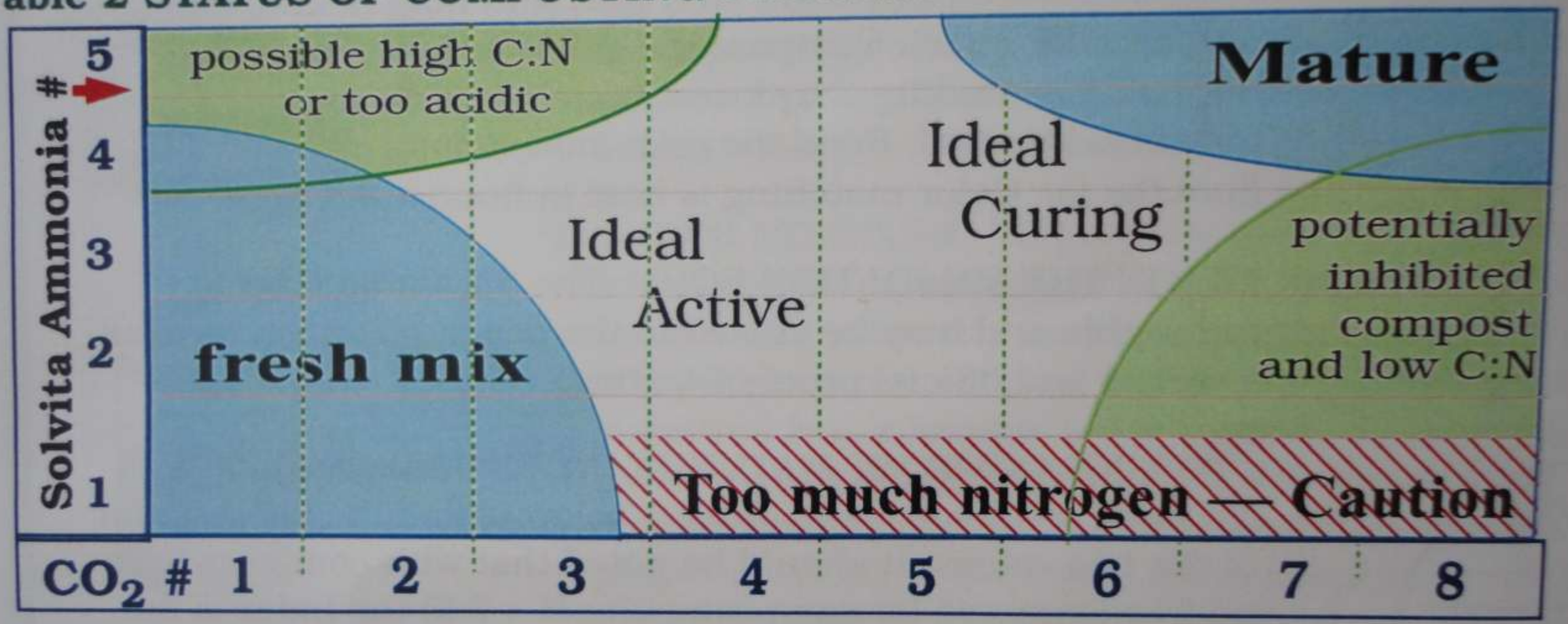
Solvita® test kit with color guide and DCR

Compost Pile Site / Sample Number	Sample Date	Pile Specifics/ Sample Location	°F	Pile Start Date	Pile End Date	DCR Results					Solvita® Rating
						Carbon Dioxide		Ammonia			
						Color Number	%	Color Number	mg	%	
CINEAS School 1	January 18, 2011	Middle	138	July 1, 2010	Nov. 22, 2010	7.41	0.13	4.06	0.41	0.23	7
CINEAS School 2	January 18, 2011	Edge	122	July 1, 2010	Nov. 22, 2010	5.58	0.59	4.94	0.00	0.00	6
Grass Roots United Base 1	January 18, 2011	Bagasse	NA	July 20, 2010	Nov. 3, 2010	6.19	0.36	4.85	0.03	0.01	6
Grass Roots United Base 2	January 18, 2011	Rice Hulls (Middle)	118	Nov. 3, 2010	Dec. 9, 2010	6.29	0.33	4.52	0.19	0.10	6
		Rice Hulls (Corner)	106								
GiveLove House 1	January 18, 2011	Corner	NA	NA	Current	4.51	1.34	3.06	0.90	0.51	3
GiveLove House 2	January 18, 2011	Corner	NA	NA	Current	4.56	1.30	3.73	0.58	0.32	4

STATUS AND CONDITION OF COMPOST PROCESS

Using both Solvita results Table 2 indicates where in the general process compost
be. Table 3 based on the Maturity Index can be used to infer the overall condition

Table 2 STATUS OF COMPOSTING PROCESS



Example: If the NH_3 result is 3, and the CO_2 result is 5, then the process is Active moving into Ideal Curing

Solvita® "Status of Composting Process" chart

Solvita® Compost Test

Tests for compost maturity only--not hygienic quality

Simple tests involving carbon dioxide and ammonia measurements using gel paddles

Determines compost maturity from a matrix of these values

Has important limitations which need to be understood

Summary

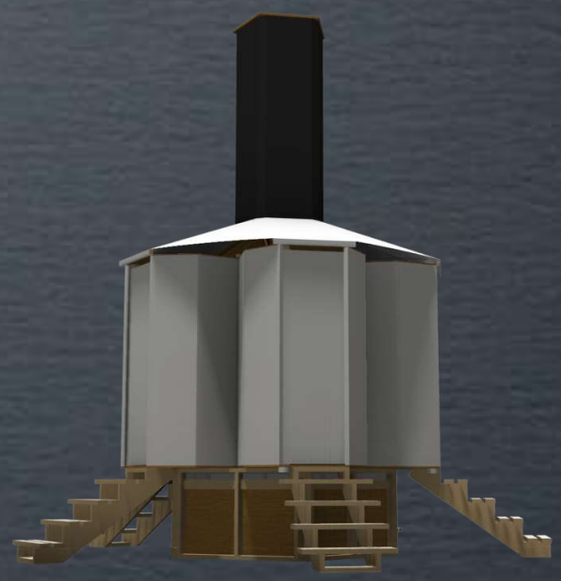
Low-cost, weatherproof, robust structure made from inexpensive materials using local labor

Structure allows for enhanced passive ventilation for both odor control and feces desiccation

High temperatures in the compost are easily achieved when the volume is big enough

First turn happens after the temperature rise

Four five-toilet arrays (20 toilets total) operating in Cite Soleil, Haiti



Thanks

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Photos by Andrew Larsen
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