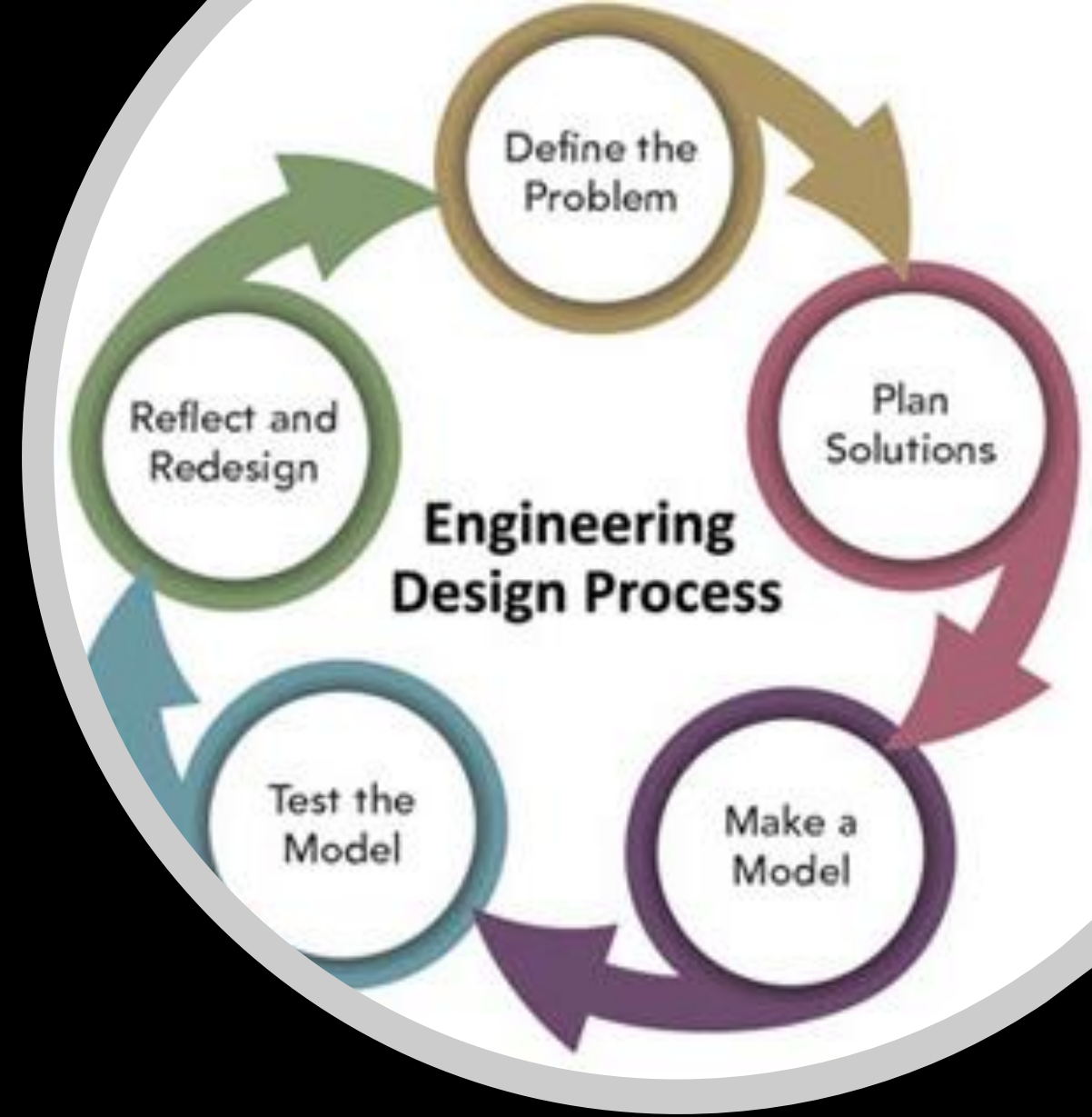




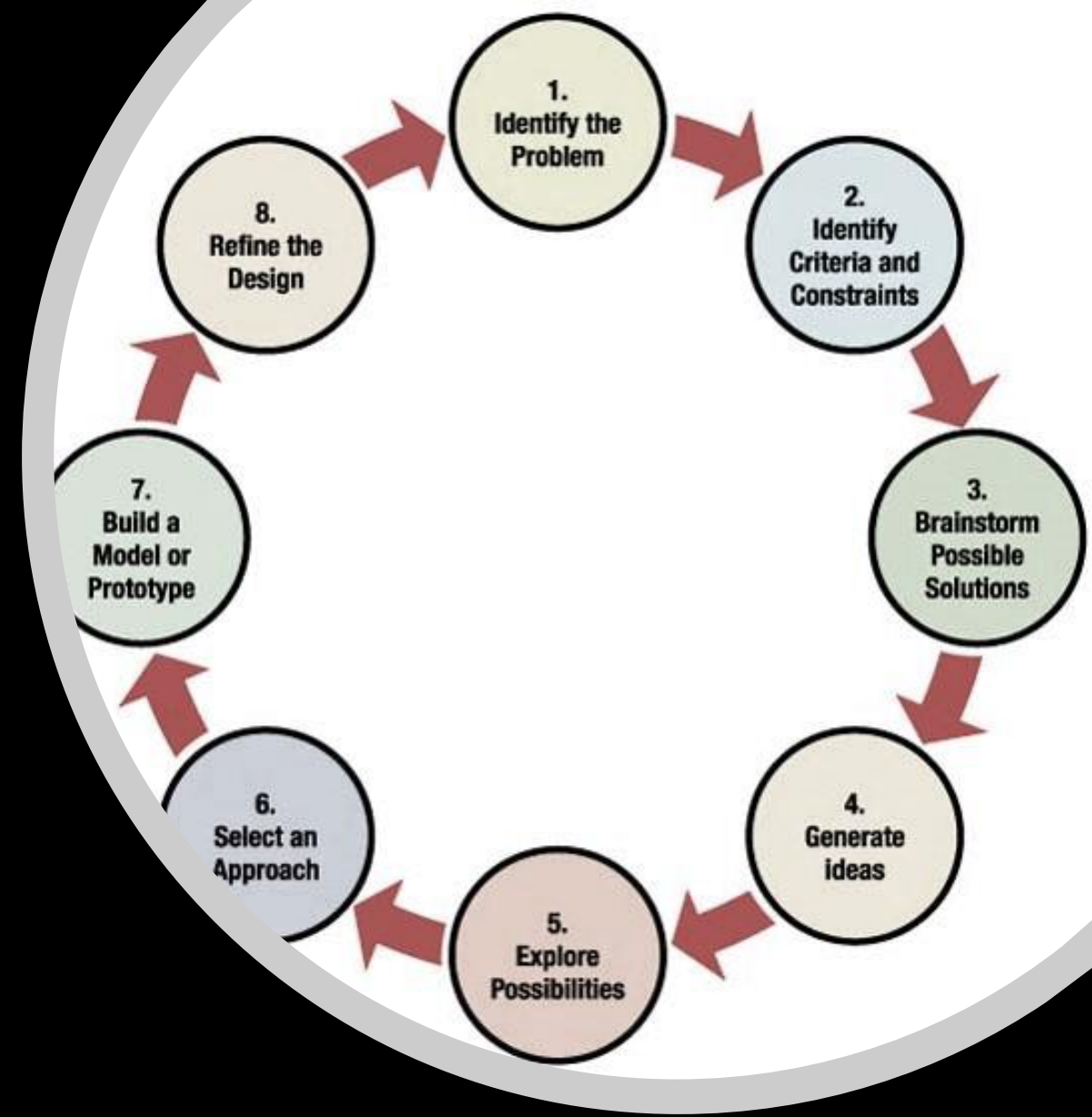
Design Thinking

Automated BioChar Injection System

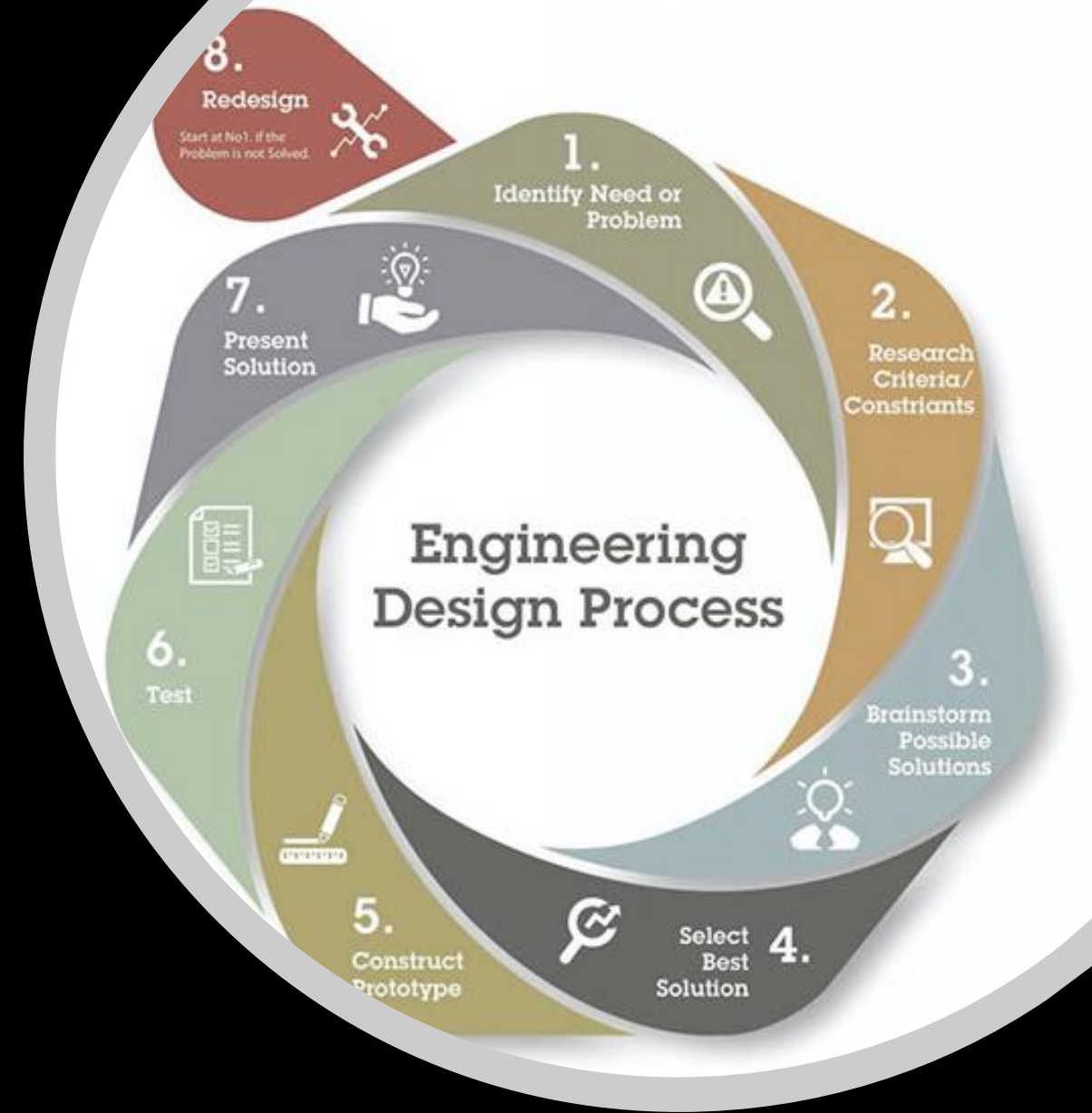
STEM Engineering Process



NASA Design Process

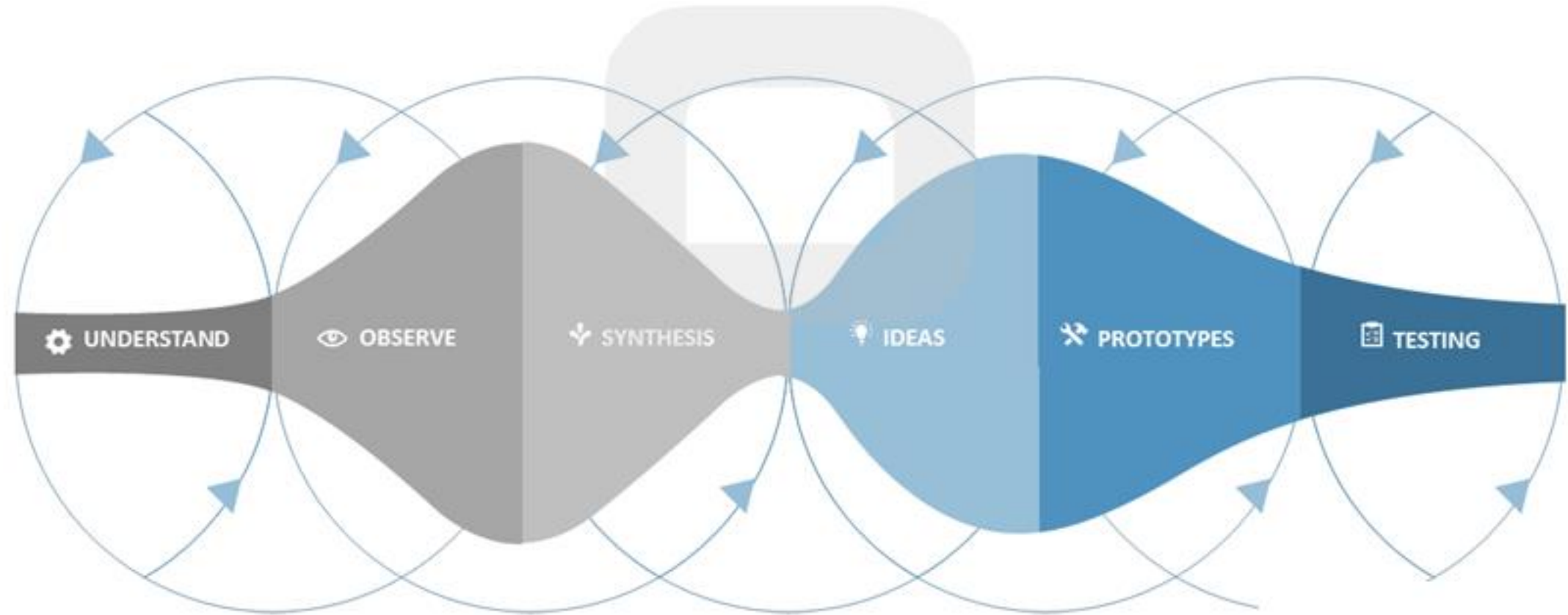


Teaching Channel Design Process



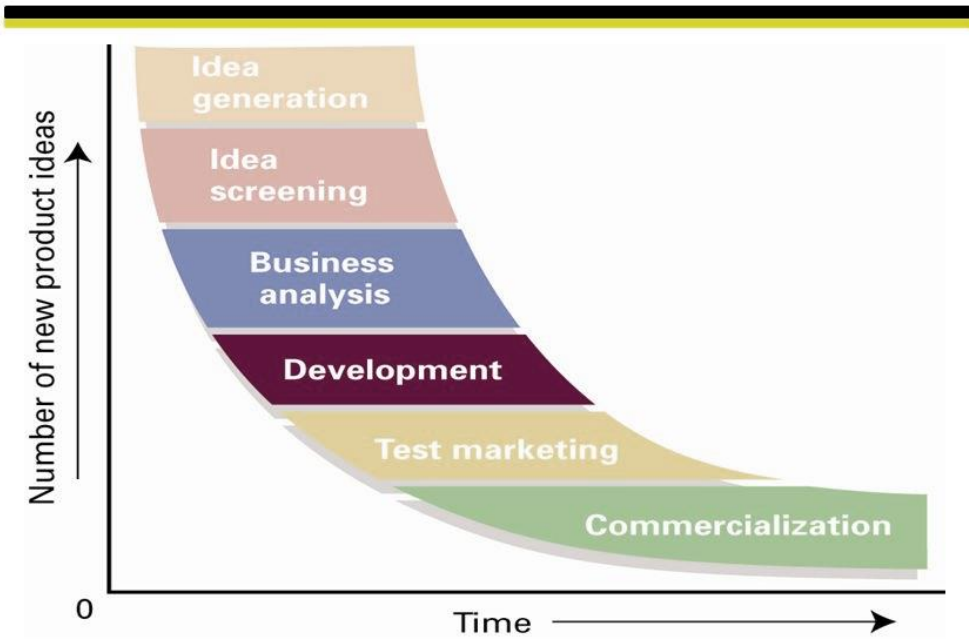
DESIGN THINKING

Design Thinking Process



Number of Ideas

New Product Development Process



Dream...

Design, fabricate, and test
electro-mechanical BioChar (BC)
injection system for the Clean
Water Machine...

December 2018 & May 2019

Goal, two design iterations.

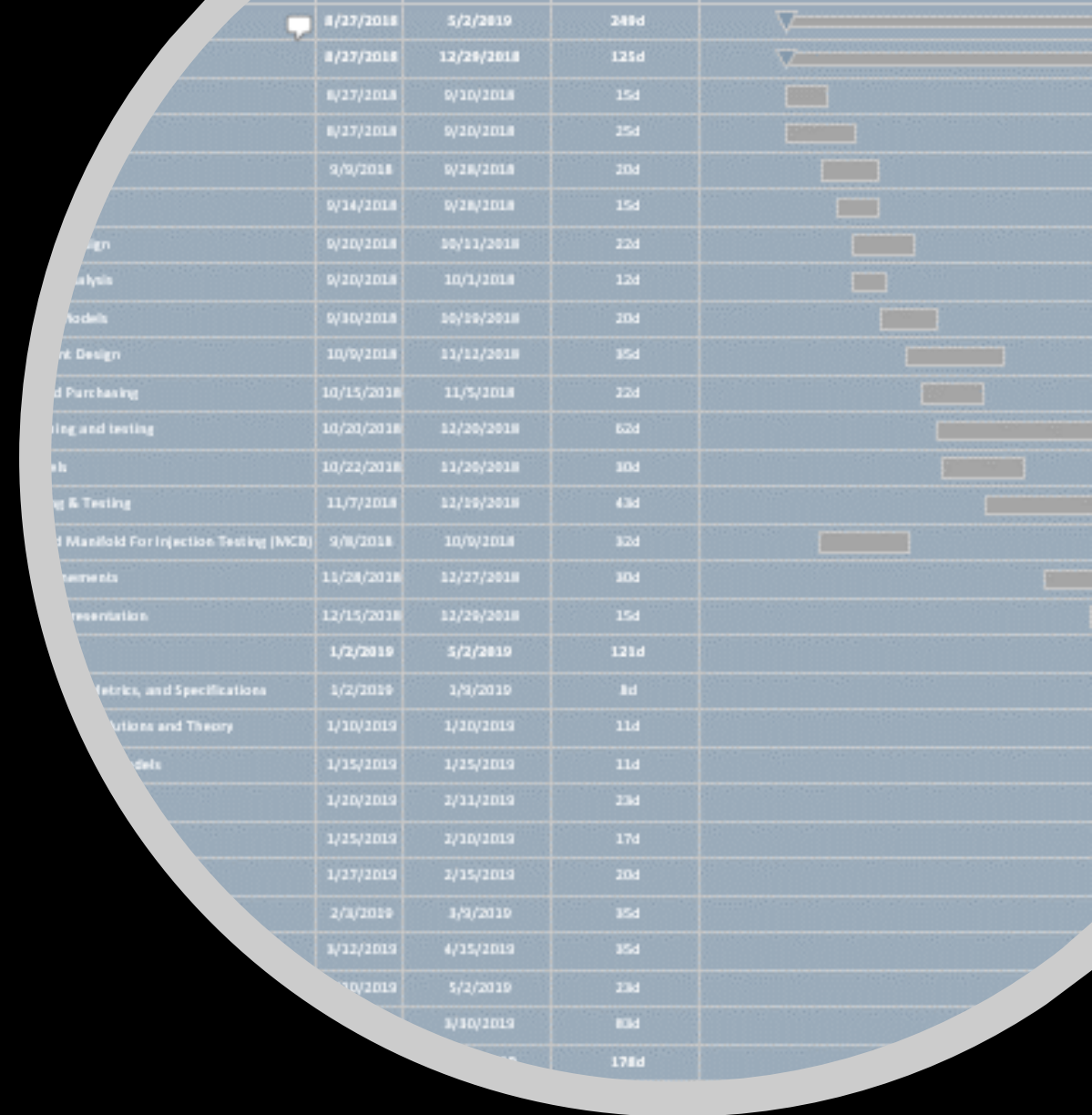
A dream written
down with a
DATE
becomes a goal. A goal
broken down into
STEPS
becomes a plan.
A plan backed by
ACTION
makes your dreams
come true.

GREG S. REID

www.TheSilverPen.com

Steps...

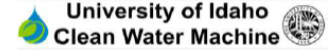
The mobile system design must accept then eject BC material into pressurized water lines in an accurate, consistent, recorded, and controllable manner.



Action...

action

- ['ækʃ(ə)n]
- NOUN
- the fact or process of doing something, typically to achieve an aim.
- "he vowed to take tougher action against persistent offenders" · "if there is a breach of regulations, we will take action"
- *synonyms:* [steps](#) · [measures](#) · [activity](#) · [movement](#) · [work](#) · [working](#) · [effort](#) · [exertion](#) · [operation](#)
- a thing done; an act.
- "she frequently questioned his actions" · [more]
- *synonyms:* [deed](#) · [act](#) · [activity](#) · [move](#) · [gesture](#) · [undertaking](#) · [exploit](#) · [maneuver](#) · [achievement](#) · [accomplishment](#) · [venture](#) · [enterprise](#) · [endeavor](#) · [effort](#) · [exertion](#) · [work](#) · [handiwork](#) · [doing](#) · [creation](#) · [performance](#) · [behavior](#) · [conduct](#) · [reaction](#) · [response](#)



Automated Biochar Injection System for the Nutrient-Energy-Water Nexus

Scope:

Form multi-disciplinary team to design, fabricate, and test electro-mechanical BioChar (BC) injection system for the Clean Water Machine reactive treatment process to facilitate phosphorus removal and recovery from agricultural waters. This project requires implementation of alternative micronized BC injection methods to enable widespread testing and validation. We need expertise and hardware designed for consistent and accurate dosing of BC with digital inputs and outputs for process monitoring in field conditions. A prototype proof-of-concept at the end of the first semester and a finalized version at the end of semester two are expected major deliverables.

Background:

The Clean Water Machine is a third-generation reactive filtration water treatment technology that uses functionalized BC as a sacrificial catalyst to remove phosphorus, organics, and other contaminants. Biochar is a cost-effective, energy-producing carbon product that results from burning biomass in oxygen-deficient environments. Upon nutrient enrichment, BC becomes a water-retentive, slow-release fertilizer for crops providing long-term carbon sequestration; previous research has demonstrated that this process may be carbon-negative. Current dosing processes are susceptible to inconsistent dosages and plugging without sensor feedback for integrated process control and leads to unacceptable experimental variability.

Currently, a Process Automation Controller (PAC) from Automation Direct® monitors water, air, and chemical dosages to stabilize flow rates for data collection and targeted water treatment capabilities. 21,000 gallons per day of water is pumped through continuous up-flow moving sand-bed filters then sterilized using onboard peracetic and ozone generation systems. Functional BC is currently injected using energy-intensive, plug-prone analog peristaltic pumps and mixing pumps which inhibit consistent dose monitoring and control.

Funds and hardware are available but specialized knowledge from mechanical and biological engineering is required to reach successful project outcome. Mechanical engineers can design and fabricate equipment while biological engineers can link the PAC and actuation networks.

Design Requirements:

Catalytic oxidation processes are demonstrated worldwide but to further realize capabilities an improved BC injection and data monitoring system is needed for automated process control. The mobile system design must accept then eject BC material into pressurized water lines in an accurate, consistent, recorded, and controllable manner.

Contact Information:

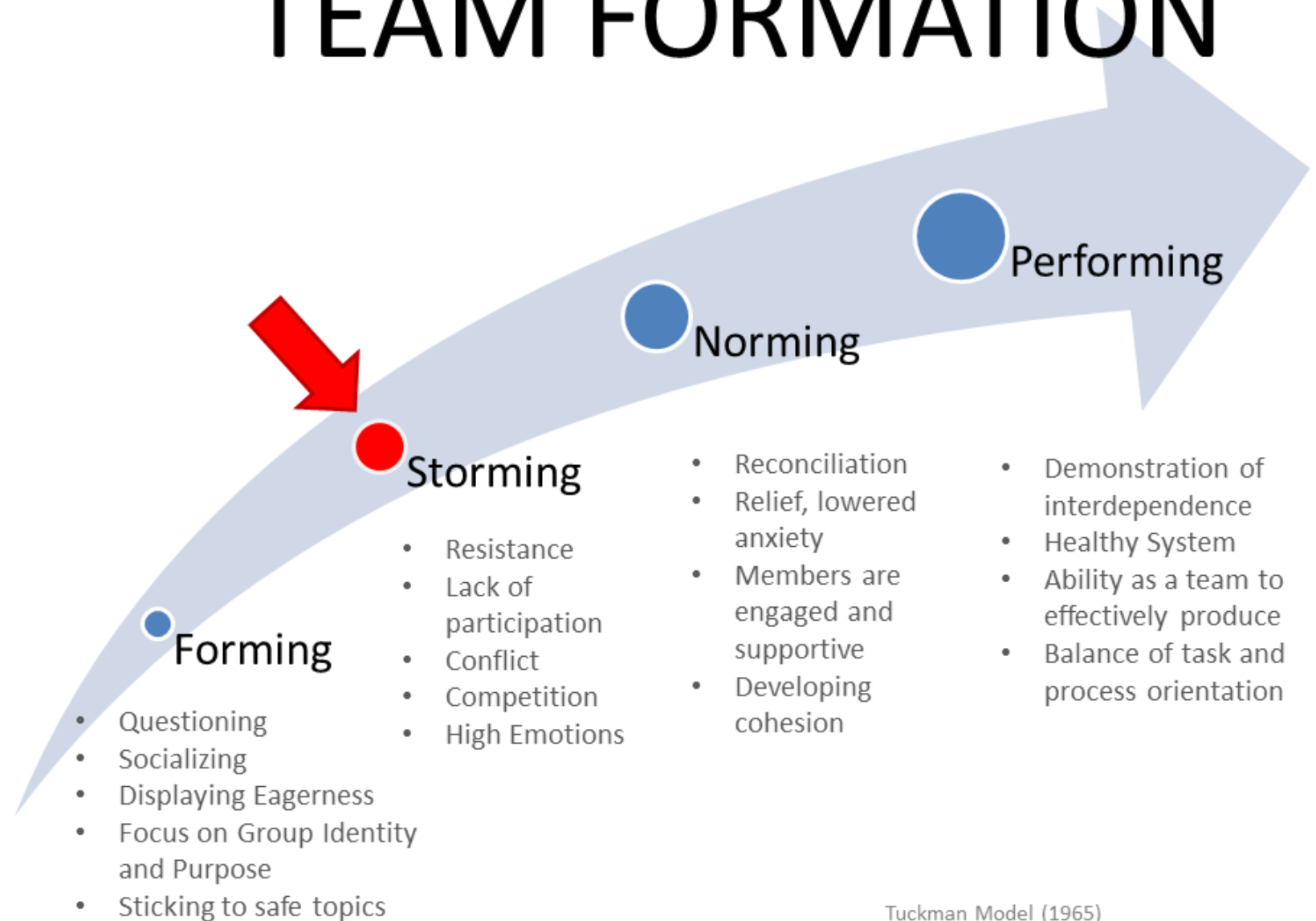
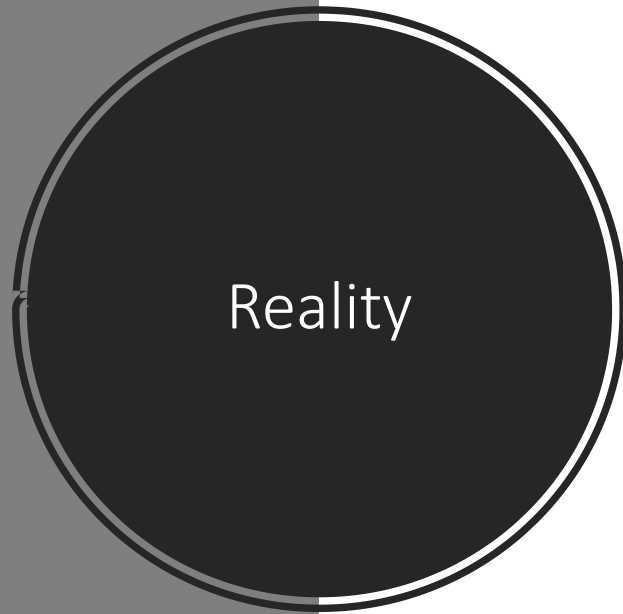
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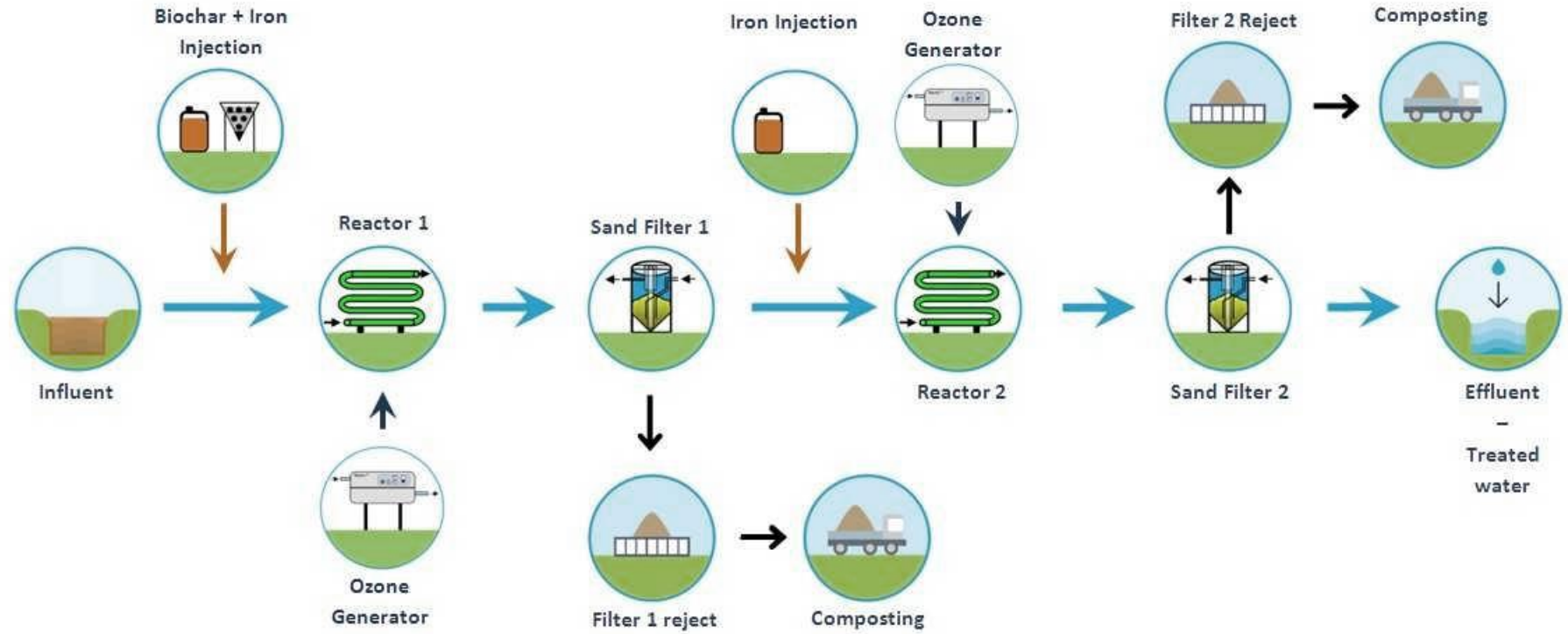
**BE STRONG ENOUGH
TO STAND ALONE,
SMART ENOUGH TO
KNOW WHEN YOU
NEED HELP, AND
BRAVE ENOUGH TO
ASK FOR IT.**

TEAM FORMATION

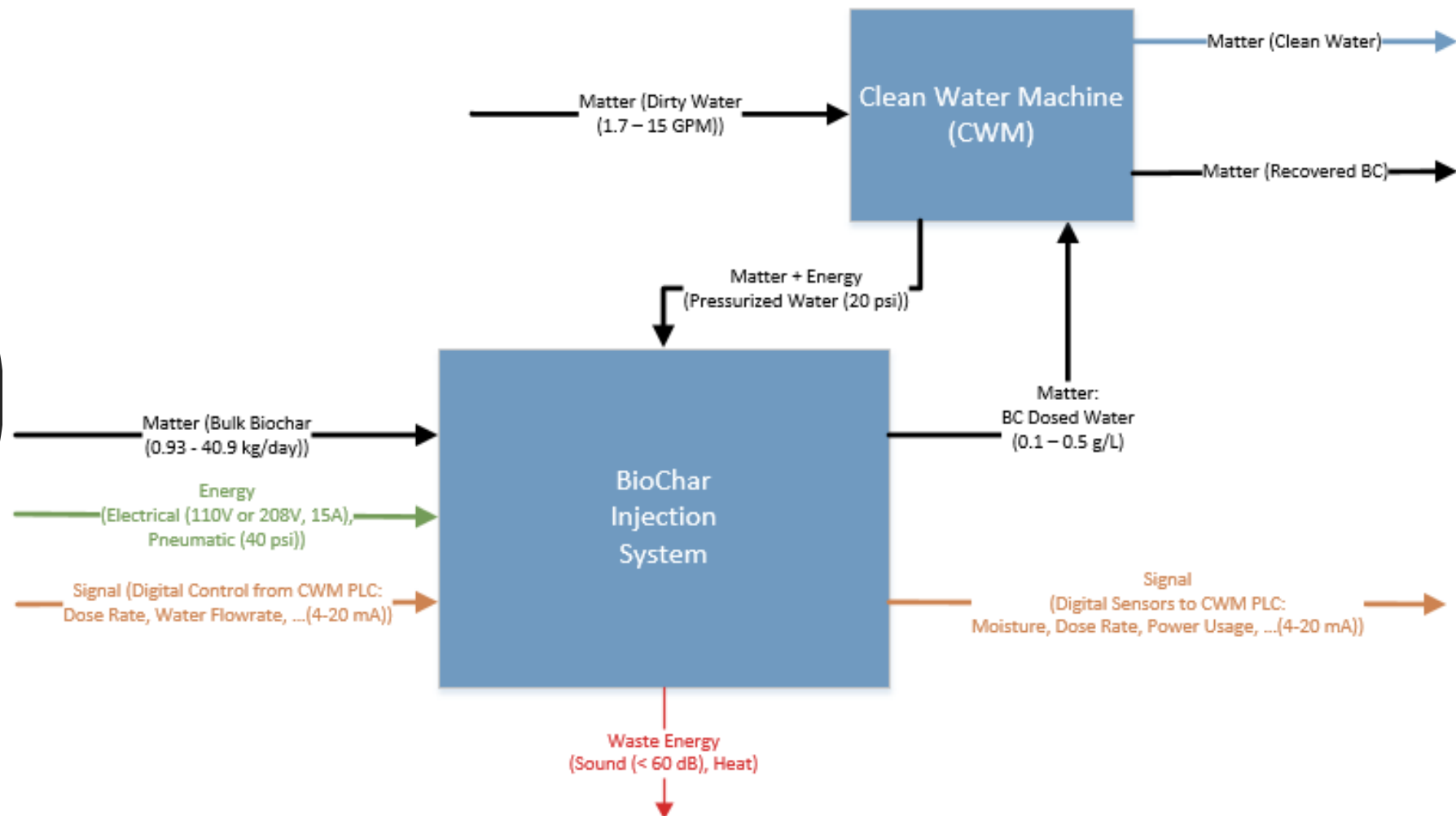


Tuckman Model (1965)
"Developmental Sequence in small groups"

Process Diagram



Function Diagram





Questions?

