GNG1103 – Engineering Design
GNG1503 – Génie de la conception

Conceptual Design/Ideation

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http://www.e-arc.in/wp-content/uploads/2016/06/e-arc-conceptual_design_artwork.jpg

Agenda

- Quiz 2
- Reminders
- **Review Questions**
- **Generality on Ideas Generation**
- **Documentation Tools for Conceptual Design**
  - Free-Hand Sketching
  - Block diagrams
- **Brainstorming as Ideation Tool**
- **Concepts Generation for** du Ski-Hill Rescue Device Case Study

Reminders

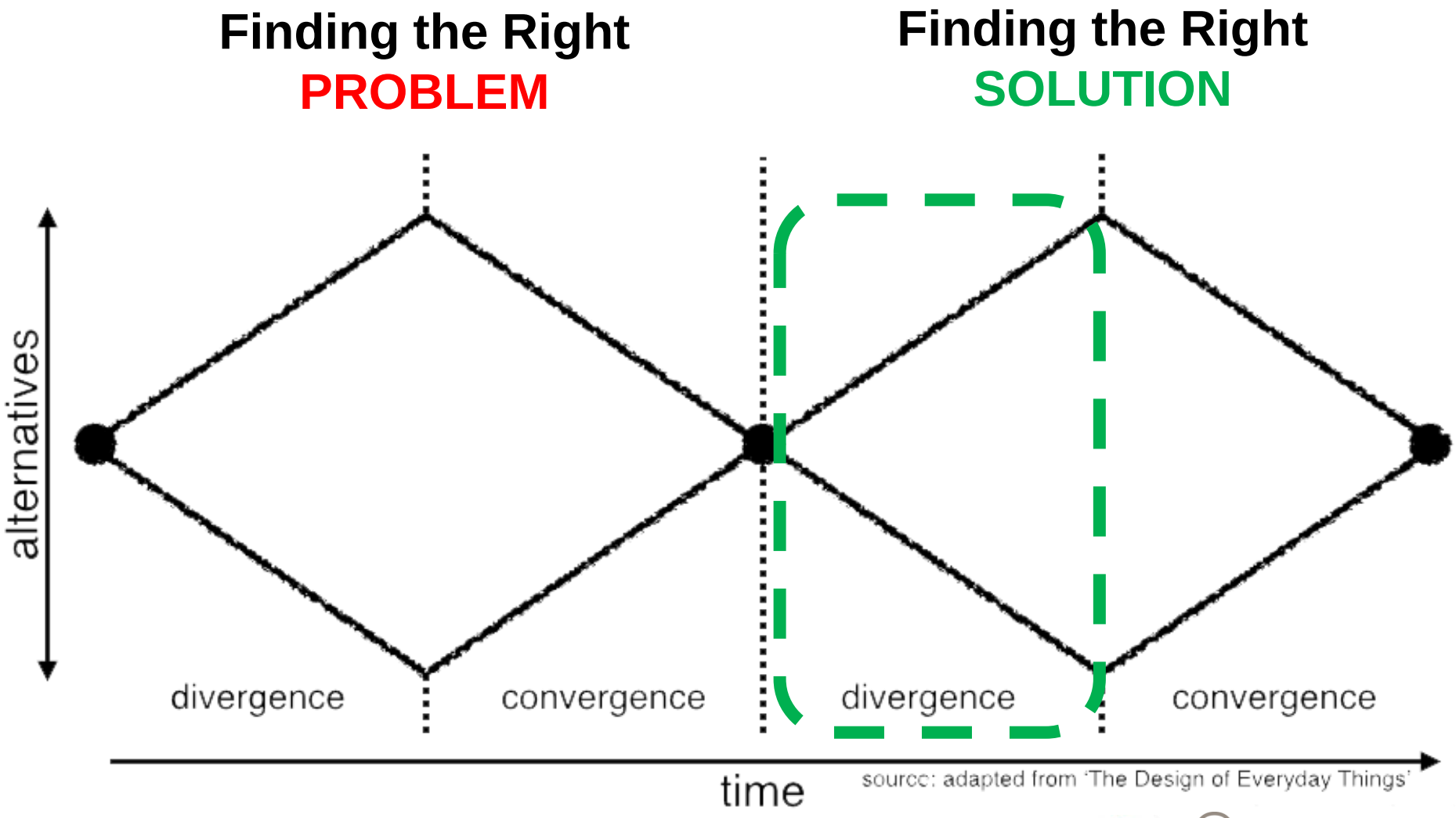
- **Lab 4** (Project): This week
- **Project Deliverable C** (Design Criteria): Feb. 02
- **Project Deliverable D** (Conceptual Design): Feb. 09
- **Project Plan** (Week 4,6,8,10): Weekly review & update
- **Peer Feedback & Team Dynamics 1**: Feb. 16
- What is your summary of **Lecture 7**?
  - Steps of the conflict resolution process
  - Types of conflict and Sources of conflict
  - Possible conflict management styles
  - Factors determining the choice of the appropriate style
  - Best style in conflict management

Review Questions

1. What is **ideation** in engineering design?
2. List and describe **two documentation tools** used in engineering design?
3. Using the **important** design criteria of your course project, produce at least **three preliminary design concepts** that could address your problem statement.
4. In the table below, indicate whether the statements are true or false.

#	**Statement**	**True/False**
1	Finding the right solution in engineering design is only a convergent process.	
2	During the brainstorming session, judgements shall be suspended	
3	Brainstorming in engineering design means generate ideas, suspend judgements and formalize framework.	
4	Conceptualization does not involve analysis and choice of a concept.	

Concept Generation



Design Thinking Process

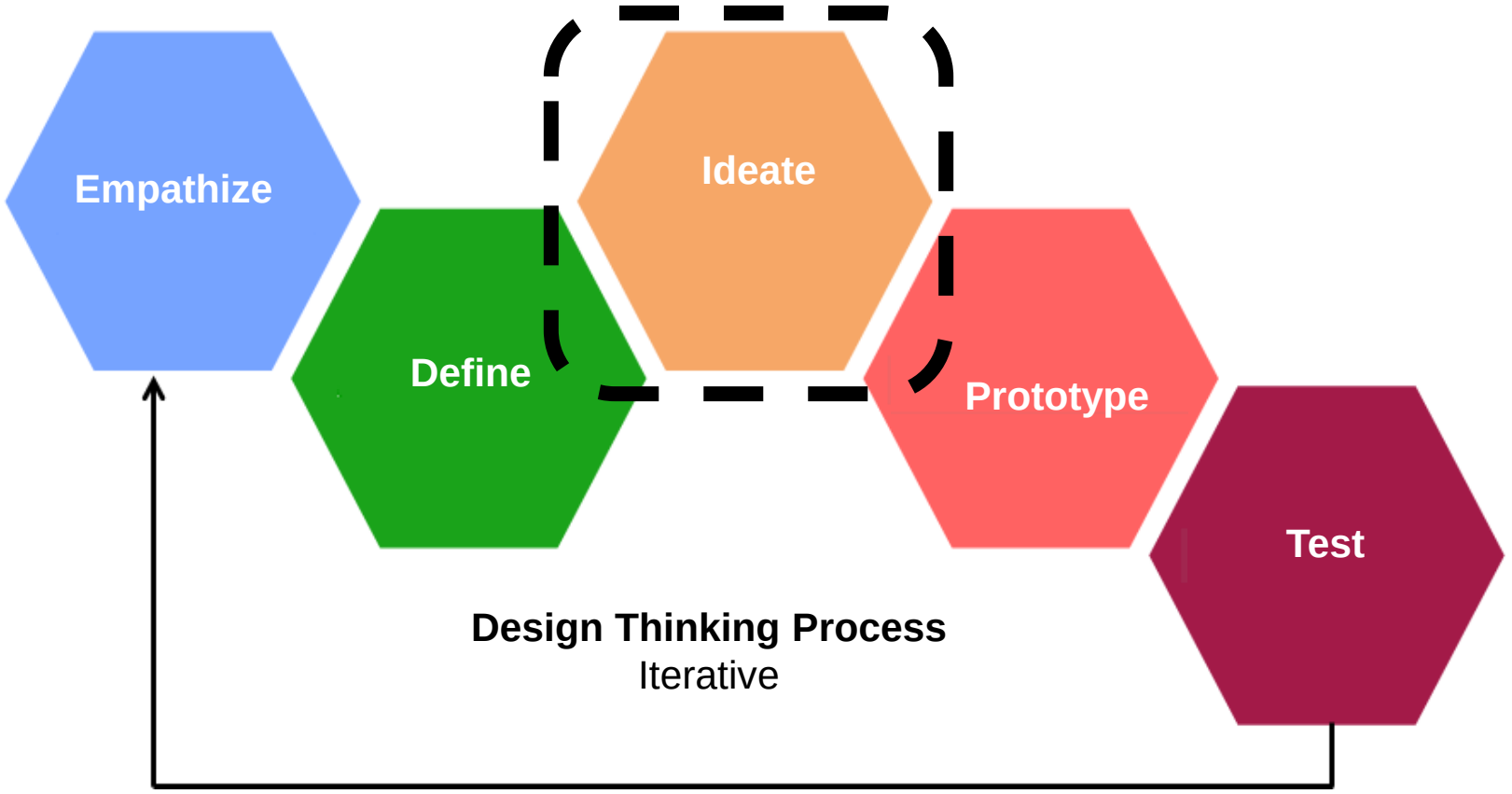


Image from: http://dschool.stanford.edu

Concept Generation

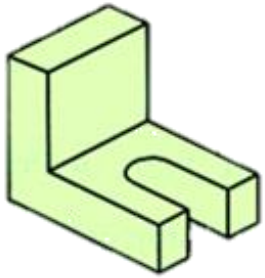
- This is the creative phase of the design process
  - Many preliminary ideas and concepts are generated
- It is a divergent phase where many possibilities are considered without judgment
- For a typical design project:
  - At least three conceptual design alternatives should be generated
  - These concepts should be well documented using sketches and descriptions
- There is no formula or set of rules to generate ideas! Rather, a set of practical strategies to:
  - Help designers enhance their inherent creativity
  - Facilitate the generation of new ideas

Freehand Sketching

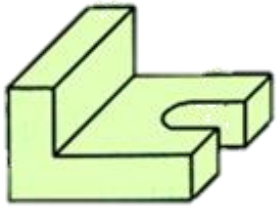
- Usually, freehand sketching is used to explore, study and communicate these design concepts
- The "BEST" design engineers can immediately communicate an idea via a freehand sketch
- **Simple:** all you need is a paper and pencil. Don't use templates and compasses. They will slow you down!

Freehand Sketching

- Although quick, sketches are planned
- Visualize the sketch
  - Size of paper & scale
  - Orientation of the object
  - Minimum detail to communicate the idea
- Type of sketch
  - Isometric
  - Oblique
  - Orthographic



Isometric

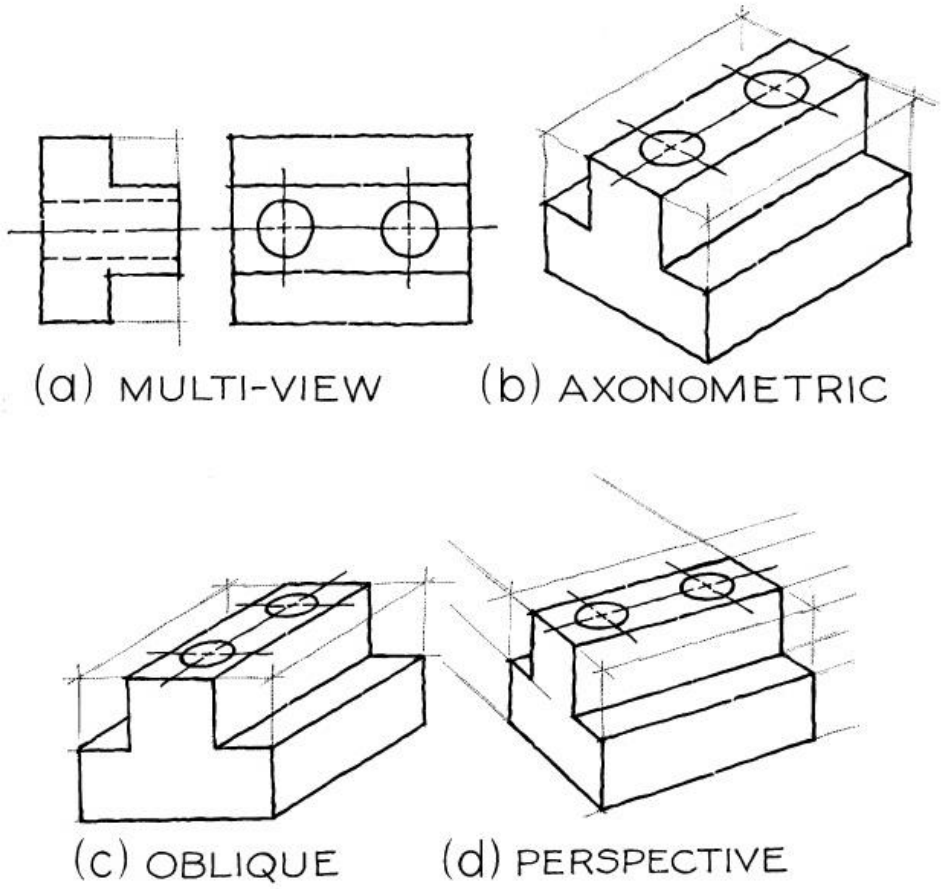


Oblique

Orthographic Projection

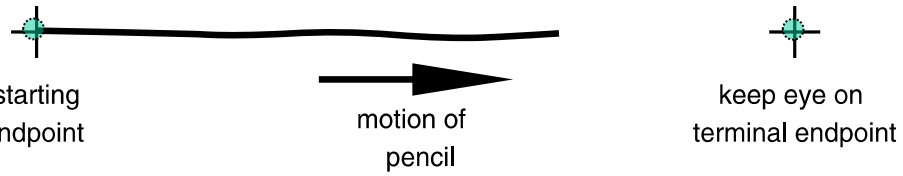
Types of Sketches

- **Multi-View** (orthographic)
  - Advantage: true faces
  - Disadvantage: hard to visualize
- **Isometric** (a type of axonometric drawing) & **Perspective**
  - Advantage: easy to visualize the object
  - Disadvantage: no true face
- **Oblique**
  - Advantage: one true face
  - Disadvantage: not "photorealistic"

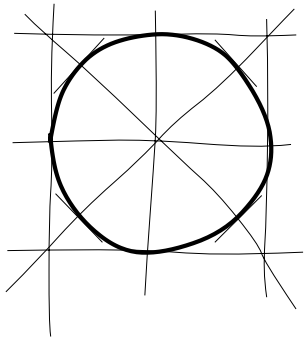


Freehand Sketching

- Fundamental rule of sketching: maintain proportions
- Hint: use standard techniques to draw lines and arcs
- Lines
  - Locate a start "dot"
  - Locate an end "dot"
  - Put pencil on start dot, keep eyes on end dot and smoothly move pencil toward the end dot (always pull, never push)

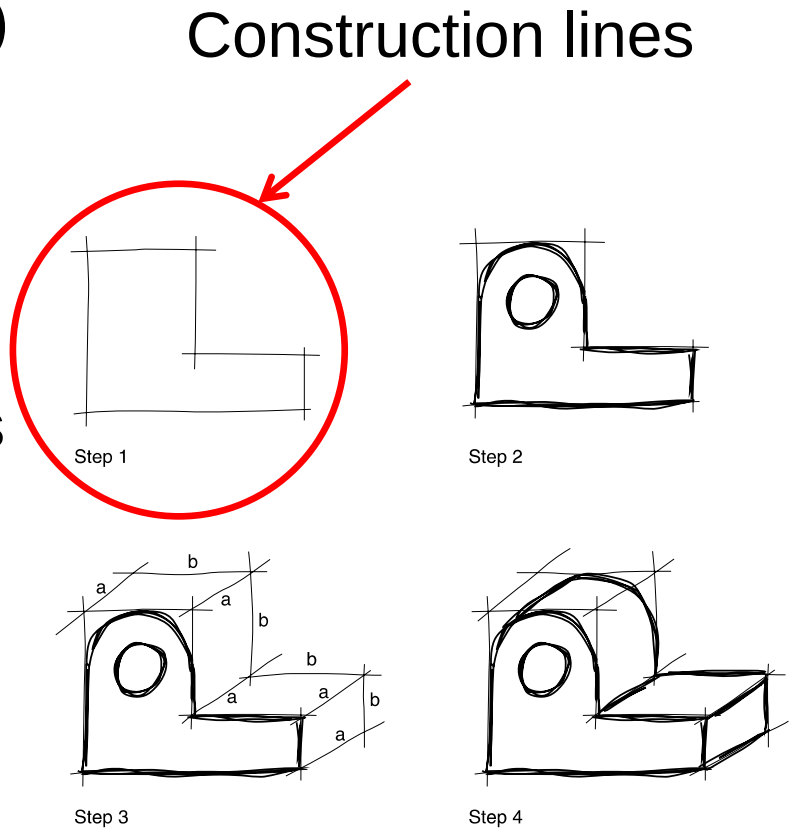


- Circles (arcs)
  - Draw light horizontal and vertical lines that intersect at the center
  - Lightly mark the radius on the lines
  - Connect the radius marks with arcs to complete the circle (adapt the natural radius of your wrist and hand)



Construction Lines

- Light and thin lines (barely visible)
- Serve as paths for final straight lines
- Intersection of construction lines specify the length of the final lines
- Points marked by the intersection of construction lines serve as guides for sketching of arcs and circles
- Guide the proportions of the sketch

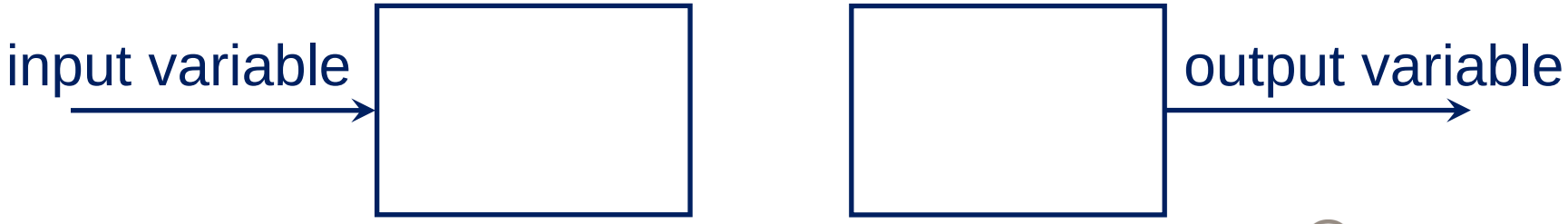


Oblique sketching

Block Diagrams

- System components (software code, electrical systems, etc.) can be represented by "blocks" in block diagrams:

- Many systems are hierarchical (i.e. composed of multiple subsystems)
- Systems must have at least one input variable and at least one output variable



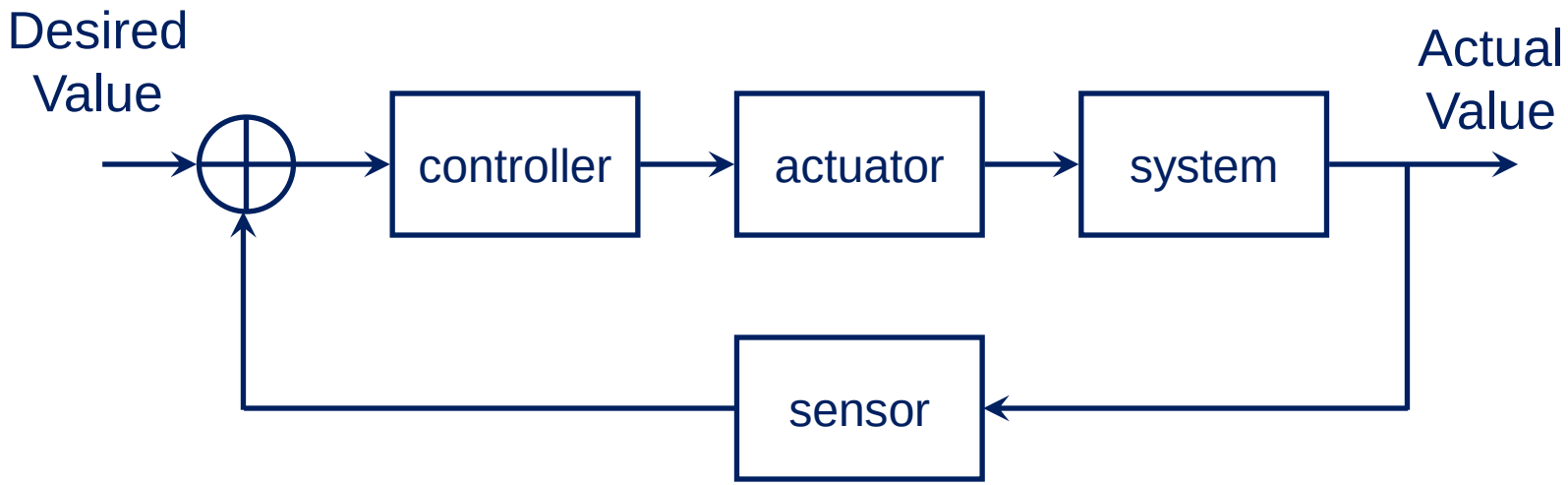
Block Diagrams

The objectives of a block diagram are:

- To provide an understanding of signal flows in the system (i.e. inputs and outputs of subsystems)
- To enable modelling of complex systems from simple building blocks
- To allow us to generate the overall system transfer function (i.e. how do we get from the input to the output)

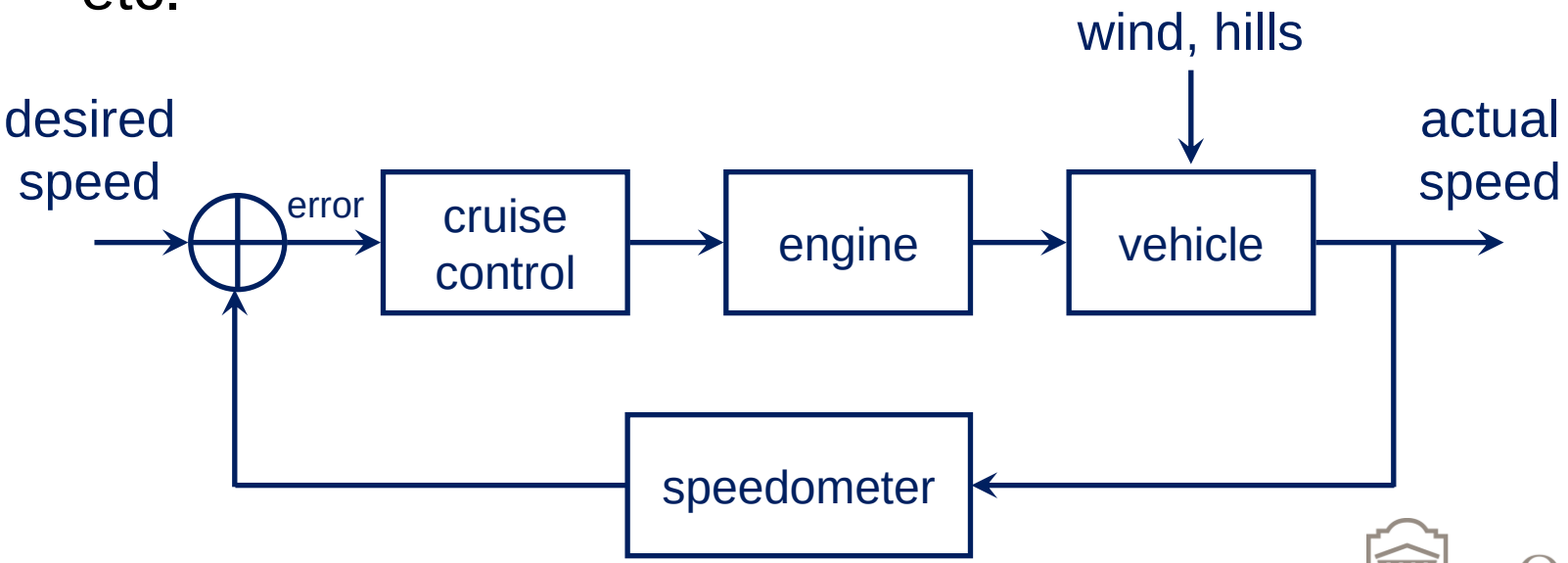
General Feedback Control System

- This is a general model and can vary significantly depending on the control system



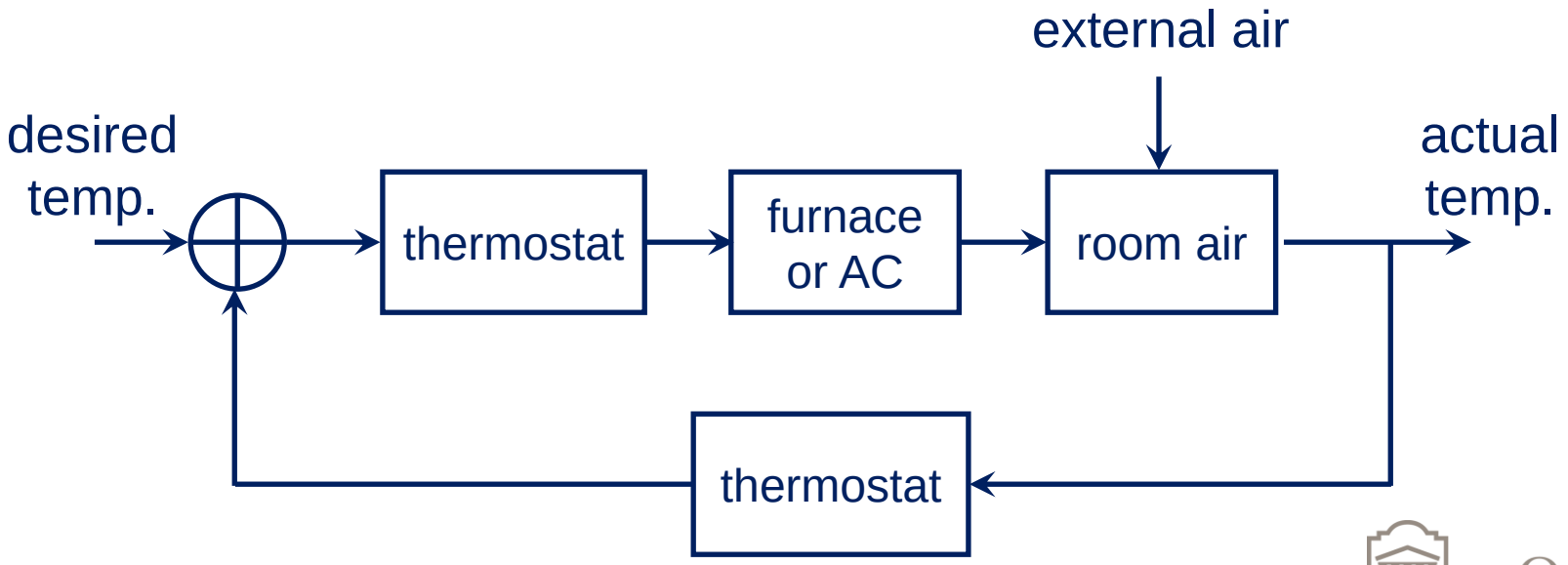
Example 1: Vehicle Cruise Control System

- **Input:** desired speed
- **Output:** actual speed
- **Error:** desired speed minus measured speed
- **Disturbance:** wind, hills, etc.
- **Controller:** cruise control unit
- **Actuator:** engine
- **System:** vehicle dynamics
- **Sensor:** speedometer



Example 2: Thermostat

- Set thermostat to desired room temperature
- Thermostat measures room temperature
- Furnace or AC turns on if measured T° is < or > then desired
- Air from furnace or AC changes room air temperature



Generating Ideas: Brainstorming Process

1. Define and agree on the objective
2. Brainstorm ideas and suggestions having agreed on a time limit
3. Categorize/condense/combine/refine
4. Analyze and assess effects or results
5. Prioritize/rank options as appropriate
6. Agree on actions and timescale
7. Control and monitor follow-up

How To Brainstorm Ideas and Suggestions

- Cross stimulation
  - Provocation is supplied by the ideas of others , *amplifying* the number of ideas that will be generated
- Suspended judgment
  - No attempt is made at evaluating ideas during brain storming sessions. Avoid remarks such as:
    - "that would not work because.."
    - "It is well known that…"
- Formality of setting
  - The more formal the session, the higher the chance of success
  - Having defined roles also helps

Format For Group Brainstorming

- Time: **20 minutes**
- The **Chairman**'s job is to:
  - Guide the session **without controlling it**
  - Ensure that only one person speaks at a time
  - Stop people who evaluate or criticize the ideas of others
  - Define the central problem and keep pulling people back to it
  - End the session when time runs out or when people get bored
  - Organize the listing and evaluation of ideas
- The **Note-taker**'s job is to record all the ideas (crazy or not … crazy is a *good* thing!) during the session into a permanent list

Course Attendance: Registration

- Use your smartphone or laptop to **register/notify** your attendance in this lecture
- Allow **geo location** in the attendance site
- Accept **cookies** from third parties applications
- Log in using only your **Uottawa** account at the link below

  https://attendance.azarm.ca/attendancerecord/gng1103f

- Your attendance must be registered only **during the lecture** and at the **time specified by the professor**
- You can also use the **QR code** below, to register quickly

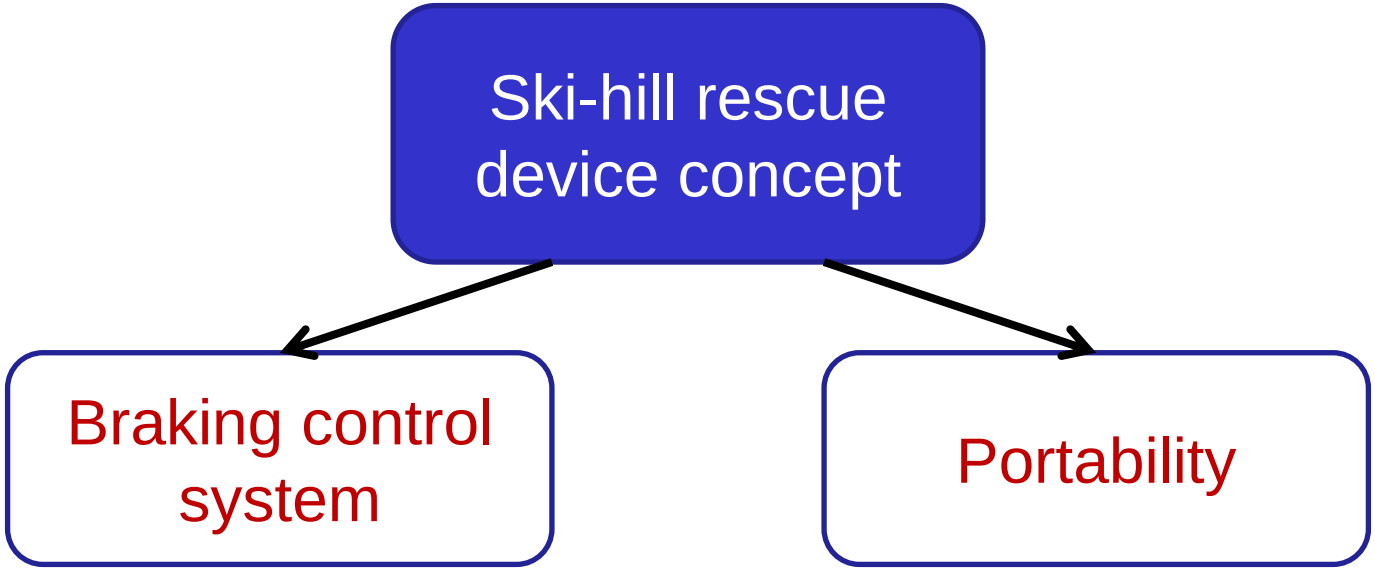
CONCEPTUAL DESIGN

Ski-Hill Rescue Device

WCDE 00395-03

Conceptual Design

- Based on a few ***important*** design criteria:



- Braking surface
- Braking control method
- Parking brake

- Allows easy transport
- Minimum size when stored

Conceptual Design For Ski-Hill Rescue Device

- **Braking and control:**
  - Braking surface: the component which contacts the snow to slow and/or stop the device's motion
  - Braking control method: the method by which the brake is engaged so that the braking surface can contact the snow
  - Parking brake: as an additional safety measure, it is desirable to incorporate a parking brake in the design
- **Portability:**
  - To allow for easy transport of the device when required
  - When not in use, the device should occupy the least amount of volume possible
  - The design should allow for a fast setup (assembly)

Activity: Brainstorming For Conceptual Design

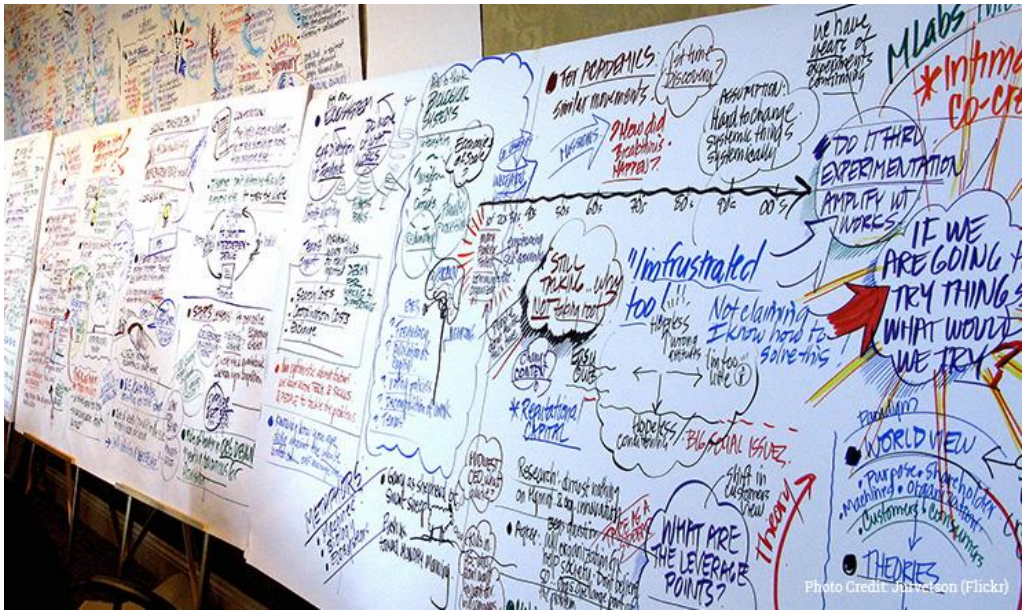
- Divide yourselves into groups of 3-5 people
- Brainstorm conceptual design ideas for one of the three elements of the braking system or for the portability

Individual Brainstorming (5min)

- Each group member silently and independently generates a list of conceptual designs for either of the three parts of the braking system or the portability

Group Brainstorming (10min)

- Free for all brainstorming session: each member of the team takes their turn to present concepts



- **Important:** team members cannot argue the merit of ideas at this stage of brainstorming (just capture them!)

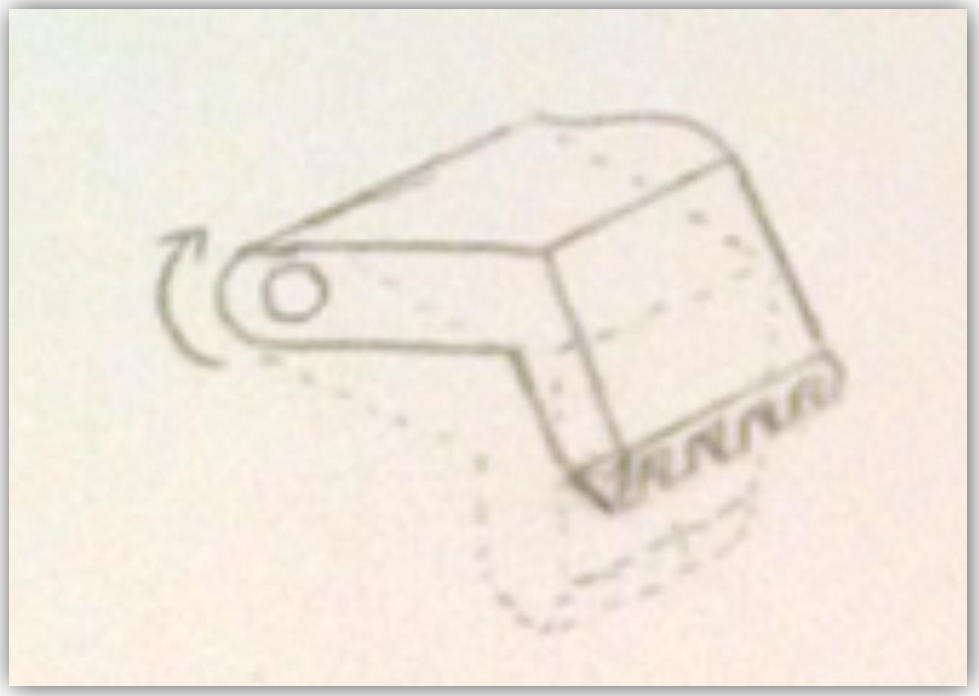
Choosing Conceptual Designs (5min)

- Categorize/condense/combine/refine/reconsider
- Analyze and assess effects or results
- Prioritize/rank options as appropriate
- Choose Conceptual Designs (in this case 3 of them!)

Share Your Solutions

Braking Surface 1: Claw Brake Surface

Module 03, Figure 1

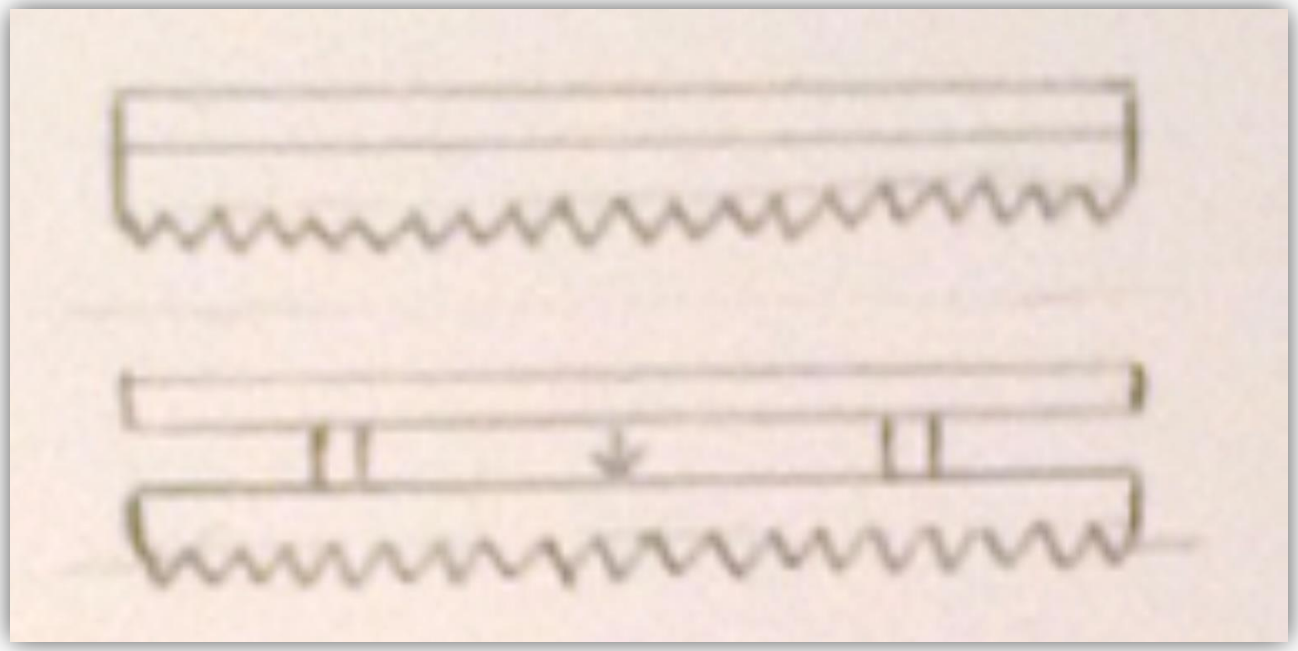


***Features*:**

Perpendicular action, gradient braking with deeper penetration

Braking Surface 2: Friction Brake Surface

Module 03, Figure 2

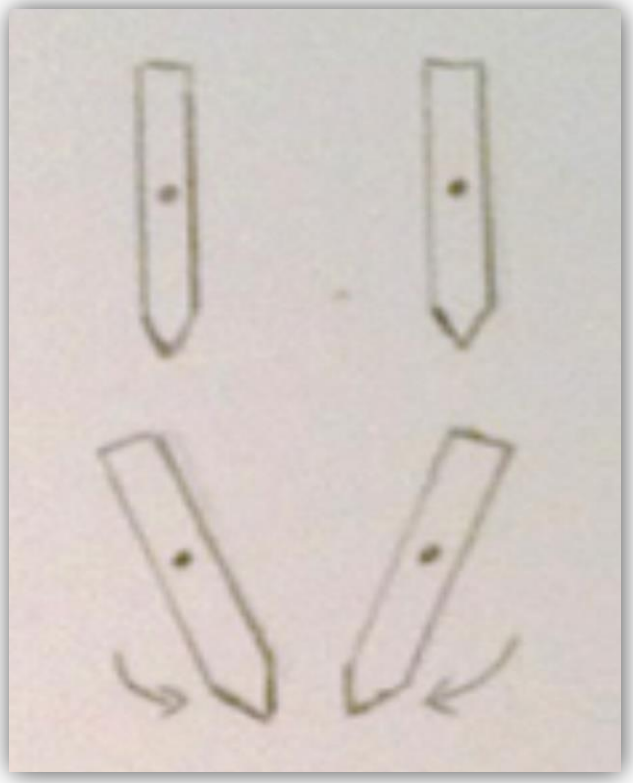


***Features*:**

Large Friction surface, gradient braking with down force

Braking Surface 3: Wedged Blade Brake

Module 03, Figure 3

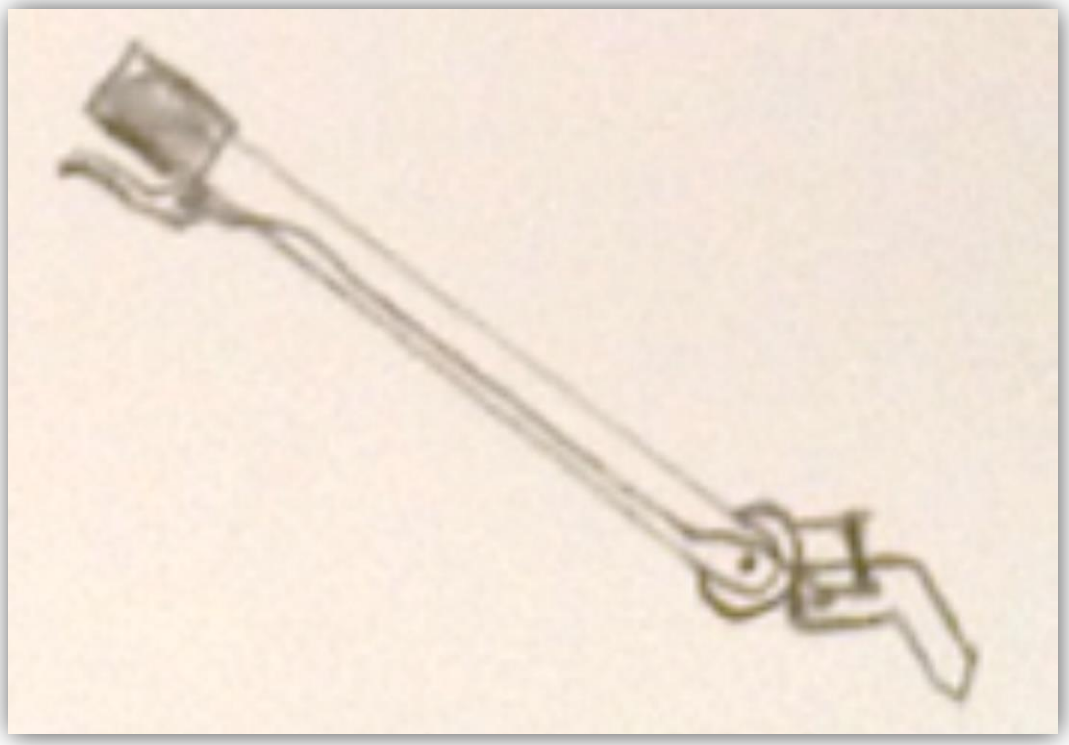


***Features*:**

Snow plough, gradient braking by angling inwards

Brake Control 1: Lever Brake Engaging Method

Module 03, Figure 4

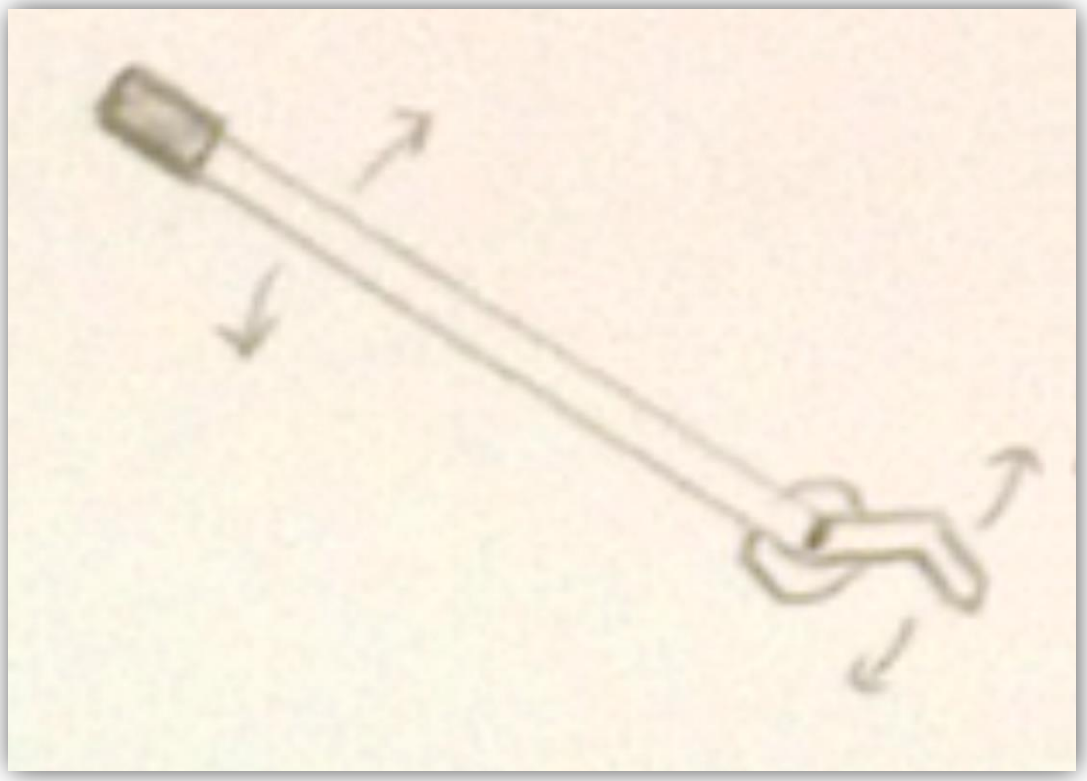


***Features*:**

Bicycle-style cable control

Brake Control 2: Handle Brake Engaging Method

Module 03, Figure 5

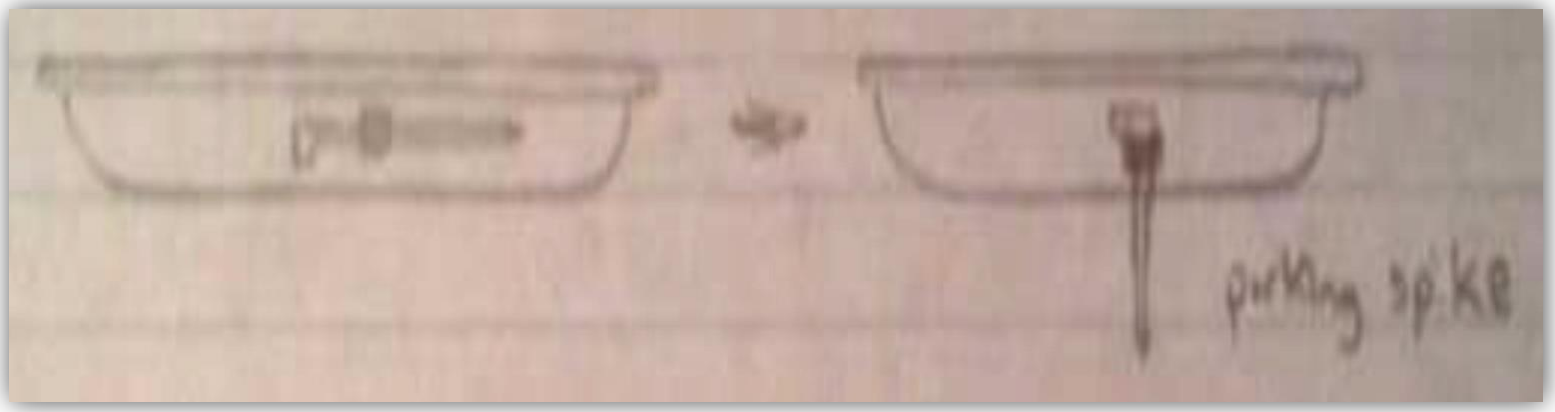


***Features*:**

Handle positions lever-style braking

Parking Brake: Parking Spike

Module 03, Figure 6

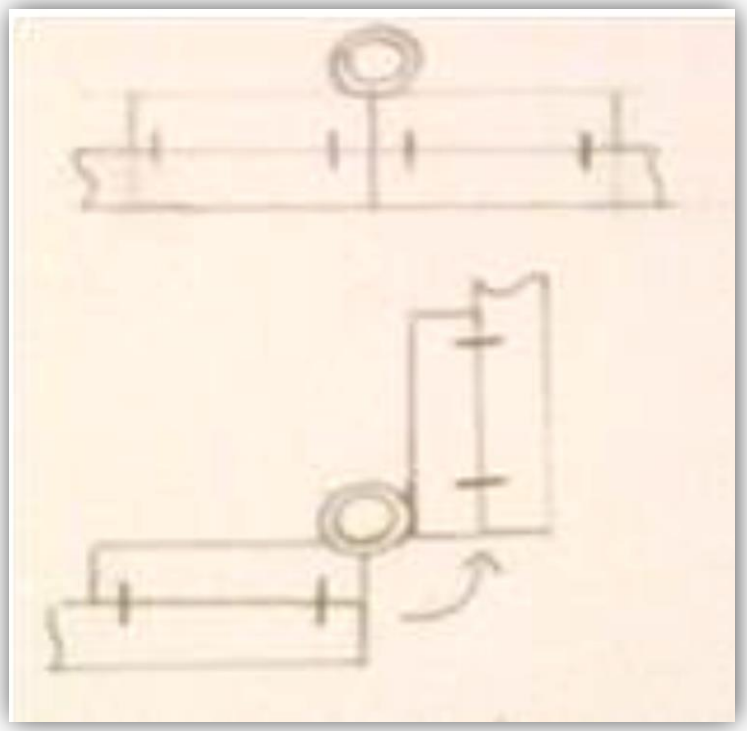


***Features*:**

Parking brake for loading purposes

Portability 1: Hinge Connection Portability

Module 03, Figure 7

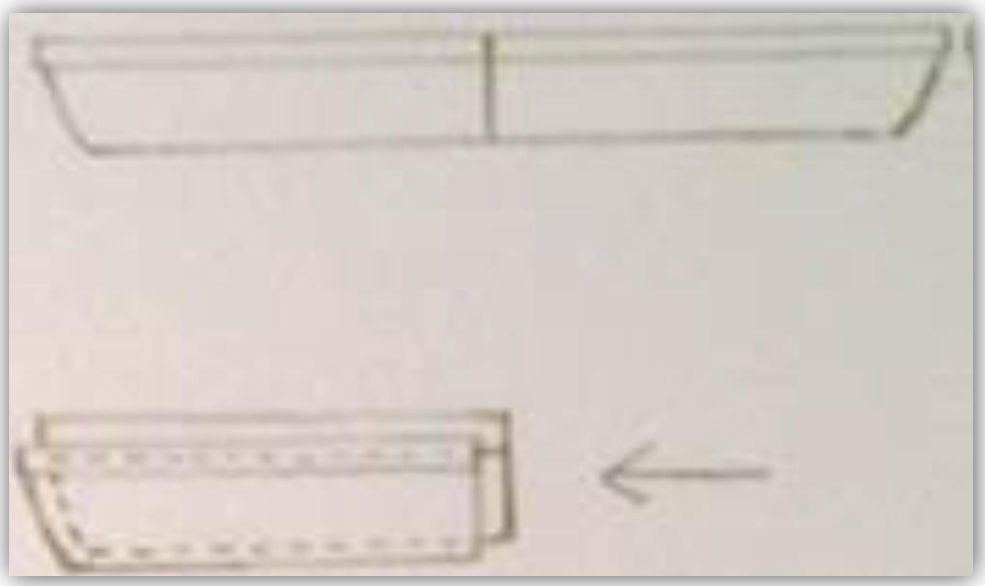


***Features*:**

Folding for assembly or storage (Q: how much smaller?)

Portability 2: Sliding Tub Sections

Module 03, Figure 8

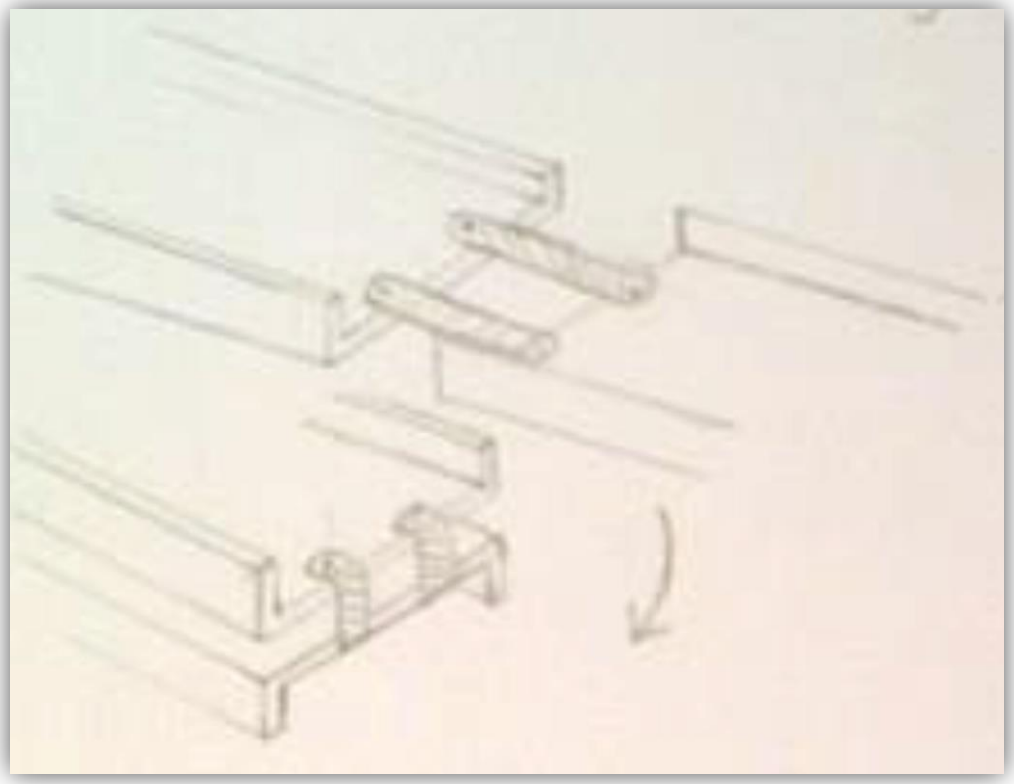


***Features*:**

Sliding sections for storage or transport (Q: practical in snow?)

Portability 3: Tether Portability

Module 03, Figure 9

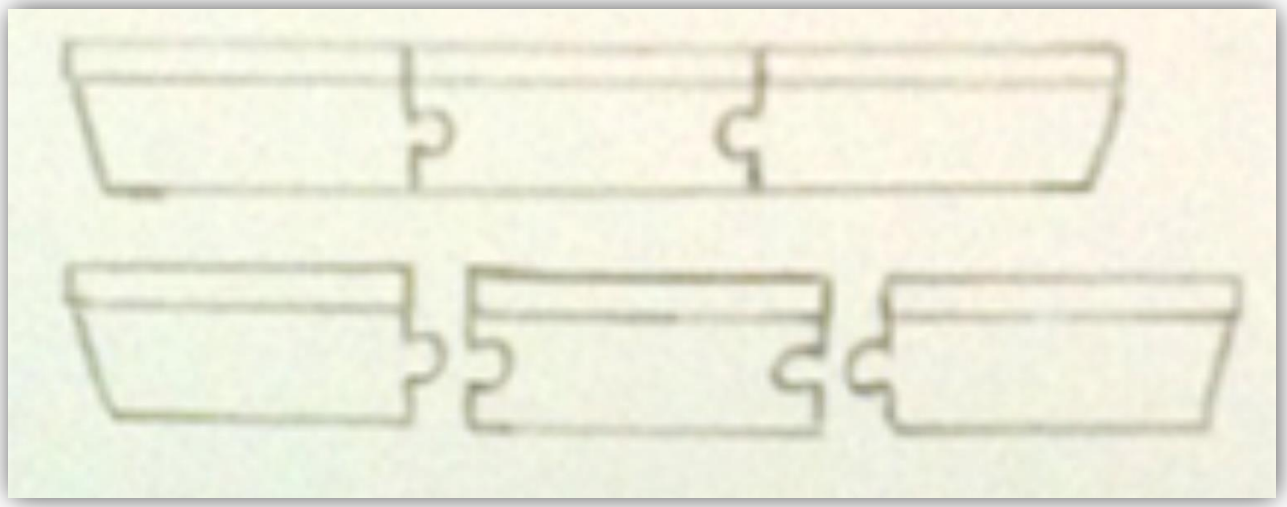


***Features*:**

Tent pole-style tether allows more freedom of motion

Portability 4: Snap-Together Portability

Module 03, Figure 10



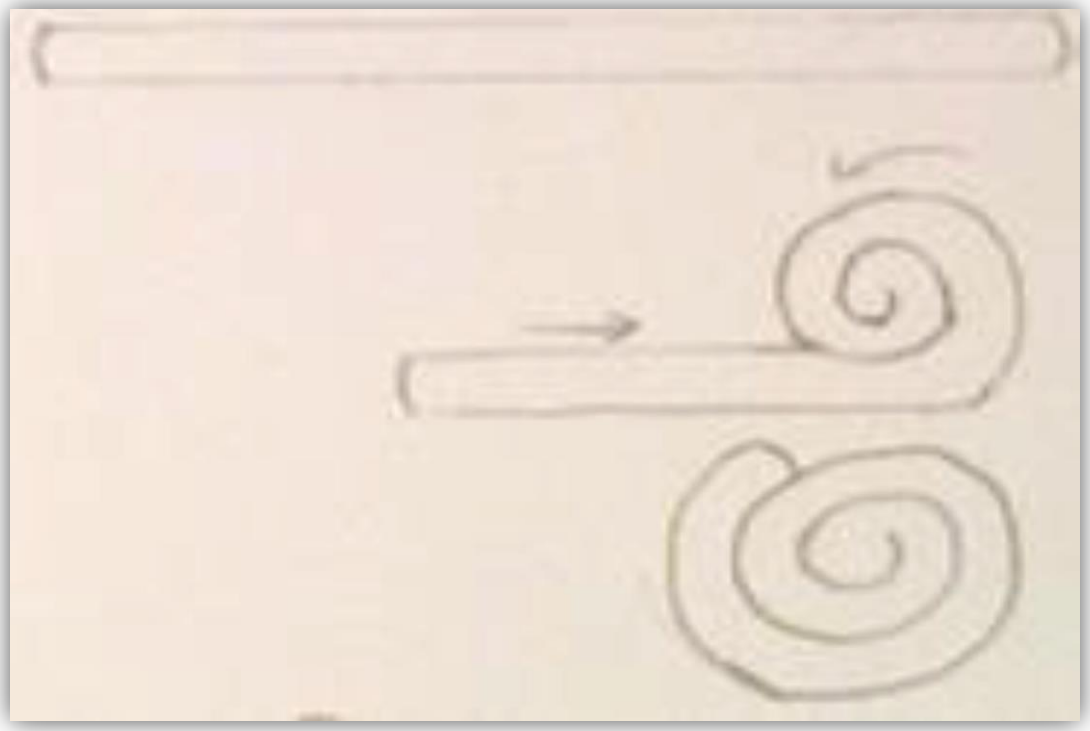
***Features*:**

Allows arbitrary stored shapes (Q: Assembly time required?

Q: Issues with lost or dropped pieces? Q: Assembly difficulty?)

Portability 5: Roll-Up Portability

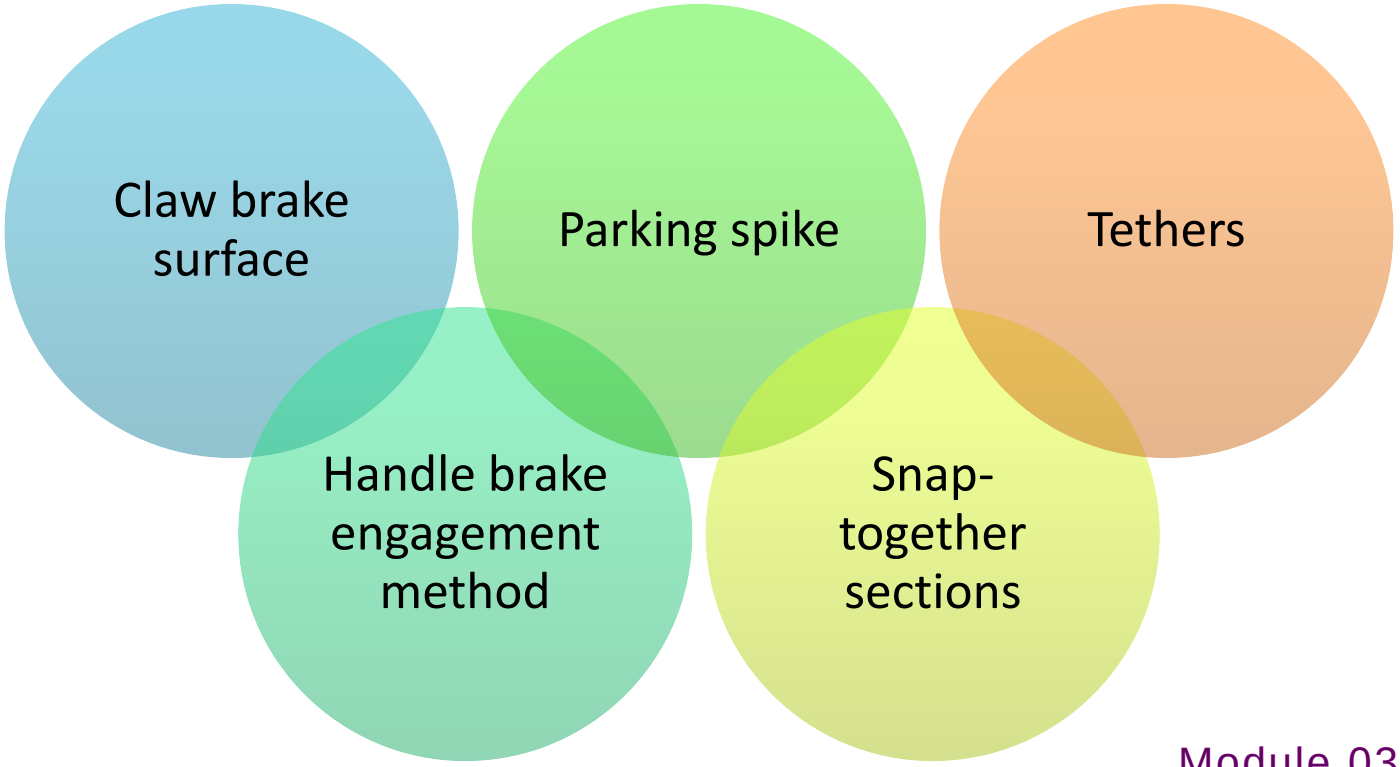
Module 03, Figure 11



***Features*:**

Roll-up for transport (Q: How? Inflatable? Requires electricity?)

Selected Conceptual Designs For the Ski-Hill Rescue Device



Module 03, Figure 12

Selected Conceptual Design Rationale

- Design team selected the **claw** as the best option for further investigation and design
  - Concerns regarding the ability of the **friction concept** to slow and/or stop the device (low coefficient of friction of snow)
  - **Wedged blade** system would likely be more complicated to design
  - **Claw** provides the most braking force and is also simple
- Gradient braking
  - Both (**Lever**, **handle**) could provide a similar amount of control
  - Cables may get jammed or become loose in snow
  - Operator restrictions on holding position (i.e. not the cable itself)
  - Using the **handle** position to actuate the braking surface is simpler, in terms of number of components. Allows hand placement anywhere