

The Role of *Illustrated Systems Analysis* in FSM Hardware Innovation

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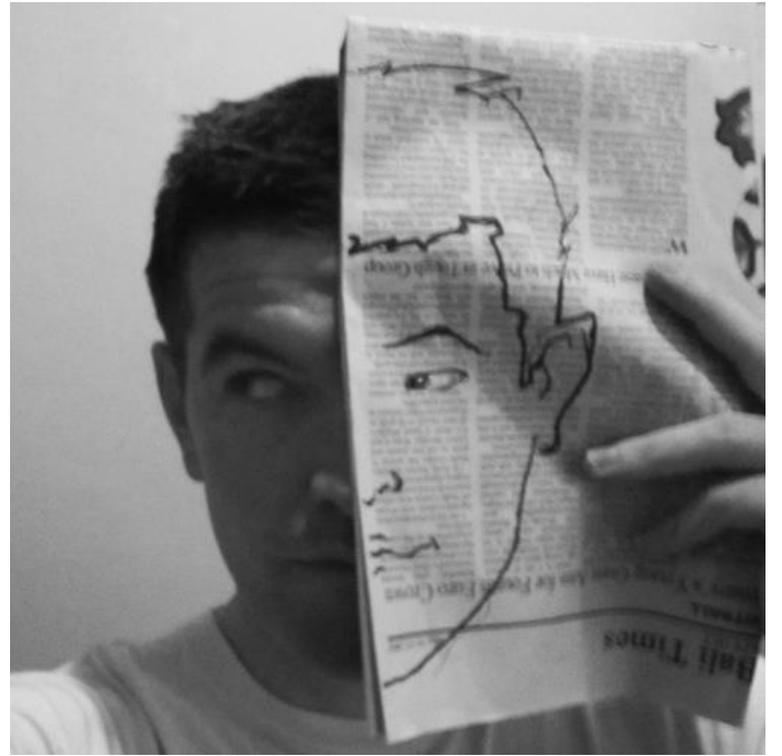
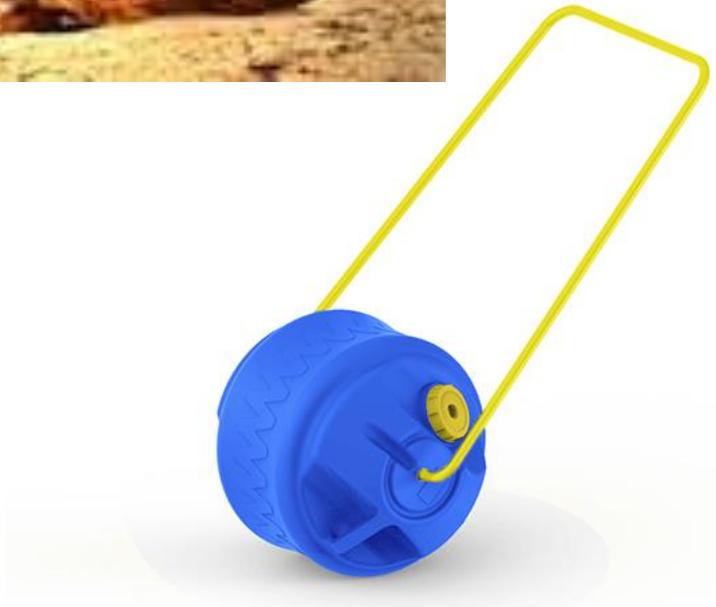


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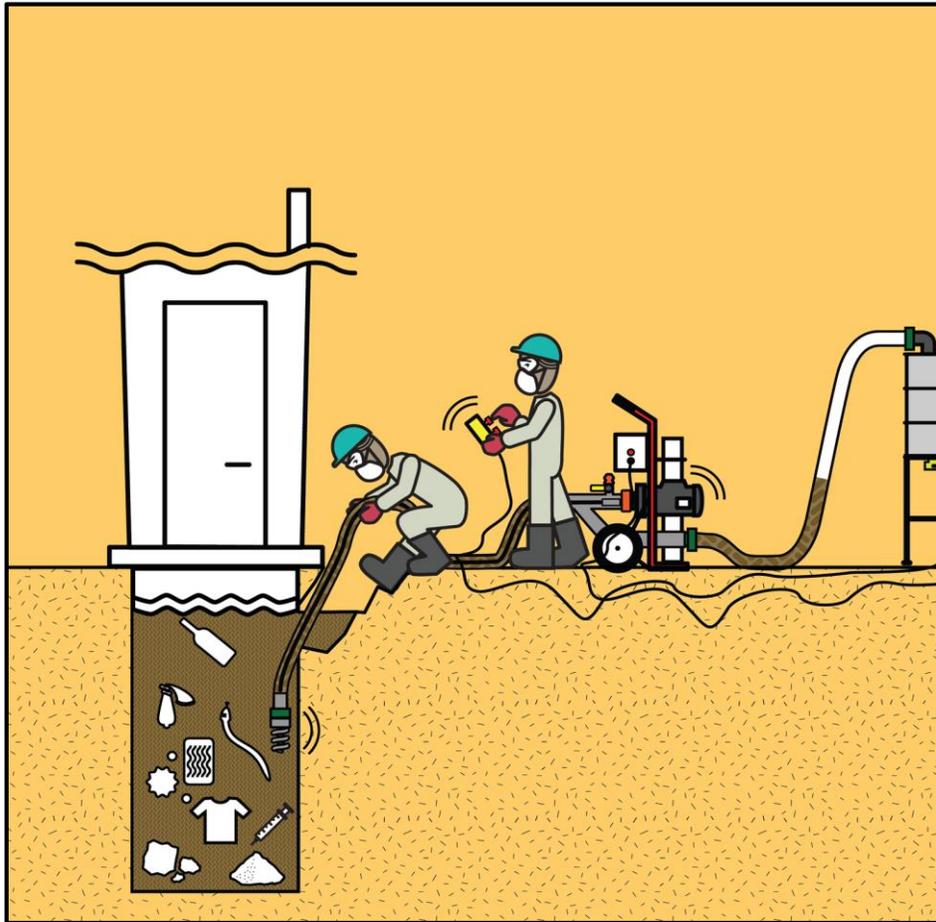




"Let's talk about emptying pit latrines"



Illustrated Systems Analysis



- More than an infographic
- Not a children's book illustration
- Not a Hollywood –style animation

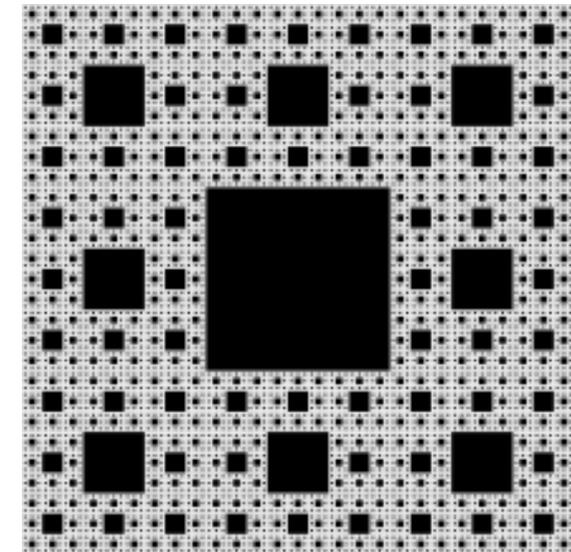
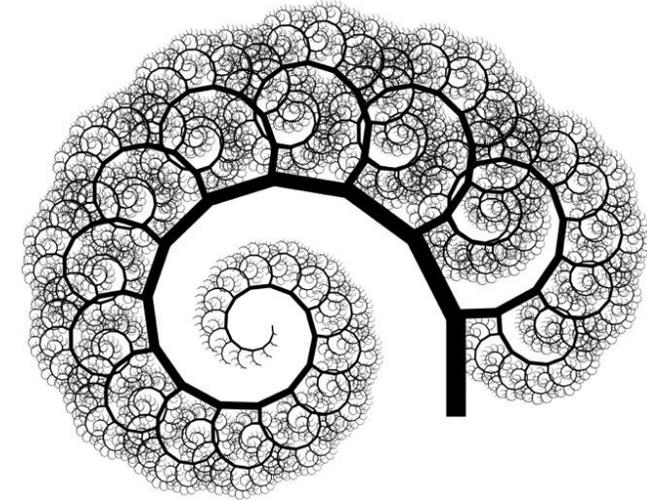
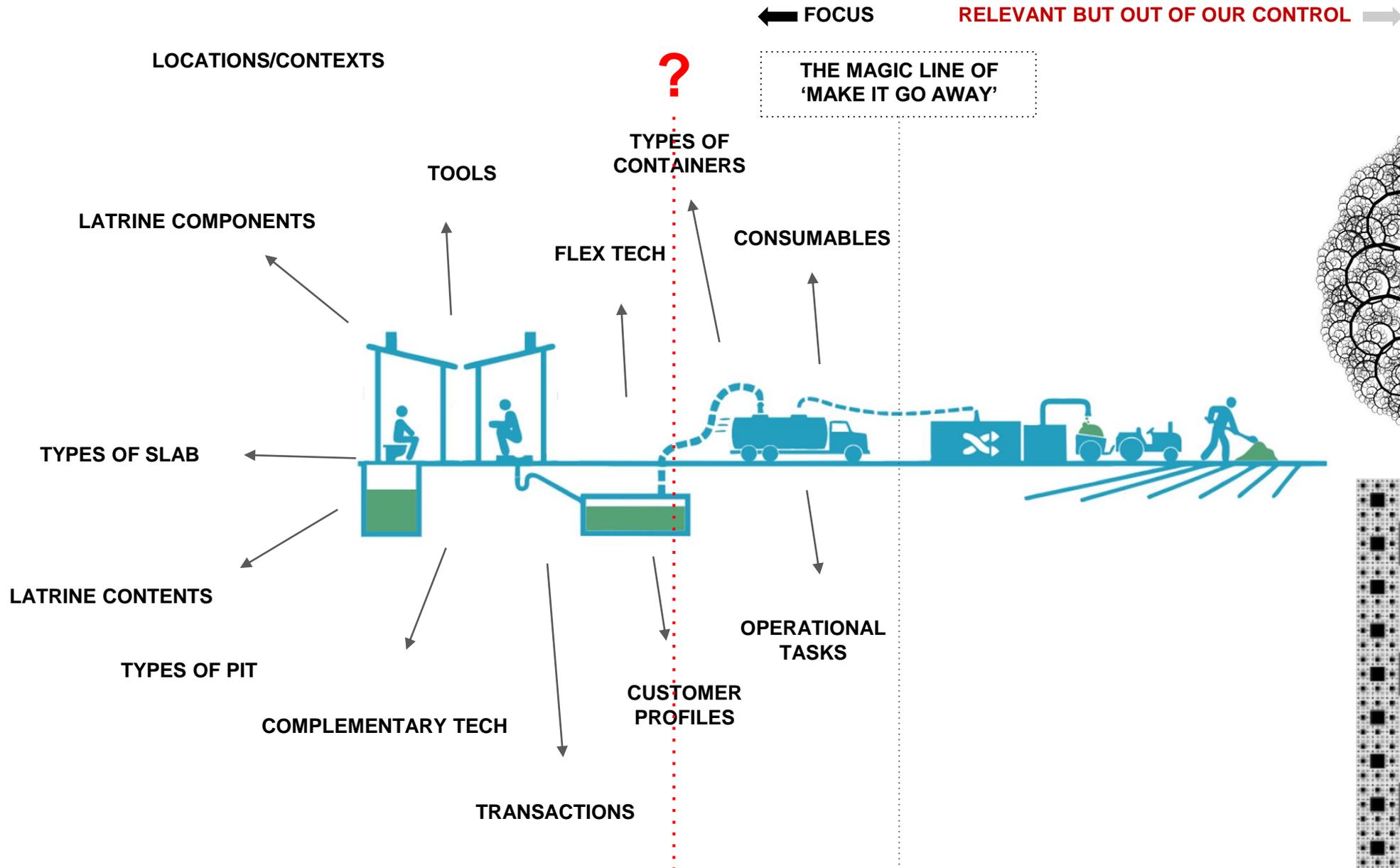
BUT

- Presentation of nuanced FSM systems
- Comprehensible to a larger audience
- Used to spark innovation

The GOAL is to GO DEEPER

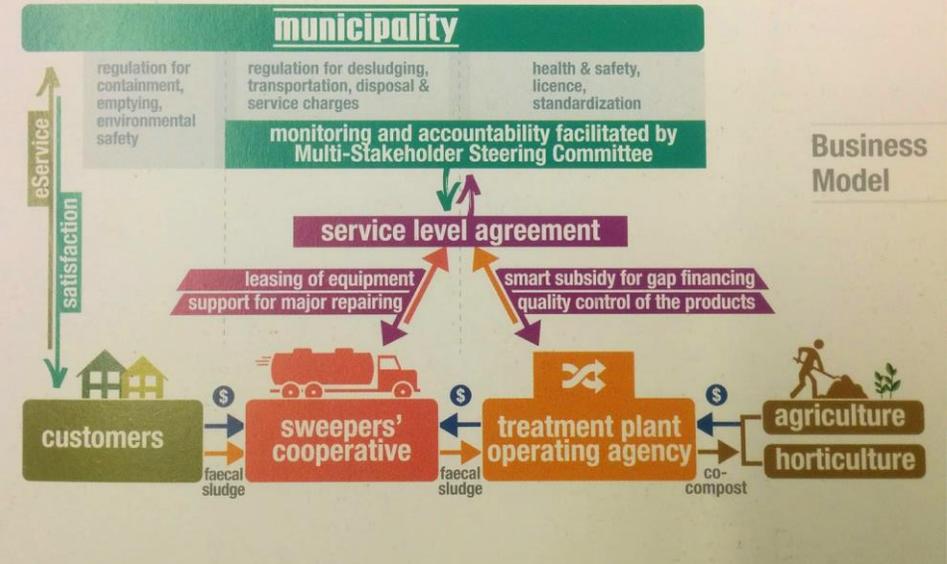
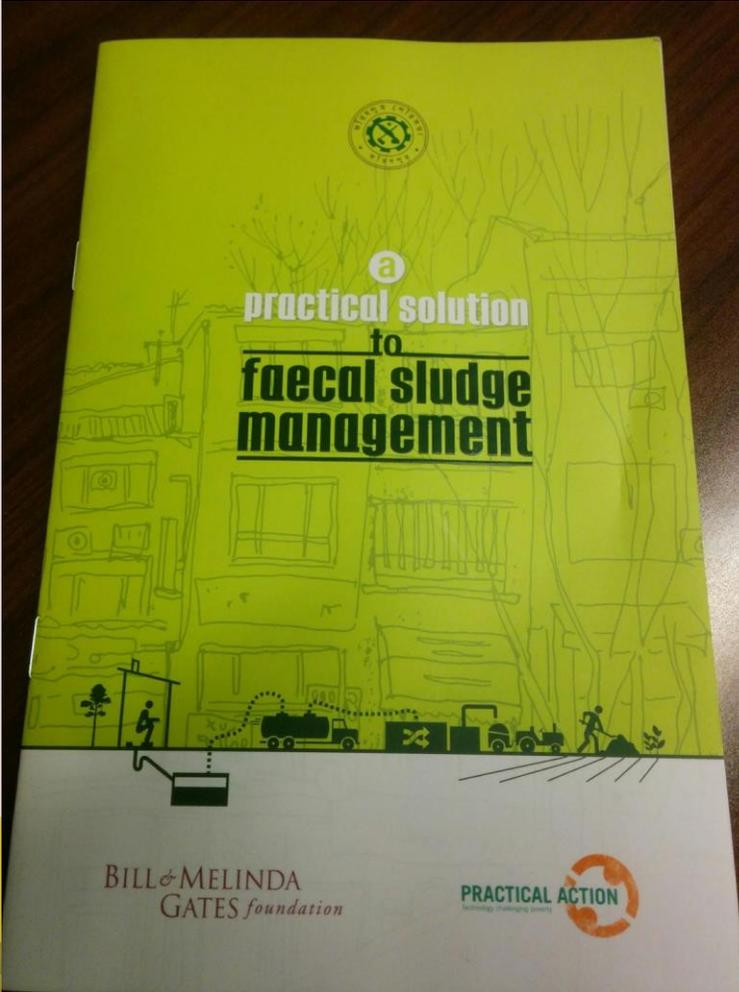
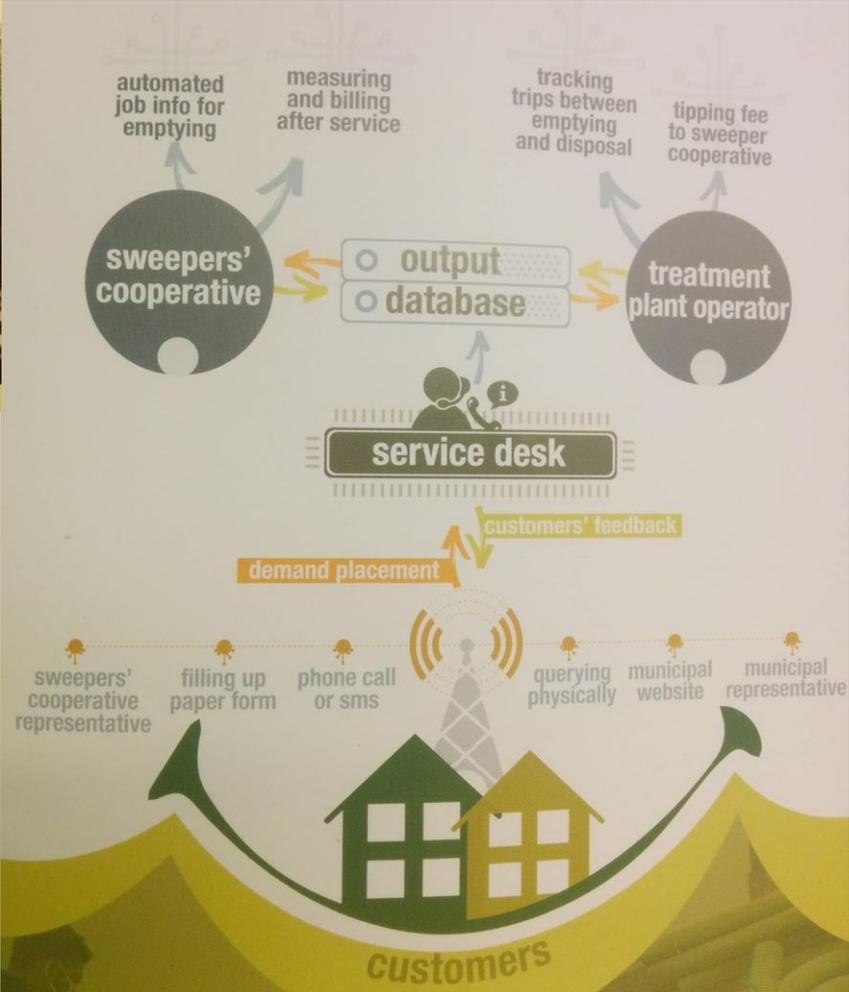
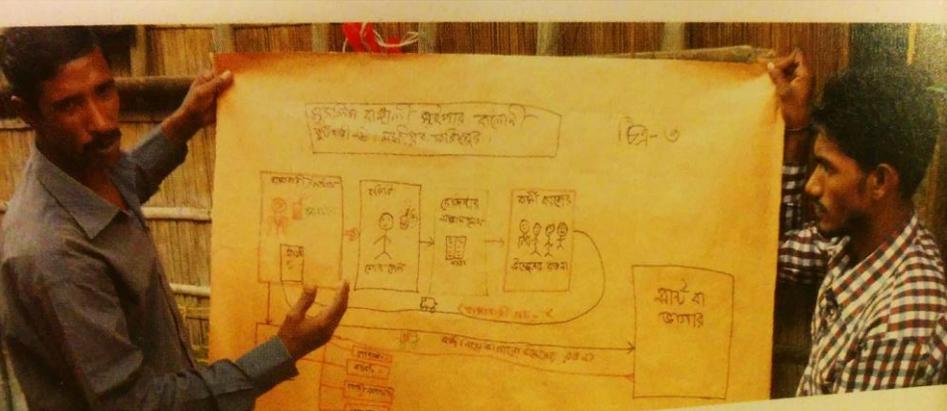
- Situation and Barriers
 - Implementation Nuances
 - Potential Safety Hazards
 - Deeper Usability Considerations
-
- Where are the gaps?
 - Where is the innovation?

Characteristics: Branches, Zooms, Documents, Clarifies



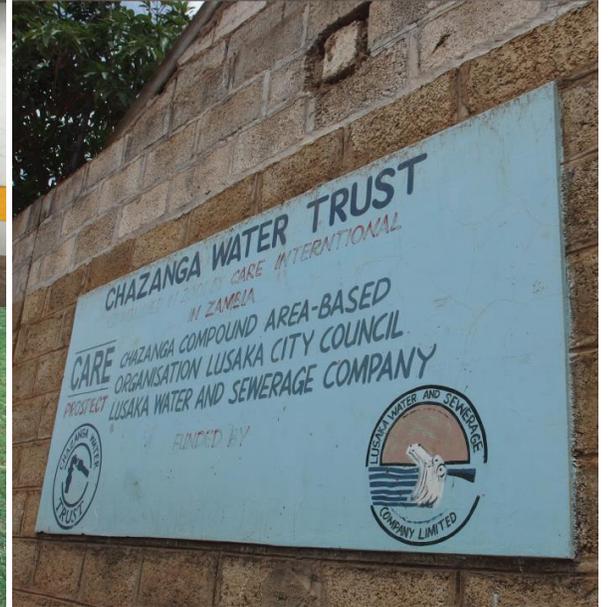
PROCESS

1. Examples of FSM related System Visuals



2. Field Testing the Flexcrevator in Lusaka (November 2017)





Field Notes - one page sheets to assist & prompt documentation across desired research topics (observation & interviews)

A

FLEX OBSERVATION PROMPTS - NOV 2017

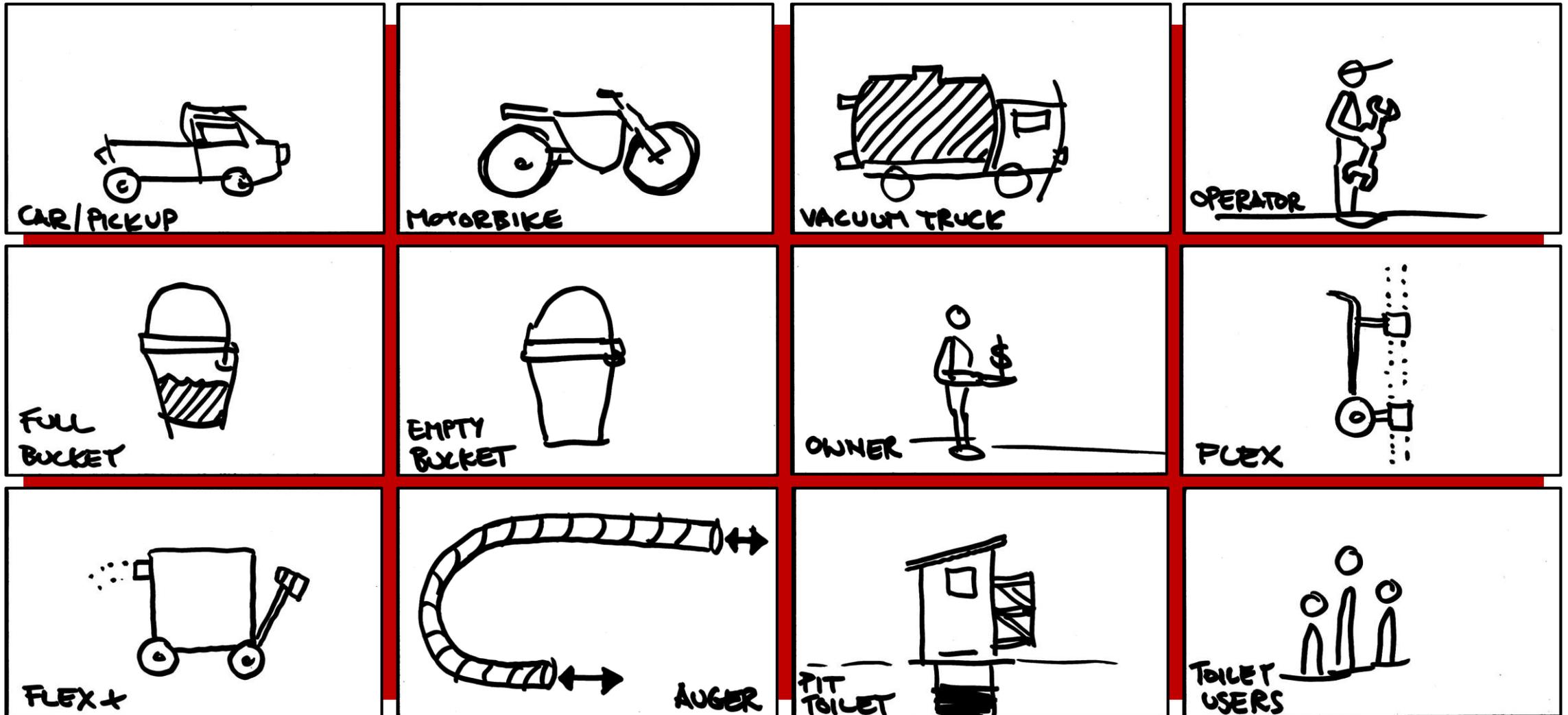
PIT LATRINE INFO	
LOCATION	
APPROX' PIT USERS	
APPROX' PIT DEPTH	
DISTANCE TO ROAD	
PIT OPENING METHOD	
PIT OPENING DIMENSIONS	
DOORWAY DIMENSIONS	
PIT TYPE	
PIT HAZZARDS	
SLUDGE PROPERTIES	
POWER SUPPLY PROXIMITY	
BYSTANDERS PROXIMITY	
OTHER HOMES PROXIMITY	
CONTEXTUAL INFO	
TERRAIN/PATHWAY	
PATHWAY MIN' DIMENSIONS	
PATHWAY RESTRICTIONS	
OTHER ACCESS FACTORS	

TASKS (MANUAL EMPTY)	
PPE DRESSING	
TOOL TRANSPORT	
ACCESSING PIT LATRINE	
SLUDGE COLLECTION	
SLUDGE TRANSPORT	
REPAIRING LATRINE	
CLEANING LATRINE	
PPE UNDESSING	
TIME TO EMPTY	
BEHAVIOURS OF NOTE	
EXCLUDER OPERATOR	
VACUUM OPERATOR	
OTHER OPERATOR	
CUSTOMER	
BYSTANDERS	
PIT EMPTYING BIZ OWNER	
TRASH EXCLUDER	
HANDLE	

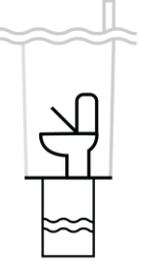
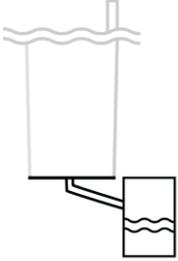
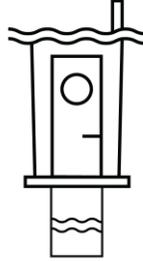
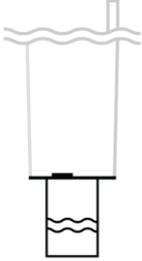
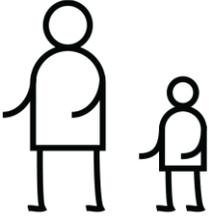
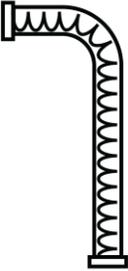
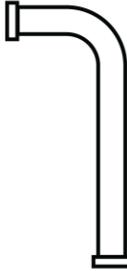
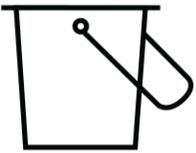
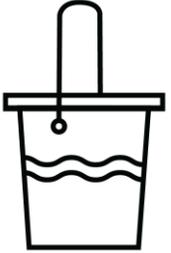
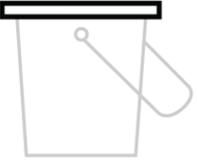
OTHER ACCESS FACTORS	
TASKS (FLEX SETUP)	
PPE DRESSING	
TRANSPORT OF EXCLUDER	
TRANSPORT OF VAC KIT	
ACCESSING PIT LATRINE	
SETUP OF EXCLUDER	
SETUP OF VAC KIT	
PREPARING PIT LATRINE	
INITIATING VAC&EXCLUDER	
CONTROLLING EXCLUDER	
CONTROLLING VACUUM	
CONTROLLING DRUM FILL	
TRANSPORT' CONTAINERS	
REPAIRING LATRINE	
CLEANING LATRINE	
CUSTOMER CLOSURE	
CLEANING EXCLUDER	
CLEANING VACUUM	
PACK-DOWN OF EXCLUDER	
PACK-DOWN OF VAC KIT	
TIME TO EMPTY	

HANDLE	
HOSE	
EXCLUDER HEAD	
JUNCTION	
MOTOR	
FRAME	
CONTROLS	
CABLES/CONNECTORS	
OTHER	
VACUUM KIT	
VAC CUBE	
CONNECTOR HOSE	
COLLECTION DRUM	
DRUM STAND	
CART	
OTHER	
OTHER TOOLS IN USE	
'FISHING' TOOLS	
REPAIR TOOLS	
CLEANING TOOLS	
OTHER TOOLS	

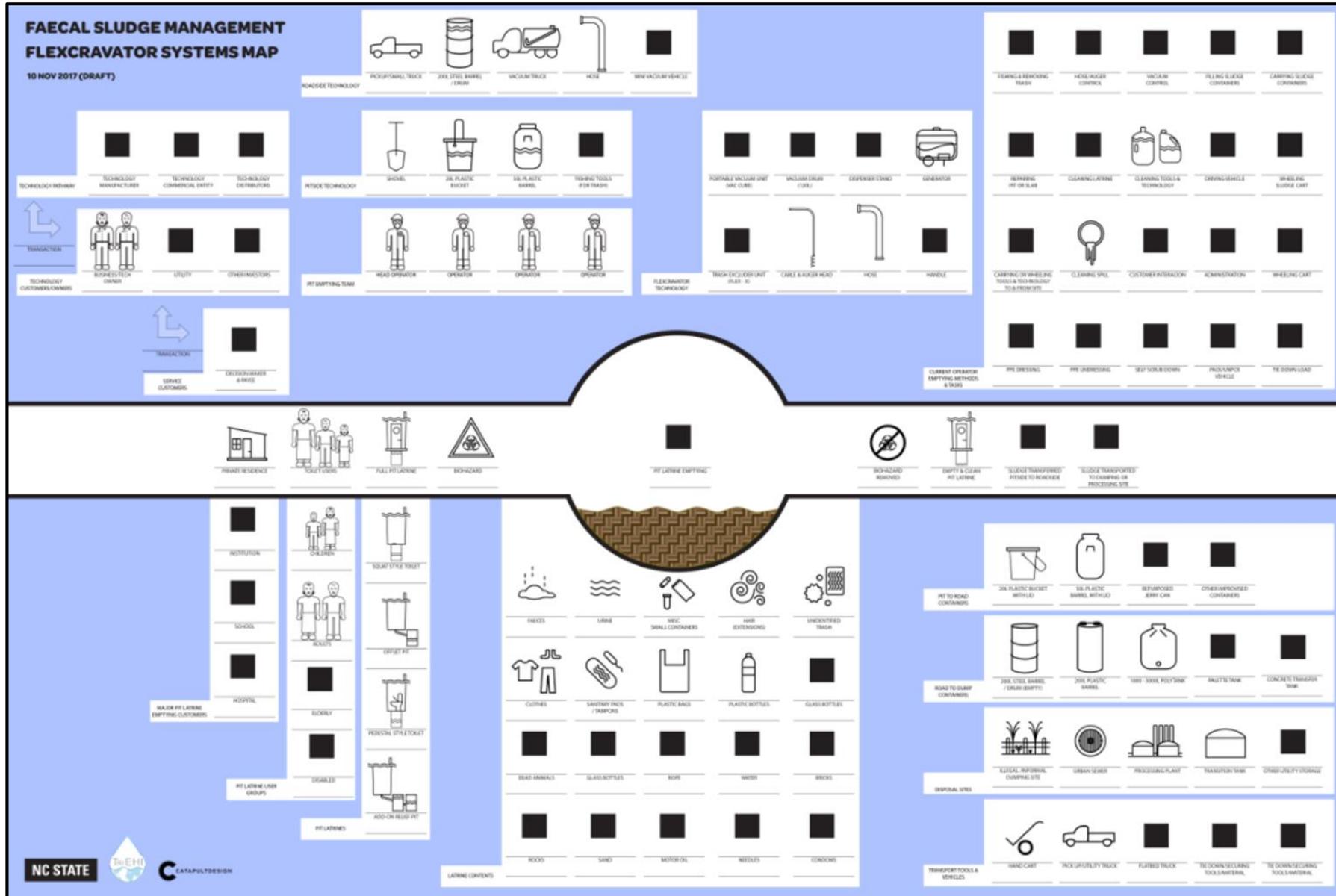
Simple icons for systems elements of pit emptying and FS all made with the intention of starting a 'library of visual assets' we can use across resources and reports we create, as well as design tools.

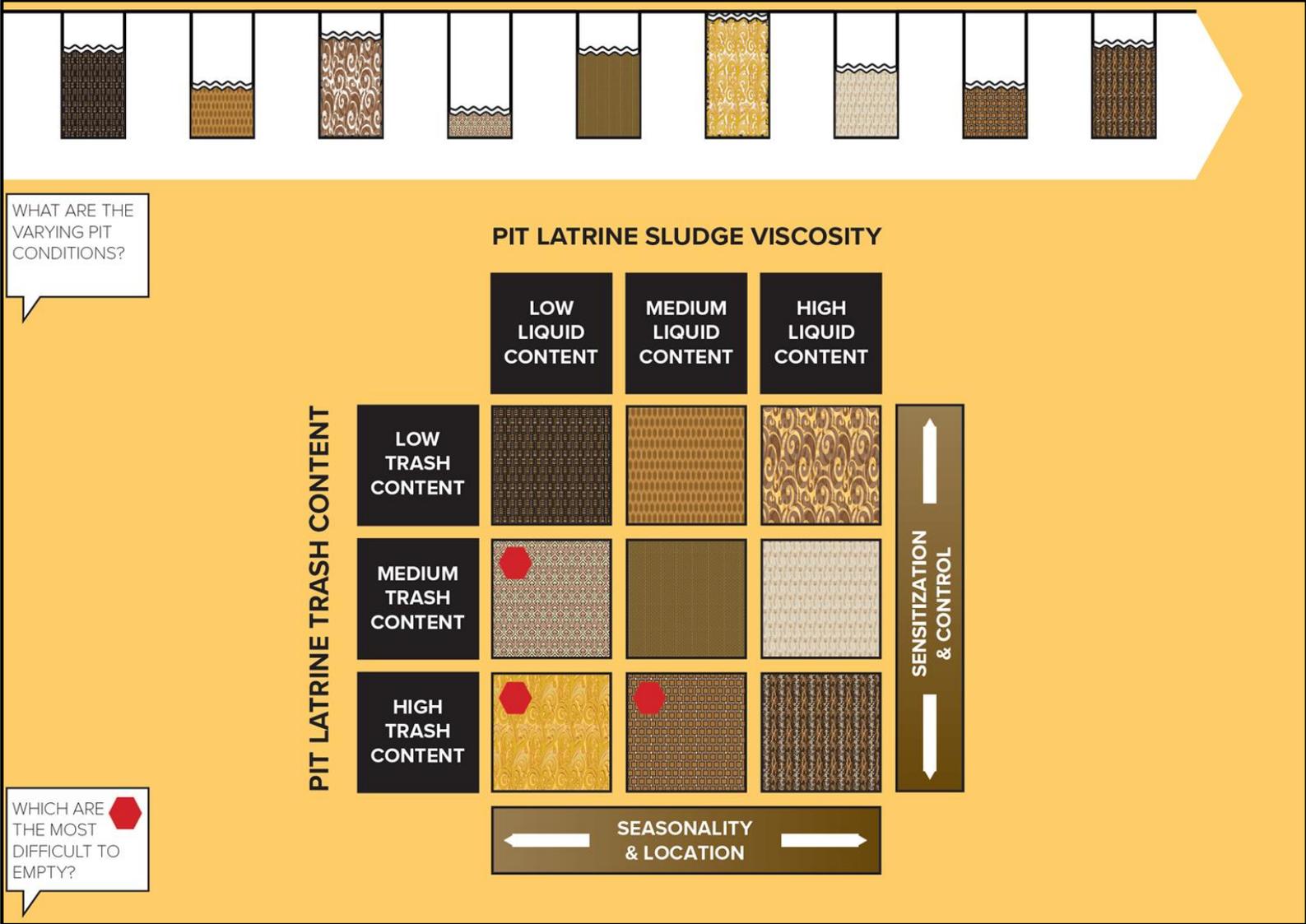


Exploring simple styles for icons to satisfy our communications needs. Illustrating complete spreadsheet lists to begin creating systems maps.

 <p>PEDESTAL STYLE TOILET</p>	 <p>OFFSET PIT</p>	 <p>PIT LATRINE</p>	 <p>SQUAT STYLE TOILET</p>	 <p>TOILET USERS</p>	 <p>OPERATOR</p>	 <p>OWNER</p>	 <p>SHOVEL</p>
 <p>AUGER</p>	 <p>HOSE & AUGER</p>	 <p>HOSE</p>	 <p>URINE</p>	 <p>FECES</p>	 <p>EMPTY BUCKET</p>	 <p>FULL BUCKET</p>	 <p>BUCKET LID</p>

Using icons to identify and explain elements, nuances/phenomena within pit emptying and FSM





3 STAKEHOLDERS - LUSAKA - PIT EMPTIERS



WE ALWAYS ENTER THE PIT THROUGH THE SIDE TO AVOID BEING LIABLE FOR ANY INTERNAL DAMAGES TO THE LATRINE

WE BUILD UP A CATCHMENT AREA TO FILL AND CLEAN BARRELS IN THAT FLOWS BACK INTO THE PIT TO AVOID CONTAMINATING MORE OF THE IMMEDIATE ENVIRONMENT

WE CLEAN AREA AROUND THE LATRINE AND EACH BARREL AFTER IT IS FILLED, AND ANY SPILL AREAS WITH A DISINFECTING LIQUID. WE USE BETWEEN 4 TO 8 LITRES PER PIT.

WE LIKE THE MACHINES BUT NOT THE CUSTOMERS BECAUSE THEY PUT TRASH IN THE PITS. ITS NOT THE MACHINES FAULT IF IT GETS BLOCKED IT IS THE FAULT OF THE PIT.

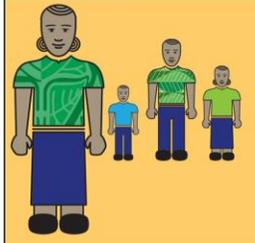
WE ARE INTERESTED IN MECHANISED SOLUTIONS THAT IMPROVE OUR CAPACITY AND ABILITY TO EMPTY MORE PITS IN A DAY TO IMPROVE OUR ABILITY TO EARN INCOME

- LABORERS
- CURRENTLY MANUALLY EMPTY BETWEEN 2 AND 4 PITS PER DAY
- WORK IN TEAMS OF 4 TO 6
- PAID ON COMMISSION PER PIT
- WEAR PROVIDED PPE (EXCEPT FOR FACE MASKS)
- WEAR IMPROVISED FACE MASKS & BALACLAVAS
- WEAR HARDHATS
- BREAK HOLES IN SIDE OF LATRINE USING SHOVEL, PICK & END OF FISHING TOOLS
- USE A LONG HANDED RAKE WITH A 'T' AT HANDLE END
- USE A LABEL TO SCOOP UP SLUDGE AND RAKE
- COLLECT BETWEEN 12 AND 36 BARRELS FROM EACH CUSTOMER
- SERVICE PIT LATRINES, SEPTIC TANKS & CESS PITS
- BASED AT WASTE TREATMENT PLANT
- CURRENTLY SORT TRASH FROM SLUDGE AT PLANT
- SOME OF TEAM TRAVELS BETWEEN CUSTOMERS AND THE WASTE TREATMENT SITE ON THE BACK OF THE FLAT BED TRUCK ALONG WITH THE SLUDGE BARRELS AND TOOLS



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4 STAKEHOLDERS - LUSAKA - CUSTOMERS



WE DONT WANT TO EMPTY THE PITS OURSELVES AND DONT HAVE THE APPROPRIATE TOOLS AND PROTECTIVE EQUIPMENT TO DO SO.

WE CANT CONTROL THE TRASH CONTENT OF OUR PIT LATRINES. PEOPLE SOMETIMES USE THEM WITHOUT US KNOWING AND WE CANT STOP THEM FROM.

WE ARE ASKED TO PROVIDE QUITE A BIT OF WATER TO ALLOW THE PIT EMPTIERS TO FLUIDIZE THE PIT. WHEN WE ARE PAYING PER BARREL THIS CAN FEEL LIKE WE ARE PAYING TWICE.

CHOLERA OUTBREAKS CAN OCCUR IN THE RAINY SEASON. THIS IS A CONCERN FOR THE SAFETY OF OUR FAMILY & COMMUNITY. WE LIKE IT WHEN THE PIT EMPTIERS CLEAN UP WELL & USE DISINFECTANTS TO PROTECT US.

WE DONT WANT THE PIT TO FILL UP TOO QUICKLY BECAUSE WE WOULD HAVE TO PAY MORE MONEY TOWARDS EMPTYING IT SO WE DONT DIVERT OUR SHOWER WATER INTO IT

- PREDOMINANTLY HOUSEHOLDS OR COMPOUNDS
- PITS WERE ON AVERAGE SAID TO BE ABOUT 2M DEEP
- LOTS OF KIDS RUNNING AROUND AREA AND BEING CHASED AWAY BY PIT EMPTIERS
- OFTEN TOILETS ARE SHARED BY OTHER HOUSEHOLDS AND NEIGHBOURS, SOMETIMES WITHOUT PERMISSION
- CUSTOMER OFTEN DOES NOT HAVE CONTROL AS TO WHO USES THE TOILET AND WHAT THEY PUT IN
- CUSTOMER PREPAYS EMPTIERS FOR A SPECIFIED NUMBER OF BARRELS. OFTEN THIS IS BUDGET DEPENDENT
- SHOWER WATER IS OFTEN DIVERTED TO THE SURFACE AND DOES NOT GO INTO THE PIT
- GARBAGE CONSISTENTLY VISIBLE ON PROPERTIES. WASTE MANAGEMENT SEEMS TO BE PROBLEMATIC BEYOND THE LATRINE
- PIT EMPTYING FREQUENCY IS EXTREMELY VARIABLE BETWEEN CUSTOMER HEARD FROM ANNUAL TO 7 YEARS



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5 STAKEHOLDERS - LUSAKA - VACUUM TRUCK OPERATORS



SOME VACUUM TRUCKS ARE MANUFACTURED, ASSEMBLED, OR ADAPTED WITHIN ZAMBIA, AND OTHERS ARE IMPORTED FROM OTHER INTERNATIONAL CITIES OLD FLEETS.

WE WOULD RATHER EMPTY SEPTIC TANKS AS THE JOB IS QUICK AND THE PROFIT MARGIN IS THEREFORE BETTER THAN PITS.

WE CHARGE EXTRA FOR TRASH EMPTYING IN PITS WHICH MAKES THEM COST ALMOST TWICE WHAT A SEPTIC TANK EMPTY COSTS.

OUR TRUCKS CAN NOT SERVICE EVERY PIT IN LUSAKA BUT THERE IS SUFFICIENT ROAD ACCESS TO MOST COMMUNITIES.

WE SEND STAFF IN TO CHECK PIT CONDITIONS FIRST BEFORE WE COMMIT TO EMPTYING THEM DUE TO UNPREDICTABLE TRASH CONTENT.

- VACUUM ON TRUCK CONTROLLED VIA GATE VALVE ON TRUCK
- TRUCK HAS WINDOW TO SEE SLUDGE LEVEL IN TANK, BUT ITS TOO OPAQUE TO SEE THROUGH
- HOSE IS ABOUT A 2.5 INCH ID (PERHAPS TO ACCESS VIA TOILET HOLE)
- VAC TRUCK CHARGE IS 1000 K TO EMPTY SEPTIC TANK
- VAC TRUCK CHARGE IS 2000 K TO EMPTY PIT. PLUS 800 FOR TRASH EMPTYING = 2800K
- RECON FIRST, TRASH REMOVAL, THEN VAC TRUCK
- 6200 LITERS TRUCK CAPACITY. PRICE IS THE SAME NO MATTER HOW MUCH IS COLLECTED, UP TO 6200 LITERS
- RBS ON VAC TRUCK. HOSES ARE WORN SMOOTH
- VAC TRUCK OPERATOR: TRASH WILL GO UP A HOSE. JUST SOME TRASH GETS CAUGHT ON HOSE FITTINGS
- VAC TRUCK OPERATORS DONT USE HOSE FITTINGS, THEY SPLICE HOSES TOGETHER WITH PLASTIC BAGS AND INNER TUBE RUBBER.
- HAVE DIFFICULTY IN EMPTYING TRUCK TANKS WITH TRASH IN IT DUE TO CLOGGING



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6 STAKEHOLDERS - LUSAKA - OWNERS/MANAGERS/NGO/PRIVATE SECTOR



WE PLAN TO HAVE CITY WIDE PIT EMPTYING SERVICES BUT NEED TO DETERMINE THE APPROPRIATE TECHNOLOGY TO EQUIP OUR TEAMS WITH.

WE HAVE TO SUBSIDISE THE PIT EMPTYING SERVICE AS THE EMPTYING FEES THAT THE CUSTOMERS CAN AFFORD DO NOT COVER ALL OF THE ASSOCIATED COSTS.

LUSAKA WATER RUN TWO PIT EMPTYING TEAMS AND NEITHER OF THEM IS LEGALLY REGISTERED. THIS MAKES US VULNERABLE TO VEHICLE CONFISCATIONS OR WORSE.

LUSAKA CITY COUNCIL IS DEVELOPING FECAL SLUDGE MANAGEMENT BY LAWS BUT THERE IS CURRENTLY NOTHING THAT GOVERNS MANUAL EMPTYING PROTOCOLS

THERE ARE PRIVATE SECTOR SOLUTIONS BUT THEY ARE EITHER NOT AFFORDABLE OR ACCESSIBLE ENOUGH TO COVER ALL OF THE LATRINES TO ENSURE CITY WIDE SANITATION SO A PUBLIC SERVICE IS REQUIRED

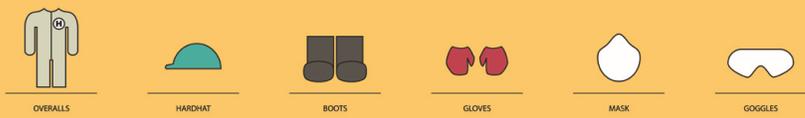
- TWO LUSAKA WATER TRUST OFFICES RUN PIT EMPTYING SERVICES, CHAZANGA AND KANYAMA
- REQUIRE TECHNOLOGY FOR TEAMS AND ARE TESTING/ COMPARING THEM VIA A SKAT MODEL TAF
- WSUP LED DEVELOPMENT OF THE PIT EMPTYING MODEL, AND HAVE SUPPORTED THE TWO LUSAKA WATER TEAMS WITH INFRASTRUCTURE
- WSUP WILL BE CO-ORDINATING THE BUILD OUT OF THE BUSINESS MODEL FOR CITY SCALE PIT LATRINE EMPTYING
- GSZ HAVE \$30 MILLION CLIMATE FRIENDLY SANITATION MONEY TO SPEND ON FSM
- PRIVATE SECTOR SERVICES IN LUSAKA
- ANDREW KLURT IS A BUSINESS LEADING CONSTRUCTION, VAC TRUCK MANUFACTURE AND EXPORT, SEPTIC EMPTYING SERVICES
- GEODI SERVICES - CONSTRUCTION, EQUIPMENT HIRE, VAC TRUCK EMPTYING
- SANITECH - MOBILE TOILET PROVIDERS AND SANITATION SOLUTIONS FOR THE MNES, SOUTH AFRICA OWNED



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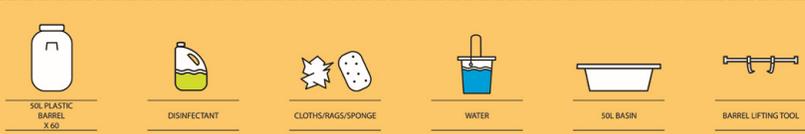
PERSONAL PROTECTIVE EQUIPMENT

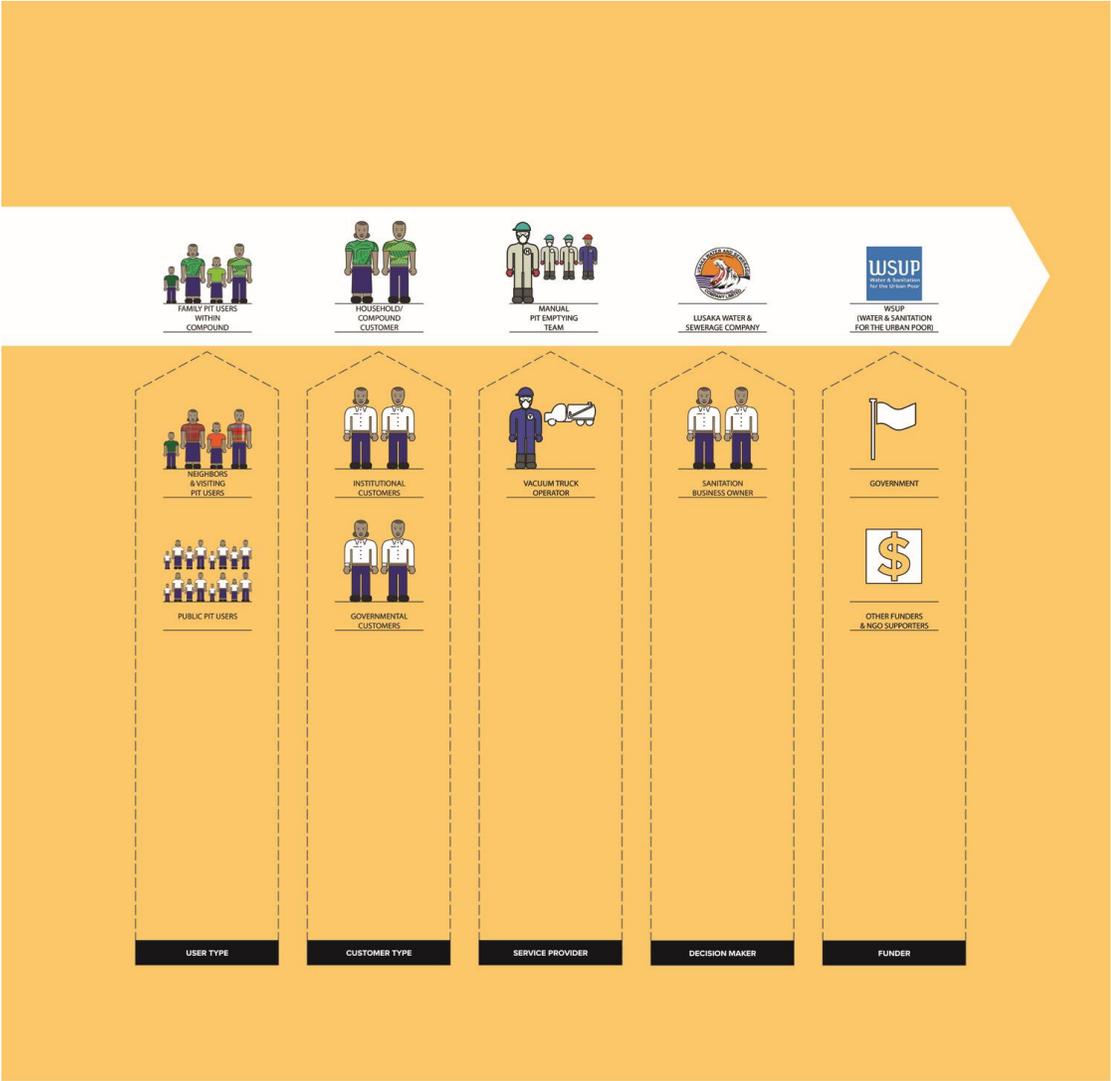


PRIMARY TOOL/EQUIPMENT



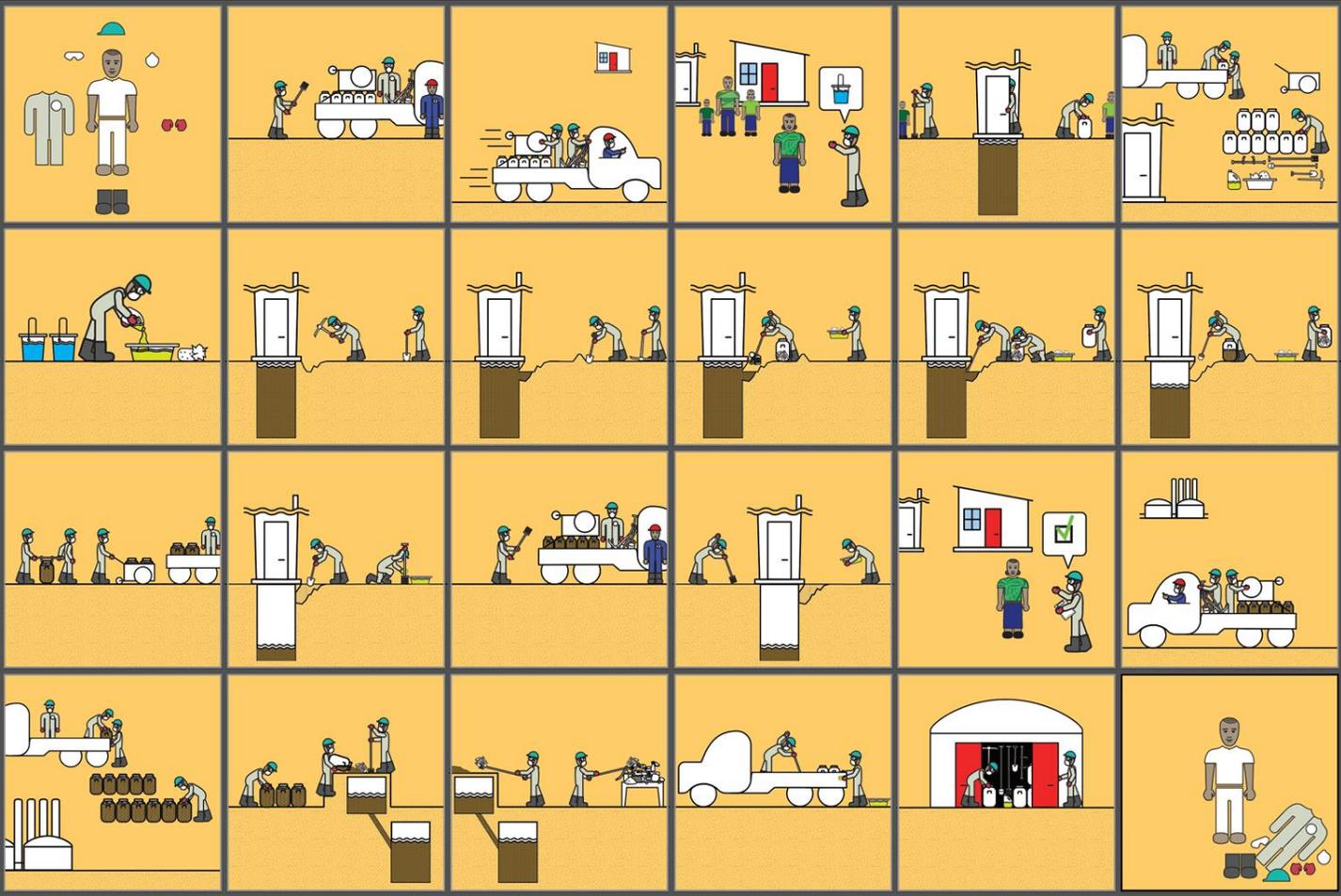
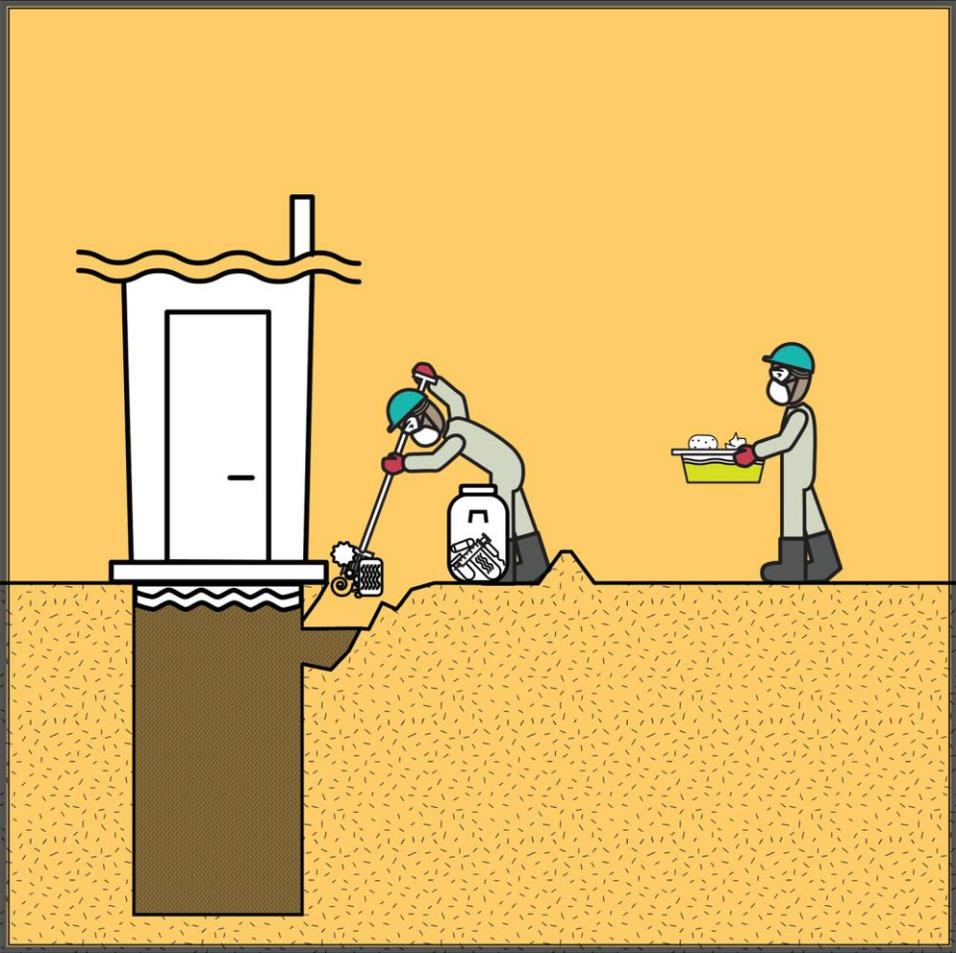
SECONDARY TOOL/EQUIPMENT





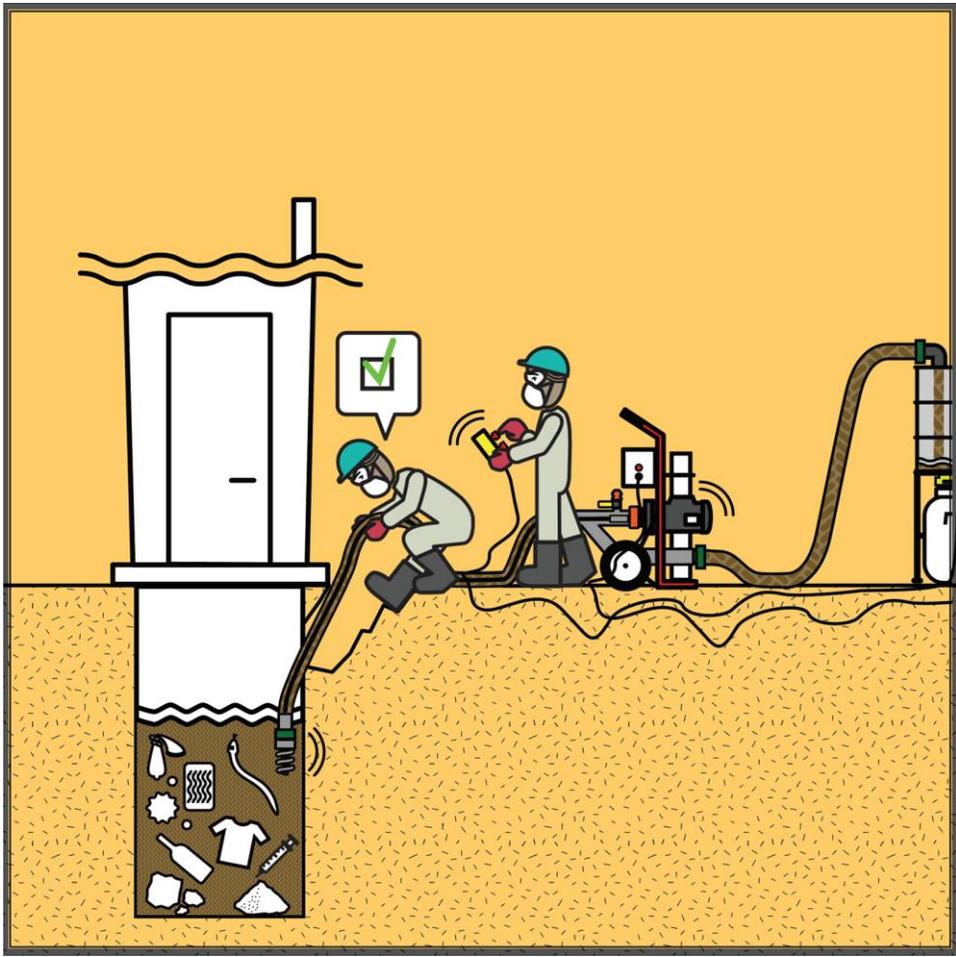
Creating Manual Pit Emptying Storyboards

Telling the story, frame by frame of how the operators empty pits manually. This allows us an easy platform to discuss bottle necks, hazards, and opportunities for the Flexcrevator design.

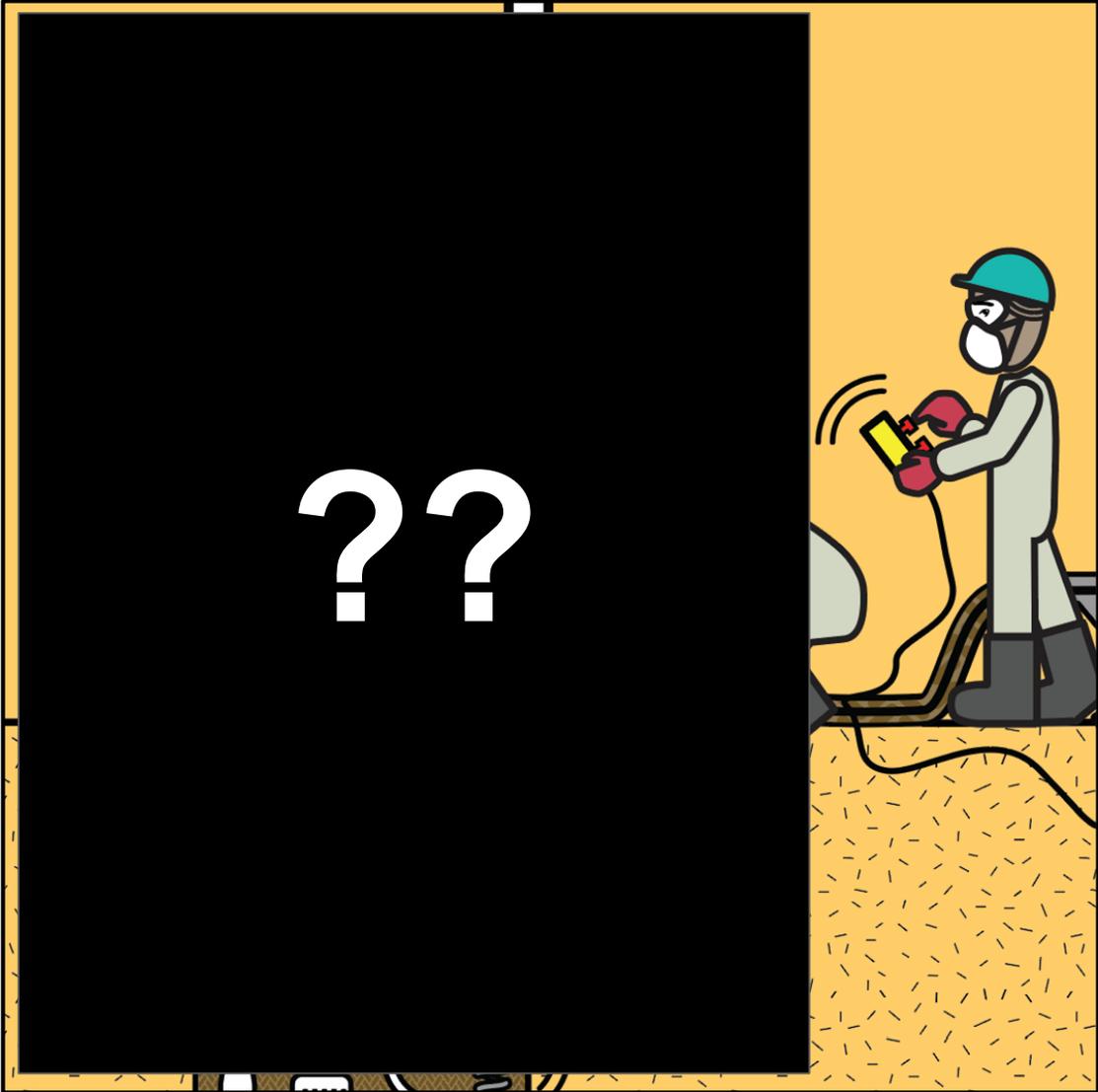


Creating 2017 Flexcrevator Prototype Pit Emptying Storyboards

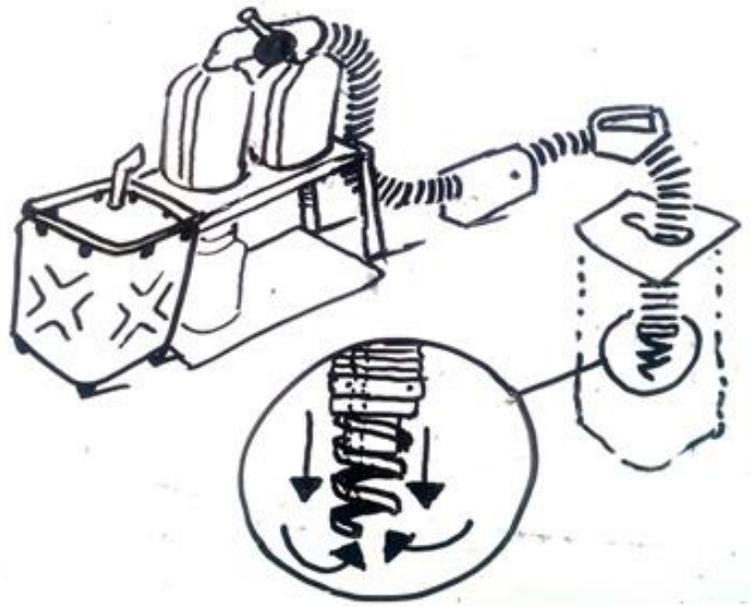
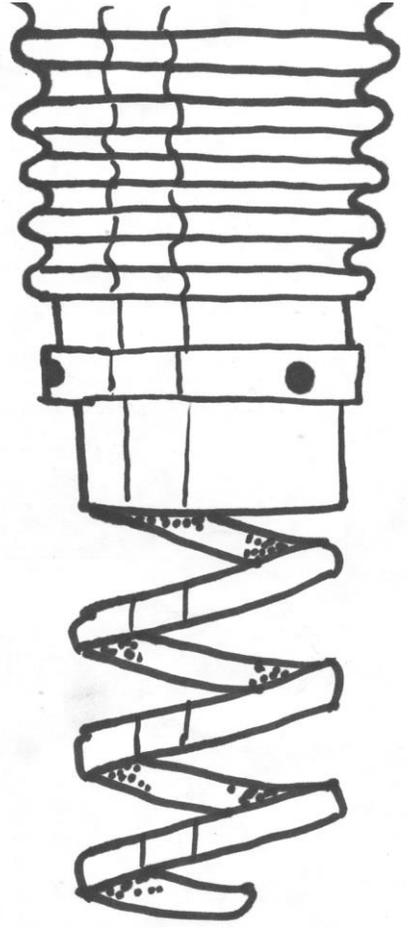
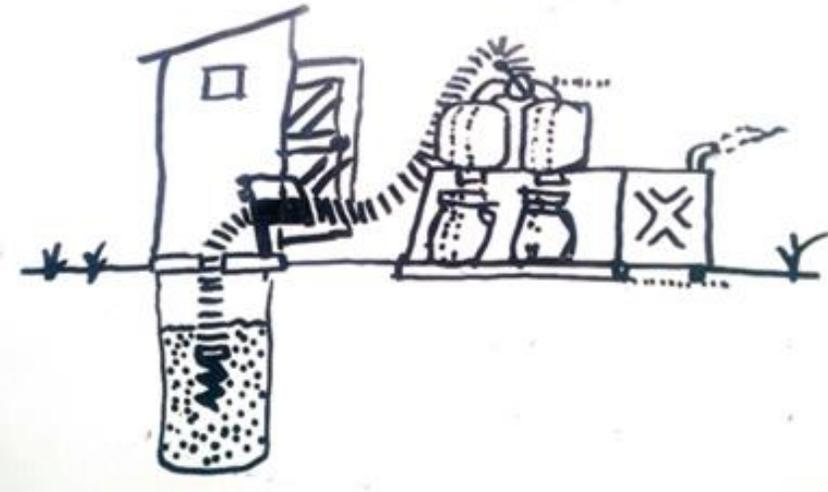
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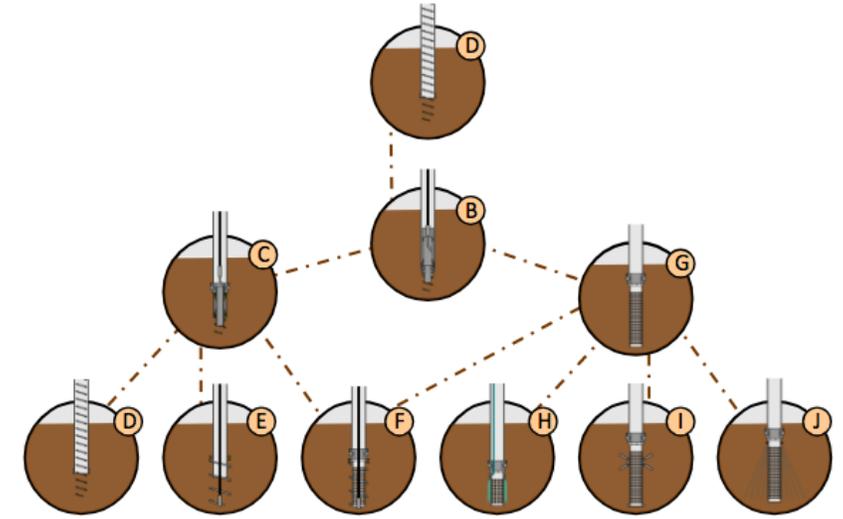
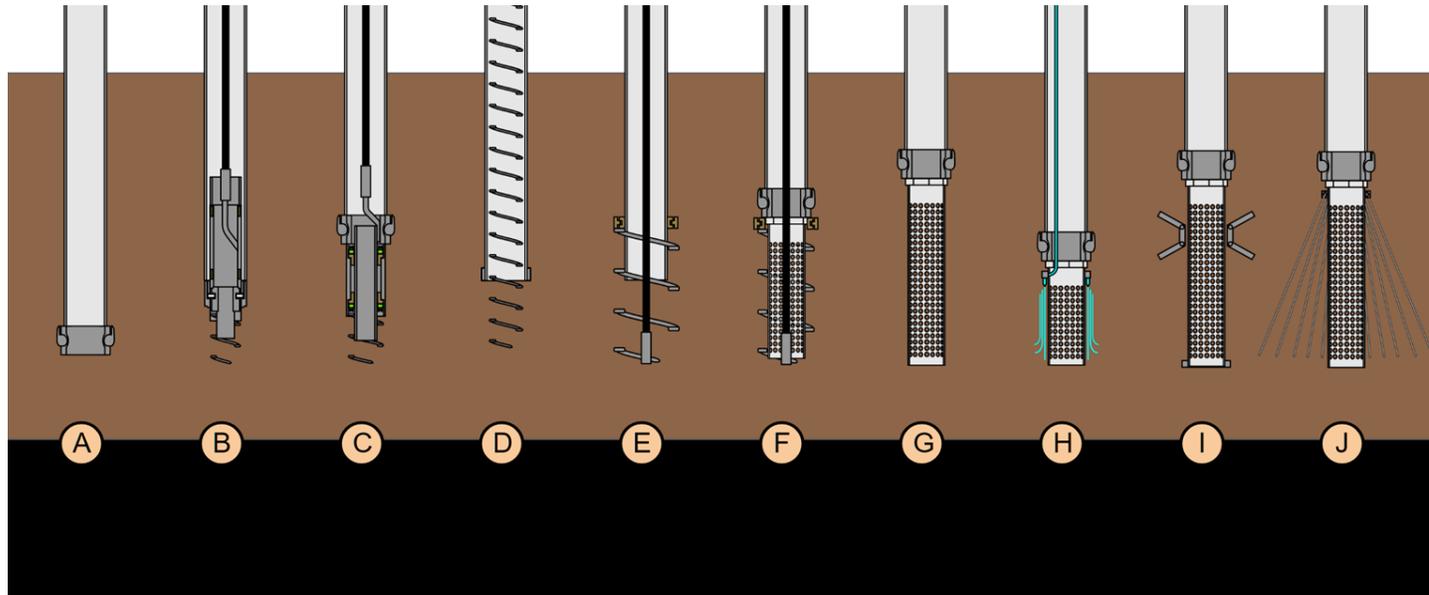


- **Visual assets and storyboards for the next iterations of the Flexcrevator system will be useful in instruction manuals, training, marketing etc and could also contribute to industry resources.**



Quick sketches used for internal team communications

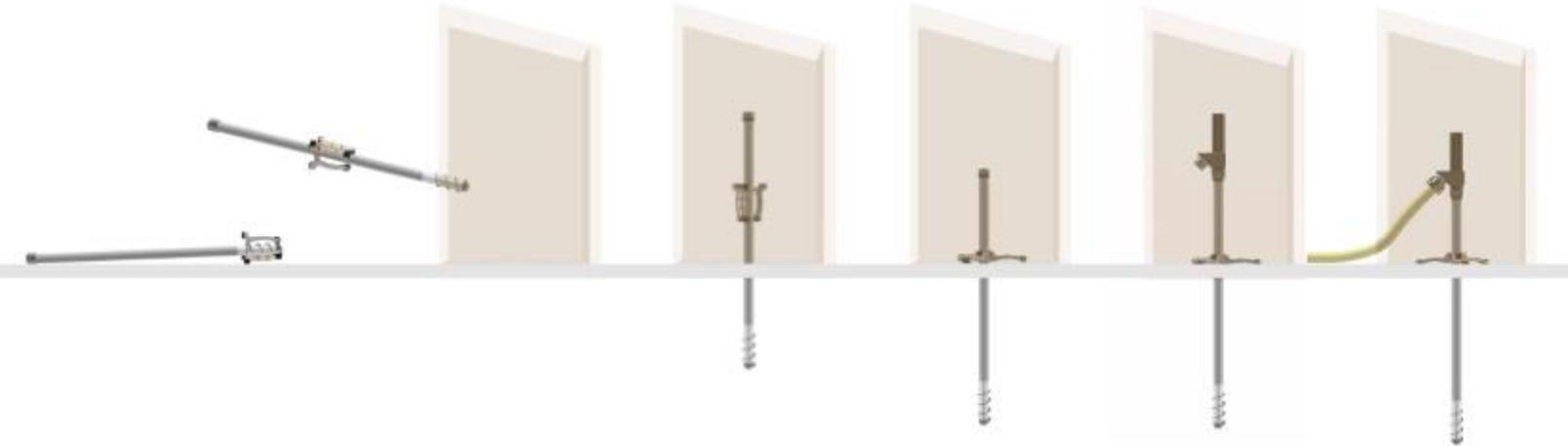




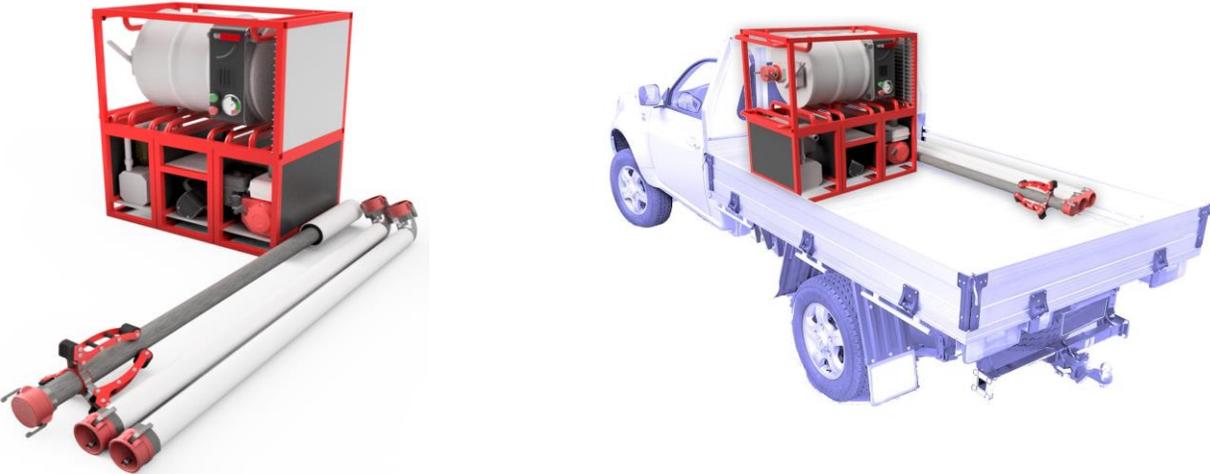
	Description	Deflection	Clearing	Size Limitation	Surface Area
A	3 inch Open Inlet (clean sludge pumping rate baseline)				
B	Auger (as field testing in Lusaka Nov. 2017)	X		X	
C	Improved Auger (vacuum seals and off-shelf components)	X		X	
D	Continuous Auger (reverse rotation)	X			
E	Auger (bottom driven)	X			
F	Auger (bottom driven with stationary OR rotating perforated screen)	X	X	X	X
G	Perforated Screen			X	X
H	Perforated Screen with Water Jets		X	X	X
I	Perforated Screen with Clearing Swiper		X	X	X
J	Perforated Screen with Wire Shield	X		X	X



1st Excluder CAD Models



Visualization of the placement of a rigid shaft Excluder into a latrine shelter



Exploring storage and transport of Flexcrevator

The FSM community and Illustrated Systems Analysis

- Presentation of nuanced FSM systems
- Comprehensible to a larger audience
- Used to spark innovation
- Saves time
- Saves money
- Ensures communication

“IT’S THE THINK, NOT THE INK”