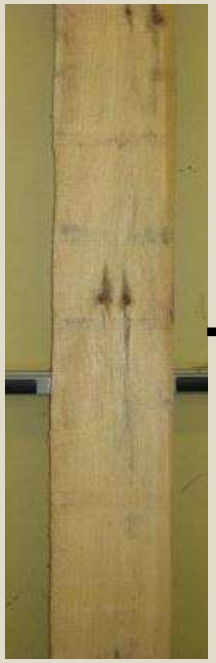
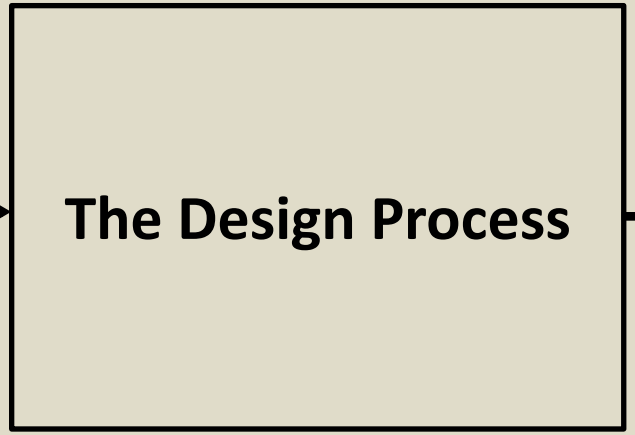
The Design Process

Or… How to Get From…



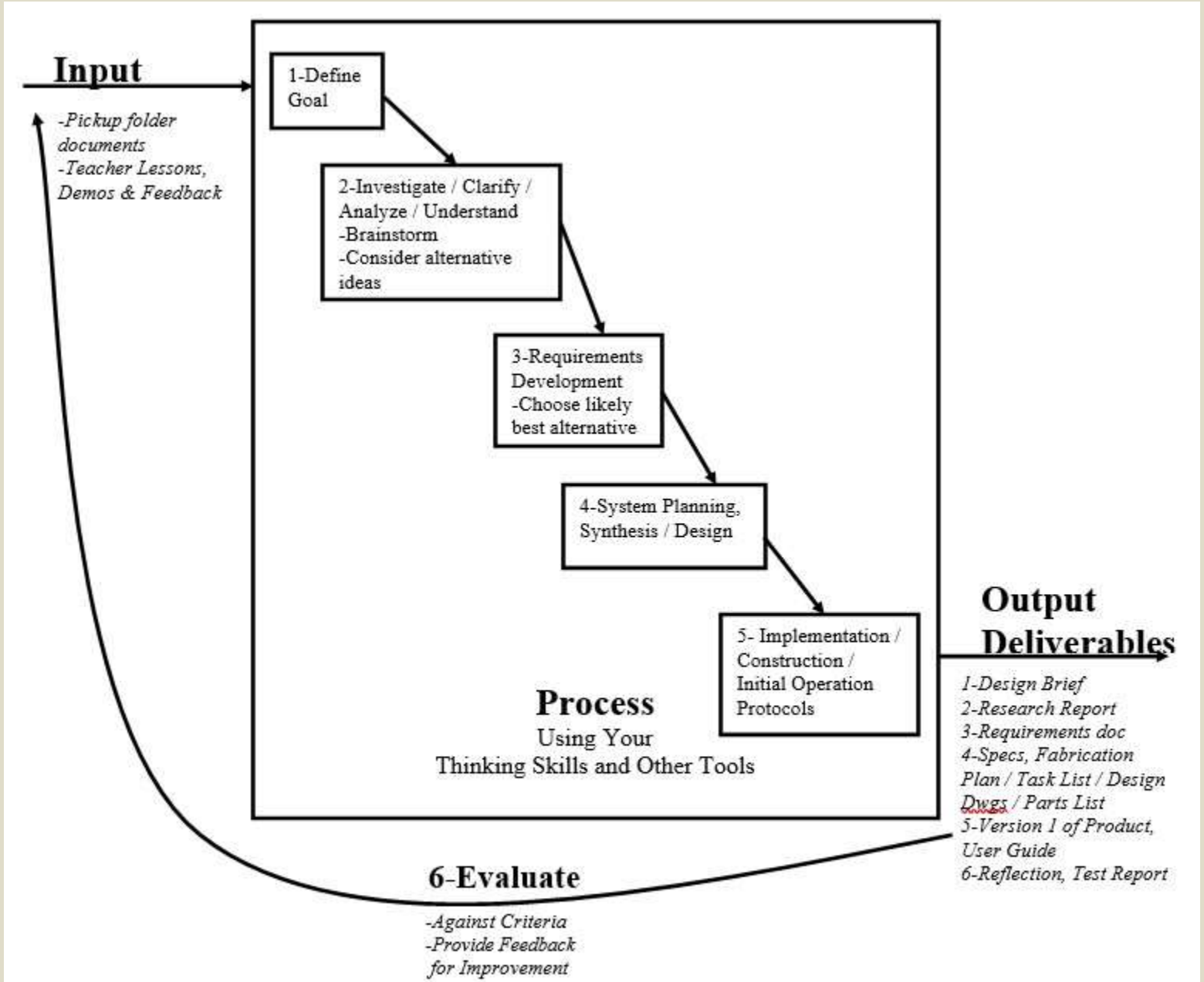
Raw Material to…



Watertight, Glueless ,
19 Piece Wooden Barrel

What is the Design Process?

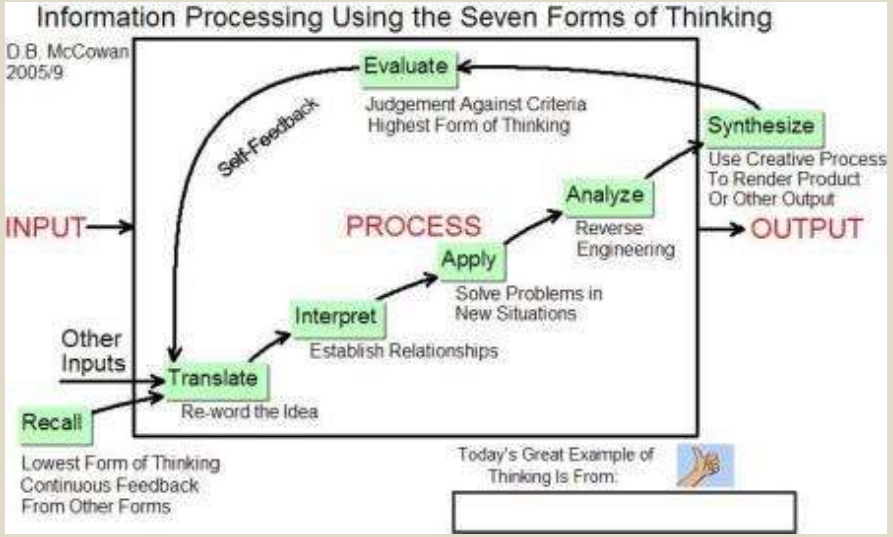
- The Design Process is absolutely fundamental to people who want to be innovative and creative.
- As a subset of “Problem-Solving”, the design process is the essence of Technological Design and a foundation for socio-economic progress.
- In very simple terms, the great bulk of the “content” of a Technological Design course is the “design process” itself.
- It is important to note, however, that there is no such single thing as “***The*** Design Process”.
- Students must appreciate that the design process itself is evolutionary -- this is very important in the sustainable society context.


Input
-Pickup folder documents
-Teacher Lessons, Demos & Feedback
1-Define Goal
2-Investigate / Clarify / Analyze / Understand
-Brainstorm
-Consider alternative ideas
3-Requirements Development
-Choose likely best alternative
4-System Planning, Synthesis / Design
5- Implementation / Construction / Initial Operation Protocols
Process
Using Your Thinking Skills and Other Tools
Output Deliverables
1-Design Brief
2-Research Report
3-Requirements doc
4-Specs, Fabrication Plan / Task List / Design Dwgs / Parts List
5-Version 1 of Product, User Guide
6-Reflection, Test Report
6-Evaluate
-Against Criteria
-Provide Feedback for Improvement

A Superset of "Issues" and "Questions to Ask" During Design Work

- Simple problems generally require only a simple inquiry and design process.
- More complex design problems obviously require a much more rigourous inquiry and design process details.
- On the following slides are activities to undertake in a typical application project in each stage of the design process.

- The student can use higher thinking skills to determine which criteria are probably the most important in the given application.
- Moreover, there can be some overlap -- investigation and analysis leads directly into Requirements Development for example.



Explore the Situation as Presented to You

GuelphChamber.com

- Explore the situation at a reasonably deep level of thinking
- Is there a problem to solve somewhere in here? Does it seem big... is it a small problem?
- Is there an opportunity to realize somewhere in here? Could this be a big job ... small job?
- Is there something here that I can address such that I can both add value to society and grow as a problem-solver?
- Re-state the situation in your own words -- translate some key information into a more useful format to give yourself some decision-making direction

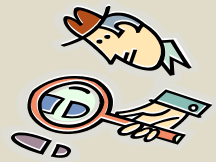
Developing a Focus and Recognizing the Problem / Opportunity

- What do I already know – ie “recall” -- that seems relevant to this situation?
- Establish at least a preliminary or initial understanding of the system environment
- Preliminary research -- ask questions and inquire of others
- Make a sequential logical list of issues or a concept / mind map relating basic situation factors to one another (for example)
- Isolate and clearly define the problem, challenge or opportunity
- **Main Written Output summary** - Concept / Design Brief -- Briefly explain your goal and "***Why my proposed Product or Process is so important***", thus giving you the motivation to succeed.

Initial Preparation -- Set up Your Framework for Staying Organized on a Project

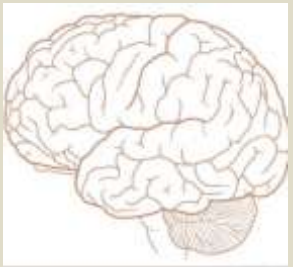
- Take a step back: if there is a problem for you to solve or an opportunity for you to realize, are you ready to tackle it?
- Depending on the size of the problem / opportunity, establish your requirements for your Design Portfolio – how do you want to communicate your solution process to people who need to know (eg for brainstorming notes, research report, sketches, design brief, requirements, drawings, parts list)
- Design your Portfolio document template – your personal design for how you want to communicate elements of your project to others
- Start the Table of Contents (TOC) for your Design Portfolio -- list your Portfolio Template, Portfolio Requirements and Design Brief at this stage – and make a commitment to updating your Portfolio Table of Contents at least weekly

Detailed Research Investigation and Analysis



- Consider a wide variety of inputs from a range of sources, including industry standards
- Assess the integrity, adequacy and appropriateness of the research resources
- Sort / organize the raw research data in a reasonably structured manner (such as in a table according to the 13 fundamental concepts of technological education)
- Model or abstract the system -- simplify it for better understanding
- Identify parameters (ie variables) that could affect product success
- Identify important functional subsystems
- Identify and analyze some previous attempts to solve this or a similar problem – their successes, failures, impacts and consequences
- Re-categorize, reduce, interpret and analyze the research data in order to help draw some justifiable preliminary concluding statements
- **Main Written Output** -- Research Report Version 1

Generating a Set of Alternatives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- Generate a variety of initial alternative ideas by brainstorming with colleagues -- “let your imagination guide you” -- brainstorming is very unstructured, but record and save your notes from the brainstorming session
- Create rough sketches or models for a reasonable subset of the alternate ideas
- Add short notes to the sketches including the pros and cons of each alternative – pros and cons should be related to design parameters that you have initially identified
- **Note**: You do not make a decision at this point. You should update your research report to version 2 with a new section on your brainstorming and alternative ideas.

Requirements Development and Choosing a Likely Best Solution Concept

- Identify the constraints that confront you or limit your options (cost, time, materials, tools etc. that are beyond your control)
- Establish clear prioritized requirements relating to each of the 13 fundamental concepts of technology as well as issues such as modularity and end-of-life
- Note that the Requirements may ultimately be used as the starting point for a test plan
- Evaluate each of the alternative ideas against the requirements in a careful and organized manner such as a scoring or ranking system
- Choose the one (or perhaps two) alternate ideas that you believe are most likely to succeed
- Defend and document the final selection of alternative solution idea on the basis of clearly stated rationale. Record your decision-making for future reference.
- **Main Written Output** -- Requirements document -- This is where you explain in reasonable detail ***"This is what my proposed product or process must do or achieve and what it must look like."***

Project Organization and Management
Who Does What By When

- Write an overview of how the project should proceed including consideration of industry standards
- Break down the overall design idea into optimal sub-systems
- Define and document the interfaces between subsystems – define the required outputs from each sub-system
- Decide which team members are responsible for which sub-system (both design and build)
- Estimate risks and prepare contingency plans (Plan B, Plan C etc.)
- In a structured table format, assign tasks to team members with due dates and create a timeline or critical path diagram
- **Note**: If your personal day-by-day Task List is well-planned, then your daily journal is as simple as adding another column or two to the task list (*Completed On Date*; *Issues Yet to Address* or *Comments*)
- **Main Output Deliverable** – Task List

Name	***Task***	***Due Date***	***Status***

Design Planning – Drawings and Specifications

- Write implementation specifications -- generally “how to make it”
- Produce detailed descriptive, shop and assembly drawings using CAD software
- A shop drawing must be complete enough that another student could make exactly what you want him / her to make without seeking any clarification
- Produce parts and materials lists in table format (bill of materials – with columns for quantity, description, part name, material, supplier)
- Identify the sources for acquiring all parts (whether to be found by you, provided by the teacher, or scrap in the shop)
- Write fabrication plans and any procedures that must be followed (for both safety and production of parts)
- All project documentation must include information pertaining to the project title, author’s name, date, version number of the document
- **Main Output Deliverables** -- Implementation Specifications such as CAD drawings, parts and materials list and fabrication plans. This is where you provide the details of ***"Exactly how we will get everything done on time and on budget".*** (The Task List addresses "Who will do it")

Implementing the Solution / Fabricating the Product

- Produce version 1 of the product according to the design specifications and the stated procedures and fabrication plan – version 1 may be a relatively simple prototype or even a non-functional scale model)
- Against your test protocols, evaluate each subsystem as it is created -- check (test) the outputs of each subsystem against the interface requirements
- Apply the specified “finishing” treatment to each part (smoothness, colour etc.)
- Assemble all parts
- **Main Outputs** -- User Instructions, Marking Labels and, of course, the physical product itself

Reflecting on the Process and Product

- Prepare test plan and test scenarios that reflect the product Requirements and the User Guide
- In some cases, Methods of Test should be written
- Evaluate / test the Product against the specified Requirements
- Write the test report
- Re-design, re-document, re-work and re-test as necessary
- Submit to Third Party Testing and Certification for an independent validation that the product meets the relevant industry standards
- Acceptance by the customers (eg verbal presentation to the class / teacher)
- Summarize “what went right, what went wrong” with respect to process and product – the “lessons learned” or "reflection" document
- Propose improvements for Version 2 of both the product and the process used to produce the product
- Implement the improvements in the next iteration of the cycle, using a compressed version of the same cycle if appropriate
- If the product you produced does not match the design drawings, then you must produce “as-built” drawings which do reflect the finished product
- **Main Written Outputs** – Test Report, As-Built document set, As-Built drawings, Theory of Operation document and Reflection document