PROJECT III: DESIGN/BUILD

Systems Thinking: Week 15

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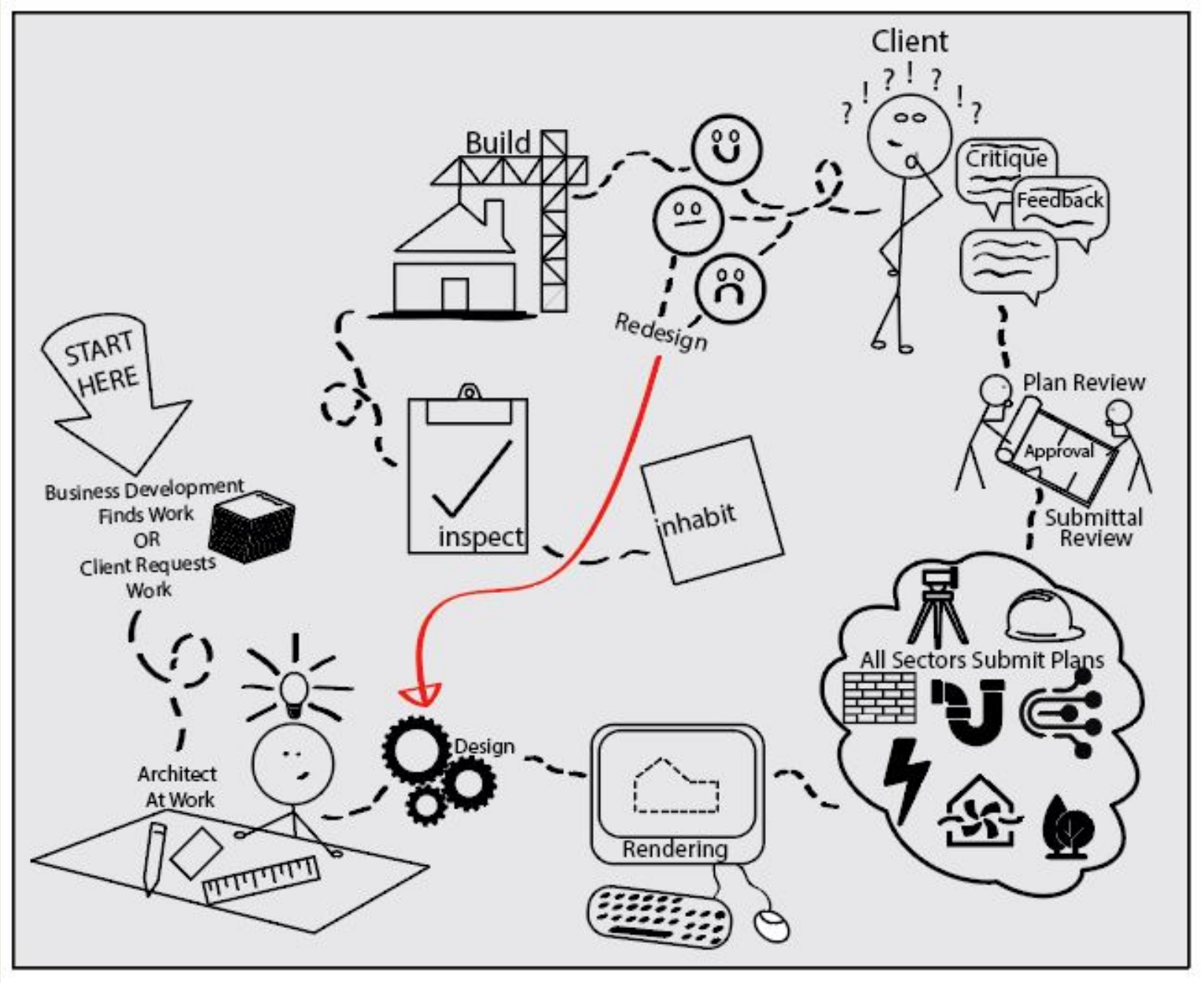
The design/build process is a routine system with the same set of steps repeated for each individual construction/renovation project.

The design/build process typically follows the same steps to achieve the same basic outcome every time: a space or place that fulfills the need of the individuals that utilize it.

- **System Boundary:** The boundary of this system is feasibility. Design must be innovating and appealing, but it must also be feasible. Feasibility can apply to not only the structural integrity of the design and build, or the materials used, but also to the timeline, budget, and wants/needs of the client. Regulations (environmental and otherwise) and safety requirements must be met. If this criteria is not reached and accounted for then the entire system collapses.
- **System Function:** Meeting and exceeding the established requirements of the project is the primary function of the system.
- **System Behavior:** Following the established system provides a way of tracking progress from exploration to implementation. The system is effected by the amount of input received, and the amount of output is effected by the progression from step to step.
- **System Process:** There is a process that an individual designer, design rm, or contractor establishes to ensure that project deadlines are met. There is a quality standard and established method for submitting documents to clients, contractors, and governing officials for review. Regularly scheduled plan reviews are mandatory and must be completed as directed. For the system to progress from step-to-step, the proper procedure must be followed.
- **System Patterns:** Patterns that can be observed are branching patterns between the designer/design team and the client and any individuals the client involves in the design process on their end. There are often numerous individuals collectively requesting the work that is to be done and thus there can be many opinions that must be heard and digested. Additionally, the feedback often follows a circle or spiraling pattern: depending on the level of success when interacting with a client, there may need to be many sessions for client review and feedback. Construction itself follows an established order to ensure safety and soundness of a building or space.
- **System Shape:** There is often a clear path from exploration to implementation but there can be a circular aspect to the system if numerous redesigns are required due to changes in opinion, budget/scope of work, and time frame. Often critiques are given/received in a round table format where individuals view the work from various angles. Due to the size of the group, individuals may need to sit adjacent to one another to adequately view the work and accommodate all persons viewing the work. The same is true for city planners to view the proposed work. Interaction with contractors and sub-contractors often follows a more back and forth approach where questions and problems are addressed in real time.
- **Living System Subsystem:**
  - Producer: individual(s) responsible for the design
  - Boundary: timeframe and feasibility of implementing the design
  - Ingestor: individuals that will be using what is being created
  - Supporter: materials/technology used to create the design
  - Decider: client/project owner
  - Tranducer: feedback leads to progress

Creating a rich picture -

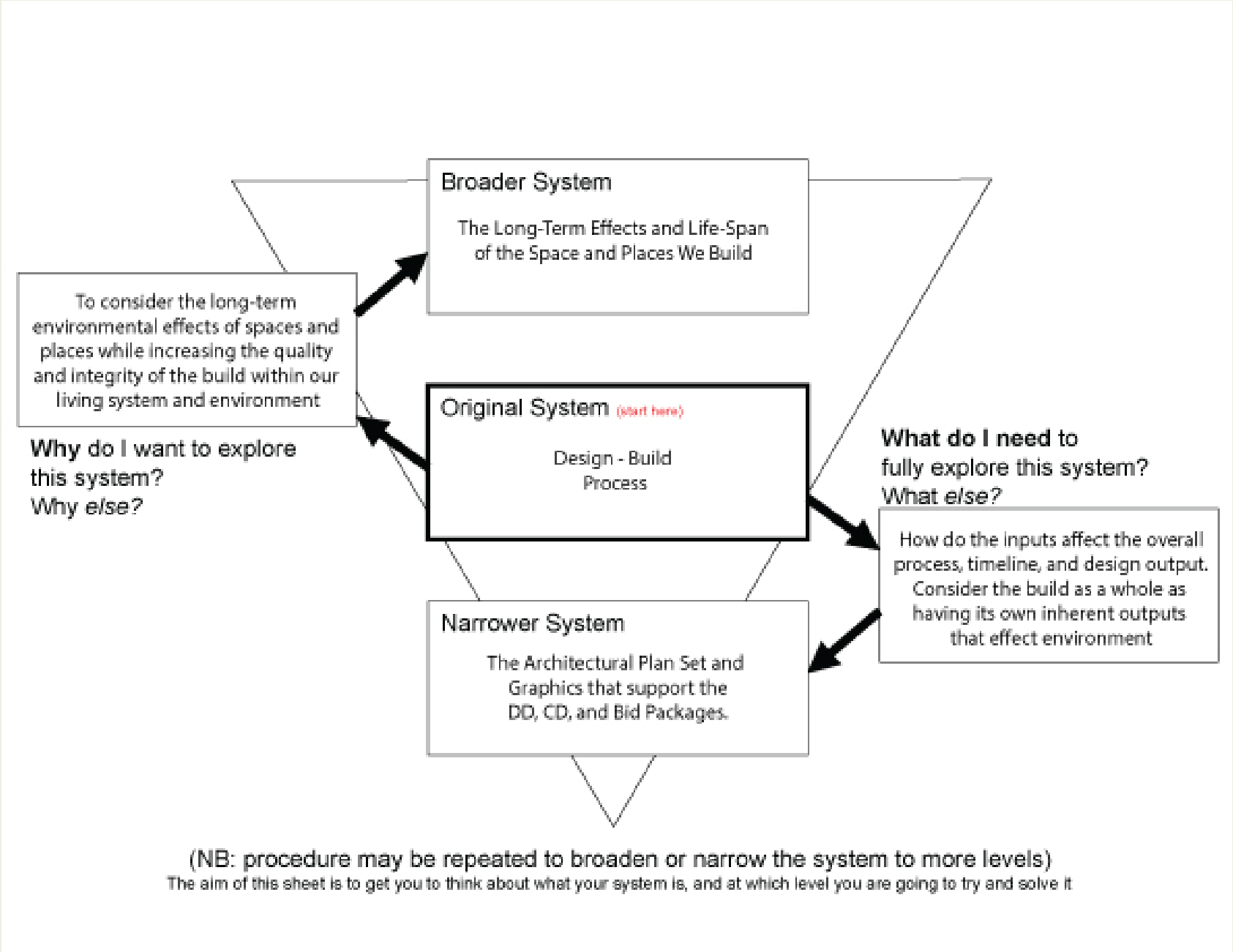
- Boundary = Feasibility
  - *Design phase must employ realistic design ideology that fulfills a need and that can be implemented successfully.*
  - *Build phase must employ adequate labor and equipment to meet vision.*



C.A.T.W.O.E.

- **CLIENT//** owner of location where construction is to be completed.
- **ACTORS//** architect, engineer, marketing, business development experts, design drafter, project coordinator, additional design team members, contractors, sub-contractors, client, inspectors.
- **TRANSFORMATION//** fulfilling a design need to rework an existing space or provide a new space that meets project requirements and code requirements.
- **WORLDVIEW//** needs to provide a space that serves a purpose and meets the needs of those who use it.
- **OWNER//** Business, building, or property owner
- **ENVIRONMENT//** LEED certification, historical preservation credits, and remediation of hazardous materials.

What is the system?



Resources -

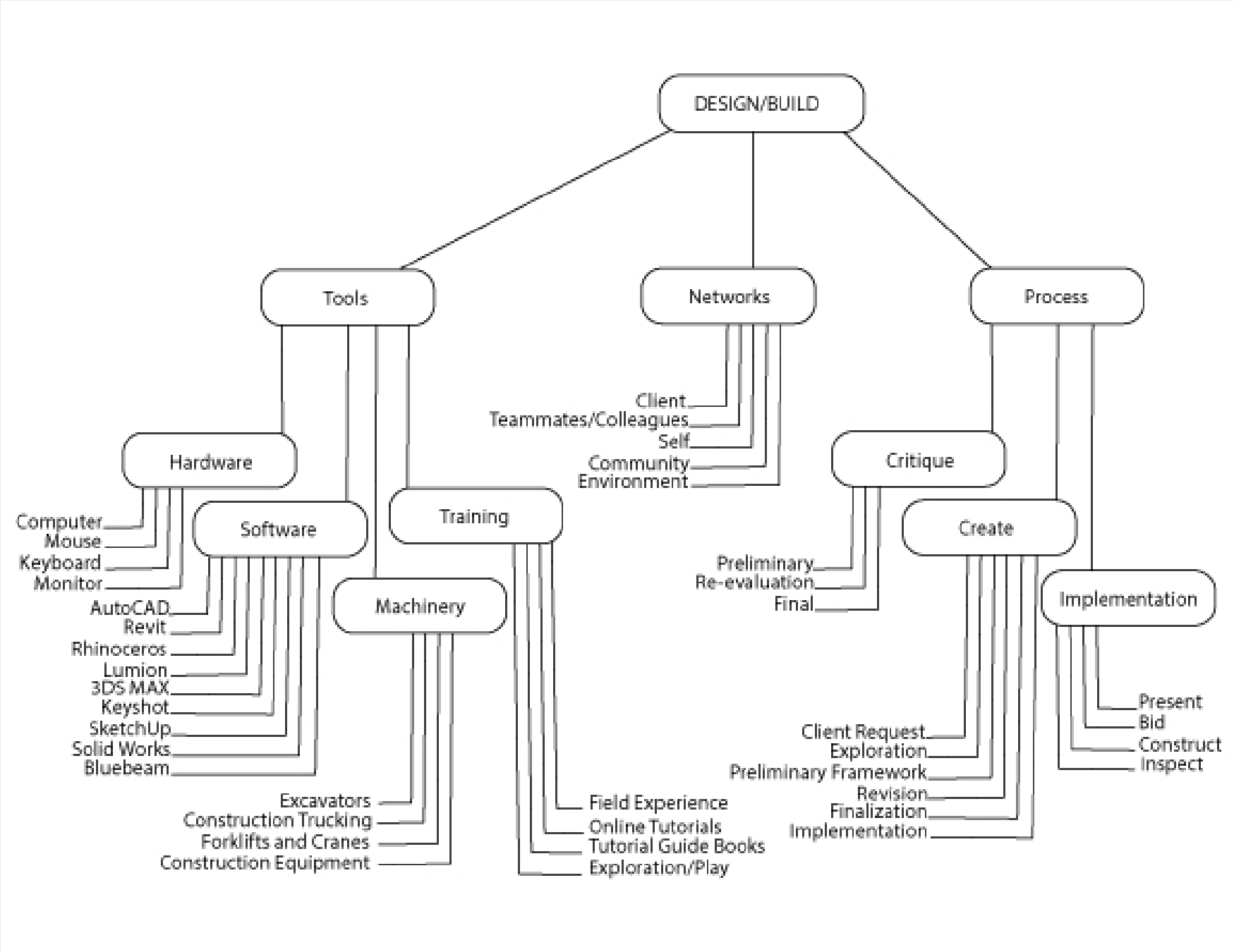
	Past	Present	Future
Around the system	Printing Materials Past uses of location Material Remediation	Budget Constraints Environmental Concerns	Addenda Life Safety Assessments Inspections
System	Site Assessment Framework Material Selection	Preliminary Design Critique - team collaborating with client Revision Materials Changes	Reassess Implement Bid Out Work Sub Out Construction Labor Force
Within the system	Client Input Design Need Established	Time Constraint RFQ and RFI Response times Submittal Turnaround	Construction Documents Groundbreaking Permits Punchlist

Constraints -

	Past	Present	Future
Around the system	Client Interest Skill Level of Designer	Internet Access Requirement Access to Program Licenses	Design Timeline Material Leed Times Future Impact
System	Site Assessment Space Allotted Historic Preservation	Existing Conditions Material Selection Availability	Completion Date Longevity of Building
Within the system	Addenda Change Orders	Design Checkpoints	Client Satisfaction Safety Lasting Effects

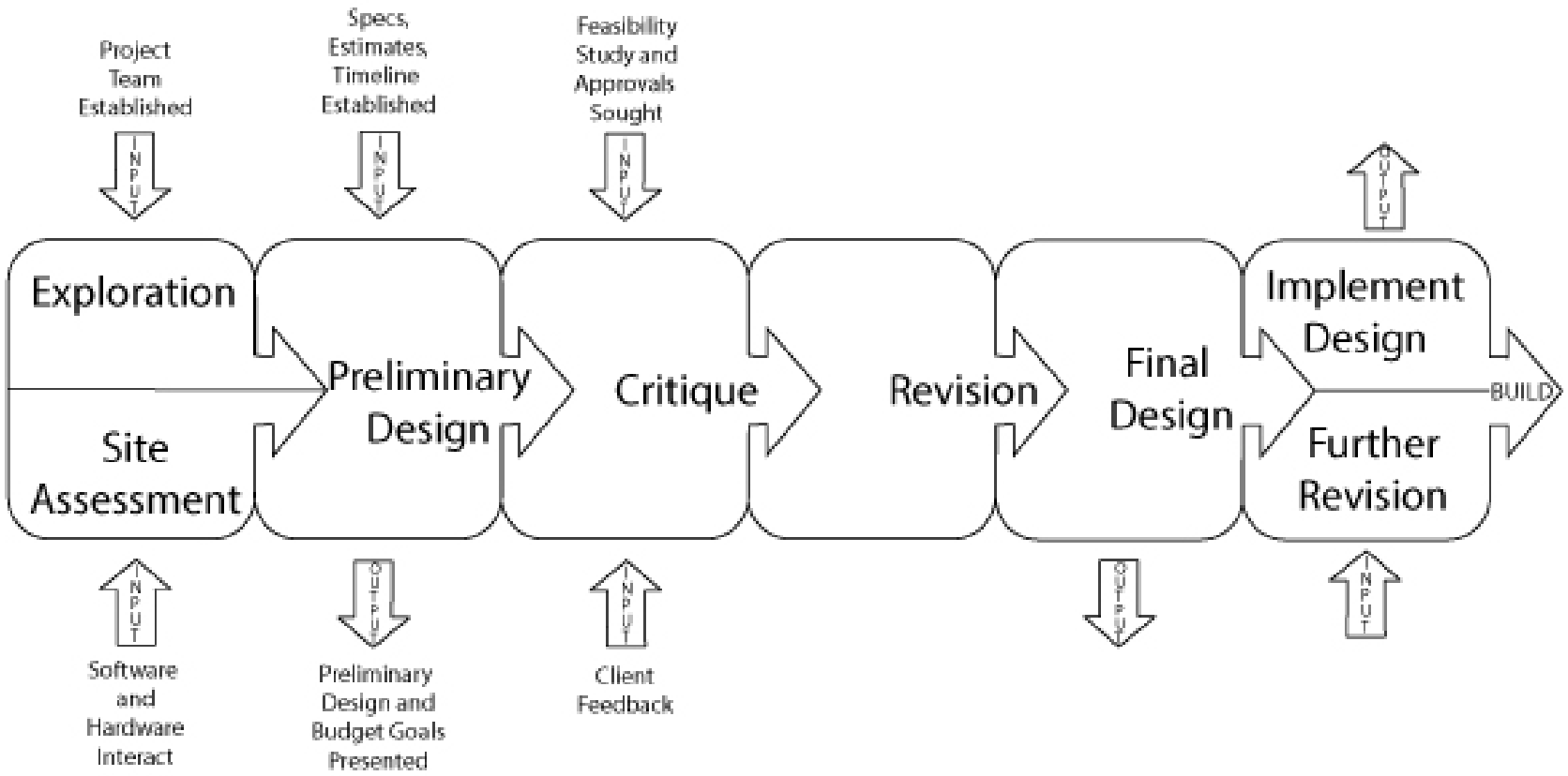
Hierarchy – Designers View

Structure Type: This diagram shows the hierarchy of the different parts of the overall system and how different concepts and requirements nest beneath them.



Modules – Client View

Structure Type: This diagram shows the modular process of steps that make
up the whole system. While there are inputs and outputs that effect the flow
of the system, each piece is essential to the overall goal.



How does time affect the system?

Past	Project Timeline to Substantial Completion	Future	Building Lifespan and Lasting Effects

Time equals money

Estimated Hours/Time Allotted is Established

Hours/time is not enough

Client doesnt agree to original time allotted hours

Client requests changes that will affect hours/timeline

Design is not approved by local governing bodies

Client Has Different Environmental Values Than Regulations Demand

Environment/Contractor affects the timeline

Technology changes and New Regulations Arise

Designed Obsolescence

Problems with the system -

- There are many points of conflict within the Design-Build process.
- Many of these conflicts can be resolved with clear communication within the design team and with the client, through redesign as needed if environmental or aesthetic concerns arise, and through time and diligence from the project team and the labor force.
- Several points of conflict and issues of feasibility stem from:
  - *The outlook of long-term environmental concerns*
  - *Material availability and specification requirements*
  - *The unknown that comes with renovating existing buildings and historical buildings or planning for new construction on a project location that has an undocumented history of previous use or a challenging terrain and environment.*
- These issues are quite common and can be addressed through 3 by learning from 3 systems methods:
  - *Closing the loop*
  - *Adjusting the systems structure*
  - *Learning from nature (biomimicry)*

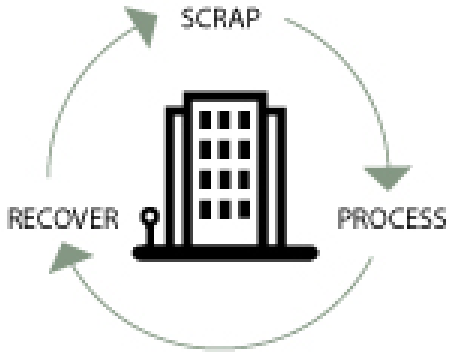
System Solution 1:

"In 2010 alone, an estimated 104 million tons of materials flowed in from project sites all over the country, accounting for as much as 40 percent of the U.S.'s annual solid-waste stream. The garbage comprises not only rubble and rotting beams, but also countless odds and ends from new construction such as cast-off nails and packaging." (Arch Mag)

Considering the implications of properly reclaiming and recycling building material is of extreme importance.

Contractors and owners alike must consider how to properly dispose of construction materials that are outdated, out of compliance, and unable to function.

Inplementing a closed loop construction system through closely monitoring material life cycles and apopting the Kohler Waste Lab system approach of recycling spent materials into new and refurbished products will drastically improve the percentage of construction and demolition materials entering the waste stream.



https://www.architectmagazine.com/technology/recycling-building-materials_o
https://kohler.design/kohler-waste-lab-dust-to-tile/

Implementing System Solution 1:

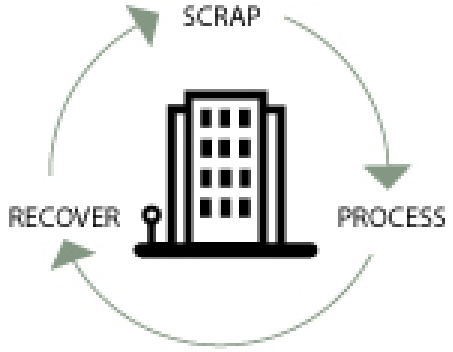
By implementing mandatory waste reintegration divisions modeled after Kohler's Waste Lab, and providing incentive programs to manufactures for participating, advancements toward creating a closed-loop system on an industrial level where waste stream materials will be reclaimed by the original manufacturer to be reprocessed into redistributed can be achieved.

https://wastelab.kohler.com/

Methods to Implement:
- Corporate tax break incentives to qualifying participants

-Discounted energy costs through partnership with utility companies to provide lower rates for rmaterials that are refabricated and reprocessed.

-Rebates program to encourage contractors and designers to discpose of materials properly to ensure they are salvaged by the manufacturers.

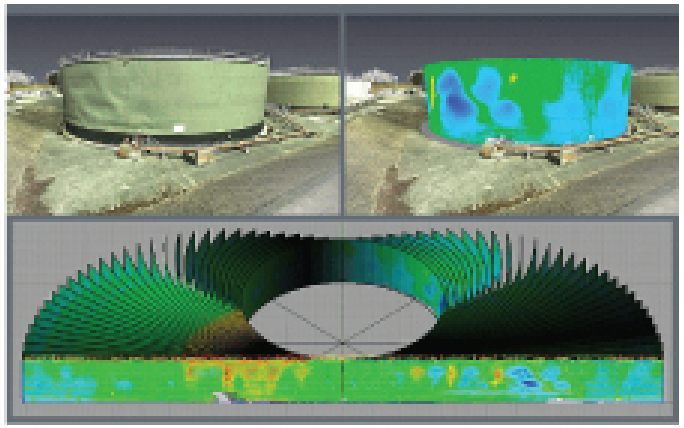


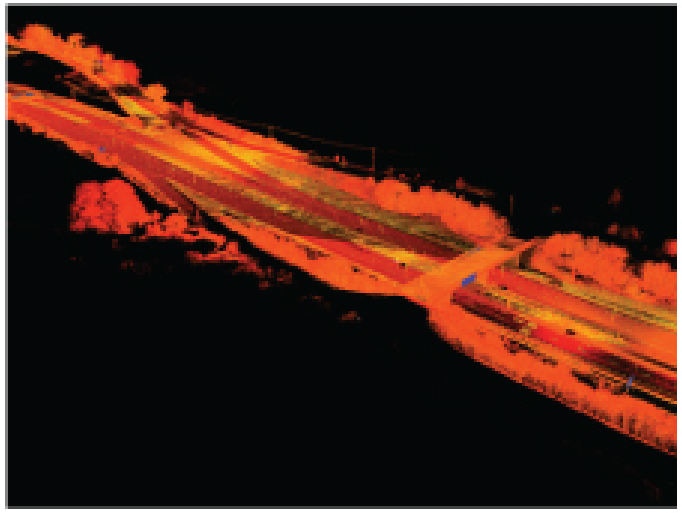
System Solution 2:

By adjusting the system structure and considering the implications of promoting a behavior change within the design-build system to incorporating preliminary 3D scan of the site into a broader range of projects can reduce uncertainty regarding unfavorable conditions, terrain, and past use of the site. It can expedite the remediation process for hazardous materials by informing the project team sooner so that unknown issues do not draw from the contingency fund and by providing a better view of the issues which greatly reducing the potential for accidental environmental contamination and laborer injury by hazardous material contact.

Thanks to advances in 3D scanning techology, scanning and the processing of scans is now more affordable and is a viable option for designers and contractors who, "can also use reality capture to produce construction documentation, such as progress milestones and quality control reports. Using 3D visualization, project stakeholders can "visit" a site from any location. Issues related to costs and scheduling for travel to project meetings are significantly reduced, and meetings can take place with greater frequency and flexibility. Shared visualization ensures clear, efficient communication and informed decisions." (Gim)

https://www.gim-international.com/content/article/low-cost-3d-scanning-solution-for-high-value-deliverables
http://www.laserscanning.co.uk/





Implementing System Solution 2:

Adjusting the systems structure and implementing 3D scanning as a standard phase of the design-build process, "laser scanning lowers risk by ensuring as-built drawings are complete and accurate and by exposing any inaccuracies early in the process, before they turn into change orders during construction. On a typical construction project, rework accounts for 12 to 15 percent of the cost of construction. With laser scanning, the ability to catch conflicts before they happen has been shown to reduce rework to 1 to 3 percent. This reduction translates into hundreds of thousands of dollars in savings on change orders, not to mention the advantage of keeping the project on schedule.

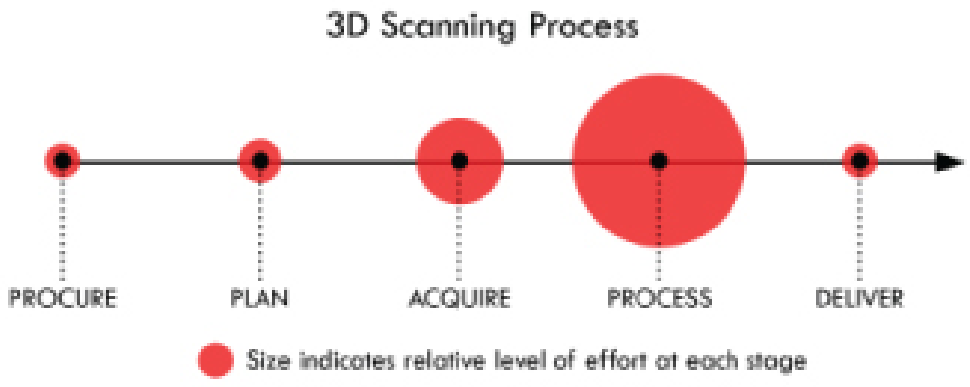


Figure 10- Level of effort

https://www.truepointscanning.com/construction
http://bim-level2.org/globalassets/pdfs/clients-guide-to-3d-scanning-and-data-capture.pdf

By including a 3D Scan cost estimate into the site inspection budget, the cost of the scan will be covered and the long term benefits of over-preparation will provide a quicker building process and decreased uncertainty.

"Doing a preliminary investigation to see if there are environmental risks is very important. If it is found that there is potential for any possible environmental factors, beginning with 3D scanning can alleviate large amounts of cost and potential interruption of your schedule. More often than not environmental factors when found on the go, will have a large effect on your critical path. Whereas when you take the preliminary action to perform a 3D scan of the area you will be able to find which ever issues the site might have and remediate them in a timely fashion." -JH, Mortenson Construction

System Solution 3:

A biomimicry approach to the design-build process can streamline the process and reduce material waste.

"Large tusks (upper canines) occur in both sexes and are used in defence against predators, for breaking through ice, in intraspecific strife, for hooking over the edge of ice for stability while sleeping in the water, and as aids to hauling out and locomotion on ice (Belopolsky 1939; Burns 1965; Chapskii 1936; Collins 1940; Fay, unpublished data; Loughrey 1959; Nikulin 1941,1947; Ognev 1935; Pedersen 1962).

This is a "Great example of the life principle, 'Optimizing rather than maximizing'. Animals will make the most of any feature they have. For instance, the walrus tusks can be used for climbing, fighting, digging tool, plow up sediments. Has multiple functions so it's worth the energy to create."
-Emily Harrington

https://asknature.org/strategy/tusks-are-multifunctional/#.X8MEBGhKjIU

Implementing System Solution 3:

Learning from the Walrus, and viewing project material uses as adaptable can save alot of money and hassle. When human error results in the miscalculation of material needs or material segments are damaged in transit, field repair work or field customization when feasible can be done to decrease waste and avoid project delays.

"Through adaptation and design changes we have been able to repurpose segments of the structural steel, instead of having to reorder and trash the original pieces, through careful refabrication and recalculation we are able to repurpose certain segments of structural steel."
-JH Mortenson Construction

"Structural steel produced in the United States contains 93% recycled steel scrap, on average. At the end of a building's life, 98% of all structural steel is recycled back into new steel products, with no loss of its physical properties. As such, structural steel isn't just recycled but "multi-cycled," as it can be recycled over and over and over again. It is truly a cradle-to-cradle material."

https://www.aisc.org/why-steel/sustainability/
https://www.bdcnetwork.com/7-ways-economize-steel-buildings
https://www.gettyimages.ae/photos/orion-drilling-co-oil-rig-manufacturing-operations?sort=mostpopular&mediatype=photography&phrase=orion%20drilling%20co%20oil%20rig%20manufacturing%20operations

Specifying standard steel lengths rather than specialty sizes seems like a no-brainer, but it's too often ignored, says AISC's Stine. For instance, ordering 20 20-foot sections is significantly less expensive than ordering 10 20 1/2-foot sections because it eliminates having to cut to size, scrapping extra steel, and paying for unusable remnants.

Updating the rich picture -

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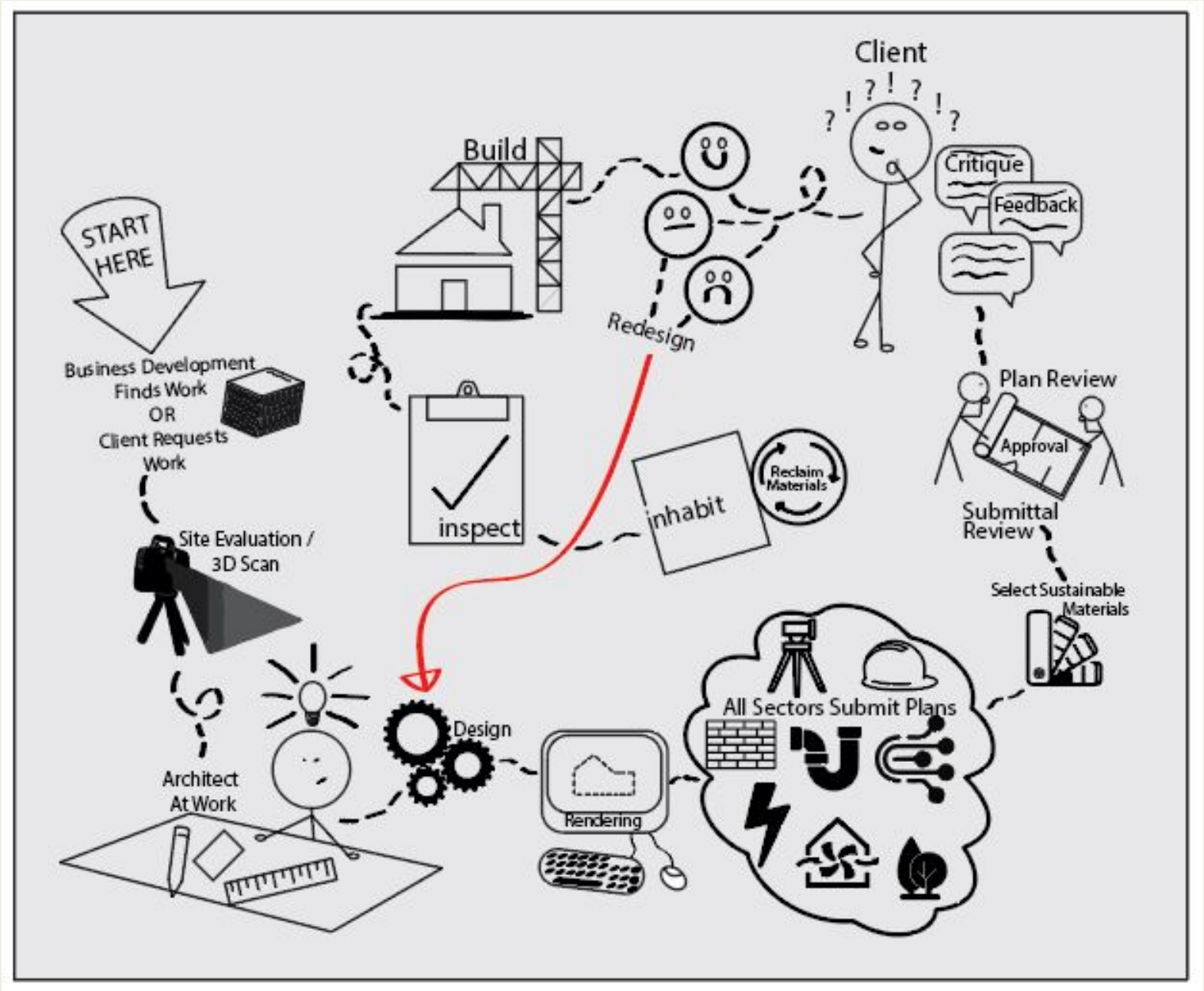

Reflections -

- **What did I learn?** I learned that the architect/designer and the contractor have varying opinions and levels of importance places on materials and their affect on streamlining the timeline and saving money.
- **What can I do with my knowledge?** Implementing more “inspired by nature’ processes is one way I can implement the knowledge I have gained through this course and this systems exploration.
- **How can I alter my process?** My current design process focuses heavily on functionality and less on thinking outside of the box because I am a young designer and my main goal is to please the client so I am afraid of taking risks and suggesting an alternative design or material that may not be well known or well received. Overcoming this fear is an important next step in my design process.
- **What else do I want to know?** I would like to focus more of the data and figures that go with LCAs as this would be an important aspect of continuing to incorporate life cycle, breakdown, and product longevity into my designs.


Thanks for stopping by!