

THE S-LAB: RESEARCH EXPERIENCES FOR ALL STUDENTS

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The S-Lab (as it has been recently named) has been operating in its current state for over a decade in the Department of Engineering-Physics-Systems at Providence College creating and managing meaningful research experiences for many students both in the sciences and in other academic departments. This paper outlines the **approach** used in the lab, the **student commitment**, the physical and software **tools** (that include a recent implementation of lab archives), as well as some of the **recent projects** that have been undertaken. The lab experience for students has been significant. The impacts of S-Labs projects around the world especially in **water, sanitation and education** will be highlighted.



Approach

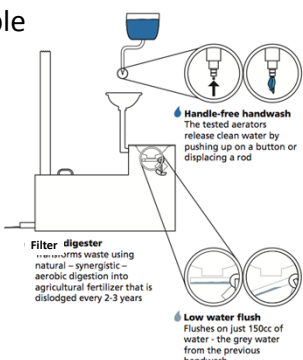
3 Steps

1. Systems Thinking – What IS the problem?
2. Relevant Science – Model the process(es)
3. Design – Use the models to inform design



Example

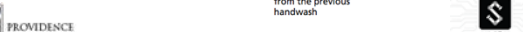
Microflush Toilet



Handle-free handwash
 The tested aerators release clean water by pushing up on a button or displacing a rod

Filter digester
 Transforms waste using natural – synergistic – aerobic digestion into agricultural fertilizer that is dislodged every 2-3 years

Low water flush
 Flushes on just 150cc of water – the grey water from the previous handwash




What goes in:

feces 124 grams	urine 240 cm ³	handwash grey water 150 cm ³
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Filter-Dewatering + Aerobic Digestion
 significant Macro organism role

What comes out:

solids <15 grams	leachate and vapors 484 grams	other volatiles 15 grams
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Recent Projects – Approach


Disinfection of the small amount of blackwater filtrate from Microflush Filter-Digester

1. Systems Thinking – What IS the problem?
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Alternative-branched functional analysis

Alternative Type	Natural/Artificial	Alternatives	Alternatives	Alternatives
Physical Kill	Natural	SOLDIS	Direct	Thermal UV Combination
			Indirect	Thermal enhancement UV lamp IR Lamp/Heater/Oven Other
	Artificial	Radiative	Other	Clay Sand Combinations/Other
			Other	Quartzitic Other
Filter-Remove	Natural	Other	Other	Semi-Continuous
	Artificial	Other	Other	
Chemical Kill	Natural	Other	Ammonia Other	Continuous
	Artificial	Other	Chlorine Other	
	Combinations	Other	Other	




Last stage traditional wastewater treatment plant

Alternative Type	Natural/Artificial	Alternatives	Alternatives	Alternatives
Physical Kill	Natural SOLDIS	Direct	Thermal	Batch
			UV Combination	
	Indirect	Thermal enhancement		
		UV lamp		
Artificial	Radiative	IR		
		Lamp/Heater/Oven		
		Other		
Filter-Remove	Natural	Clay	Semi-Continuous	
	Artificial	Sand		
		Combinations/Other		
		Osmotic		
Combinations	Other	Continuous		
	Ammonia			
Chemical Kill	Natural	Other	Continuous	
	Artificial	Chlorine		
		Other		
Combinations	Other			




Soak Hole: Natural Sand Continuous

Alternative Type	Natural/Artificial	Alternatives	Alternatives	Alternatives
Physical Kill	Natural SOLDIS	Direct	Thermal	Batch
			UV Combination	
	Indirect	Thermal enhancement		
		UV lamp		
Artificial	Radiative	IR		
		Lamp/Heater/Oven		
		Other		
Filter-Remove	Natural	Clay	Semi-Continuous	
	Artificial	Sand		
		Combinations/Other		
		Osmotic		
Combinations	Other	Continuous		
	Ammonia			
Chemical Kill	Natural	Other	Continuous	
	Artificial	Chlorine		
		Other		
Combinations	Other			




SOLDIS: Thermal Batch

Alternative Type	Natural/Artificial	Alternatives	Alternatives	Alternatives
Physical Kill	Natural SOLDIS	Direct	Thermal	Batch
			UV Combination	
	Indirect	Thermal enhancement		
		UV lamp		
Artificial	Radiative	IR		
		Lamp/Heater/Oven		
		Other		
Filter-Remove	Natural	Clay	Semi-Continuous	
	Artificial	Sand		
		Combinations/Other		
		Osmotic		
Combinations	Other	Continuous		
	Ammonia			
Chemical Kill	Natural	Other	Continuous	
	Artificial	Chlorine		
		Other		
Combinations	Other			



SOLDIS: UV+Thermal Batch


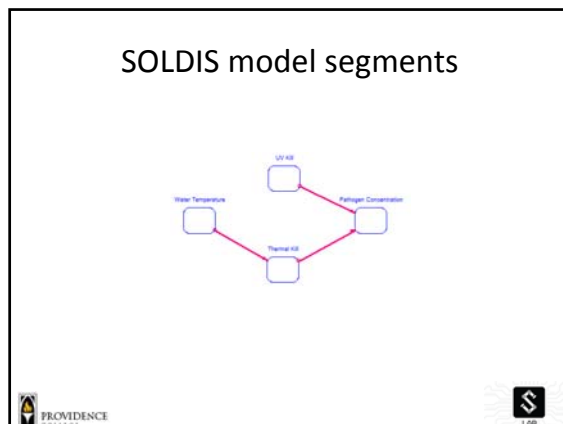
Alternative Type	Natural/Artificial	Alternatives	Alternatives	Alternatives
Physical Kill	Natural SOLDIS	Direct	Thermal	Batch
			UV Combination	
	Indirect	Thermal enhancement		
		UV lamp		
Artificial	Radiative	IR		
		Lamp/Heater/Oven		
		Other		
Filter-Remove	Natural	Clay	Semi-Continuous	
	Artificial	Sand		
		Combinations/Other		
		Osmotic		
Combinations	Other	Continuous		
	Ammonia			
Chemical Kill	Natural	Other	Continuous	
	Artificial	Chlorine		
		Other		
Combinations	Other			

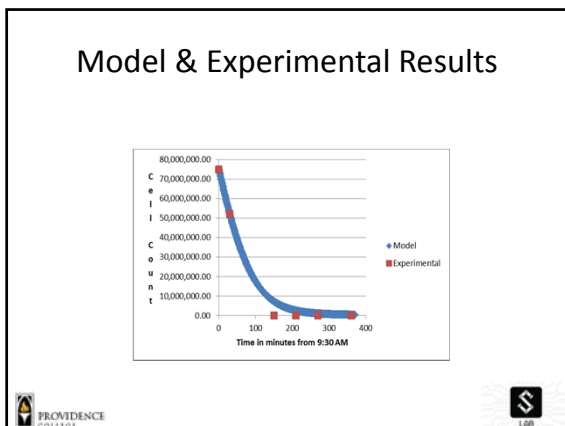
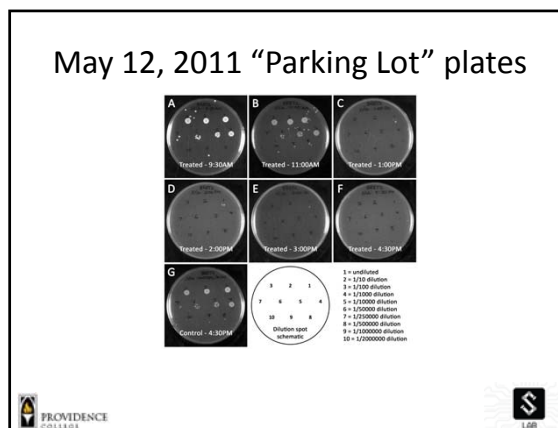
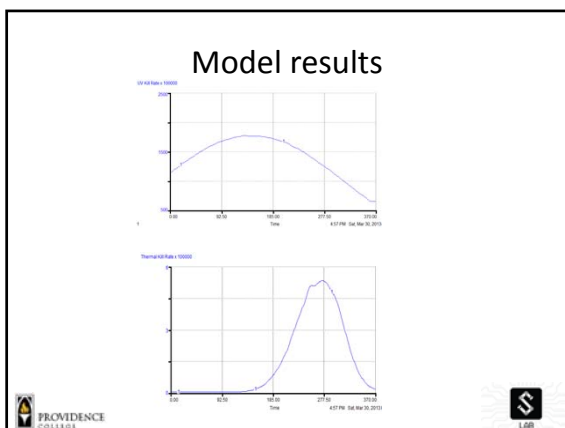
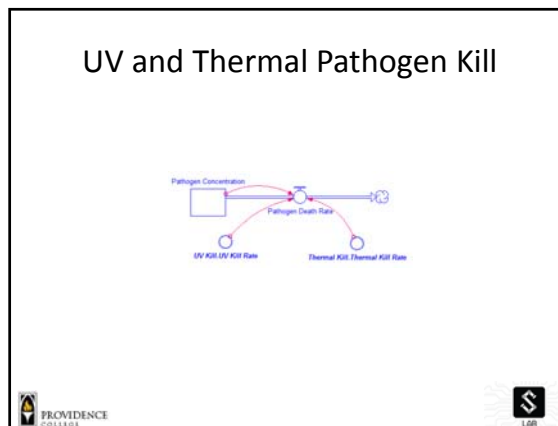
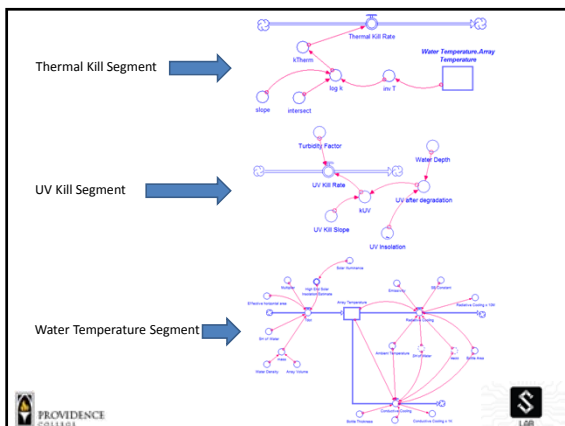


Recent Projects – Approach

Disinfection of the small amount of blackwater filtrate from Microflush Filter-Digester

1. Systems Thinking – What IS the problem?
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SOLDIS: UV+Thermal Semi-continuous

Alternative Type	Natural/Artificial	Alternatives	Alternatives	Alternatives
Physical Kill	Natural SOLDIS	Direct	Thermal	Batch
		Indirect	UV	
	Artificial	Combination	Thermal enhancement	
		Radiative	UV lamps, IR Lamp/Heater/Over Other	
Filter-Remove	Natural	Clay	Semi-Continuous	
	Artificial	Combinations/Other		
		Quinonic		
		Other		
Chemical Kill	Natural	Ammonia	Continuous	
	Artificial	Other		
		Chlorine		
		Other		

Recent Projects – Approach

Disinfection of the small amount of blackwater filtrate from Microflush Filter-Digester

1. Systems Thinking – What IS the problem?
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S-Lab Current research

Alternative Type	Natural/Artificial	Alternatives	Alternatives	Alternatives
Physical Kill	Natural SOLDIS	Direct	Thermal UV Combination	Batch
		Indirect	Thermal enhancement UV lamp	
	Artificial	Radiative	IR Lamp/Heater/Oven	
		Other	Other	
Filter-Remove	Natural	Clay Sand	Semi-Continuous	
	Artificial	Combinations/Other		
		Osmotic		
		Other		
Chemical Kill	Natural	Ammonia	Continuous	
	Artificial	Other		
		Chlorine		
		Other		

Human Urine to disinfect blackwater



S-Lab Current research

Alternative Type	Natural/Artificial	Alternatives	Alternatives	Alternatives
Physical Kill	Natural SOLDIS	Direct	Thermal UV Combination	Batch
		Indirect	Thermal enhancement UV lamp	
	Artificial	Radiative	IR Lamp/Heater/Oven	
		Other	Other	
Filter-Remove	Natural	Clay Sand	Semi-Continuous	
	Artificial	Combinations/Other		
		Osmotic		
		Other		
Chemical Kill	Natural	Ammonia	Continuous	
	Artificial	Other		
		Chlorine		
		Other		

Charcoal from coconut filter



Commitments

- Majors and Non-Majors
- 1- 2- 3- credits
- Student time commitment:
 - 1 credit – 2.5 to 3 hours per week
 - 2 credits – 4 to 7 hours per week
 - 3 credits – 8 to 10 hours per week
- Required to write a grant proposal
- Required to do a poster presentation
- Encouraged to present at ECSC Conference
- Encouraged to co-author paper with faculty
- Faculty time commitment:
 - One on one meeting with each student (or student team) ~30 minutes/week
 - S-Lab Group Meeting (1 hour/week)
 - Lab time with students (varies ~ 2 afternoons each week)



Tools

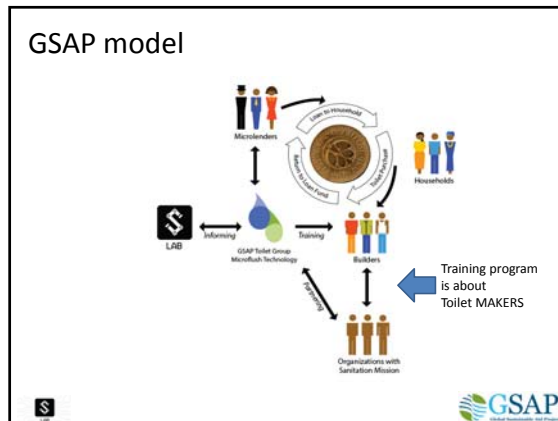
- Hardware:
 - Tools: 2 ton hydraulic press, Drill press, Table saw, Grinder, Oven, Incubator, Finger brake, Hand drill, Plastic welder, Heat gun, Solder station, Hand tools
 - Technology: Computers, Printer, 3D Large Format Printer, Power Supplies, Scopes, Meters, Data Loggers, Extensive Probreware
- Software:
 - Desktop Suite, Sigma Plot, Voxler, ISEE Stella, Sketchup Pro 2014, Solid Works, LabView, LoggerPro, JAVA, Web-centric utilities
- LabArchives



Plus + pre-set folders & custom setups
+ students like it
+ notebook sharable and is web-centric
Minus- clumsy archiving to local server for legacy storage
- can be expensive (free version has limited storage)

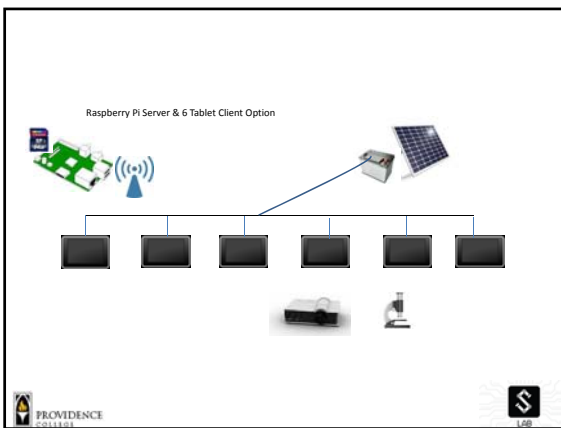
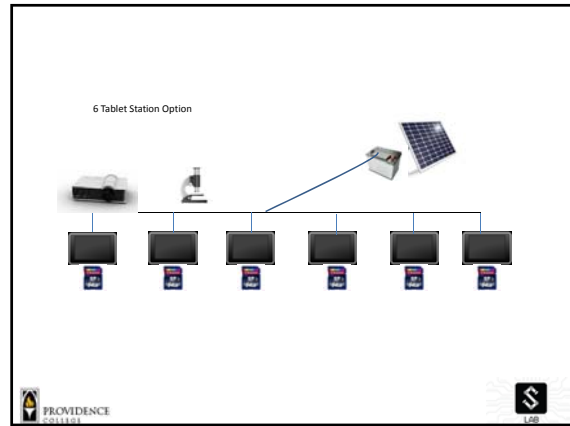
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Number of Notebooks	Unlimited	Unlimited	Unlimited
Share (read only)	✓	✓	✓
Allow Comments	✓	✓	✓
Interface with GraphPad Prism	✓	✓	✓
Store and view all versions of all entries	✓	✓	✓
Share (Read/Write)**	✓	✓	✓
Assign DOIs	✓	✓	✓
Storage included***	25 MB	100 GB per user**	1 GB
Annual Subscription	Free	\$89.00 per user**	\$10.00 per student**
Additional Storage per year	N/A	\$9.99 per GB	N/A



Other Projects in the S-Lab

- Agri-charcoal Coop
- Gutters from Garbage – rural rainwater harvesting
- Comprehensive School WASH program
- Rural IT Lab when power isn't available
Learning Lab in a Box !



A good place to stop.

Invitation to visit the S-Lab.
Questions.



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