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# **STEM PROJECT TRAINING and STEM & MAKERS FESTIVAL/EXPO. OF THE ERASMUS+ KA2 PROJECT**

**# 598367-EPP-1-2018-1-SE-EPPKA2-CBHE-JP**

**“INTEGRATED APPROACH TO STEM TEACHER TRAINING”, STEM**

***24-28 November 2022***

**Nevsehir, Turkey**



# Design Heuristics for creative ideation

Keelin Leahy

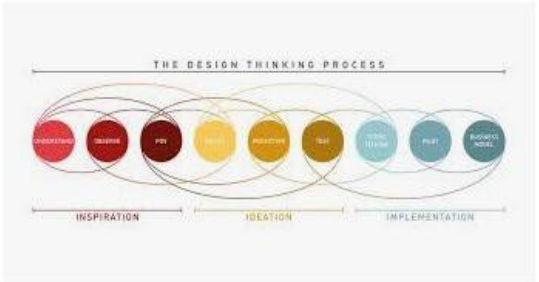
*University of Limerick*

*Ireland*



**CREATIVITY AND DIVERSITY**  
**DURING THE IDEA GENERATION PHASE**  
**CAN LEAD TO INNOVATION IN STEM**

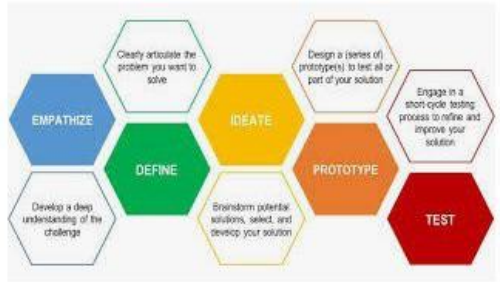
# Problem / Project-based context...



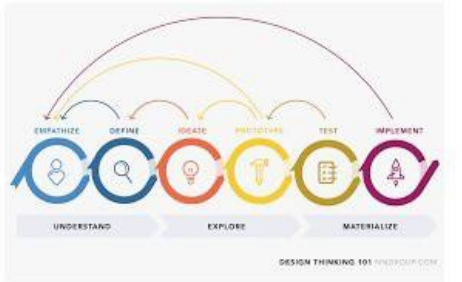
Design Thinking: A Quick Overview ...  
interaction-design.org



The Design Thinking Move...  
medium.com



Design Thinking | Oceanit  
oceanit.com



What is Design Thinking? (And What Are ...  
medium.com



A Response to the Stanford d.school'...  
blog.usejournal.com



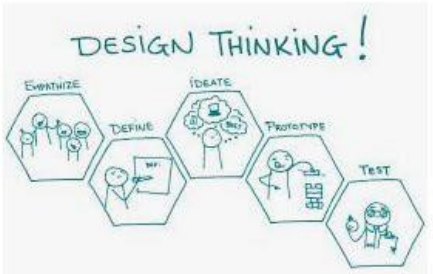
Design Thinking  
cit.illinois.edu



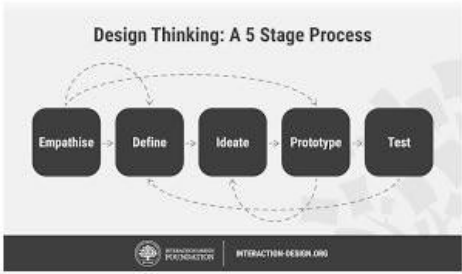
What is Design Thinking? | Interaction ...  
interaction-design.org



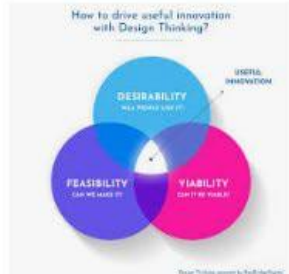
Design Thinking Isn't Just For Your ...  
productcoalition.com



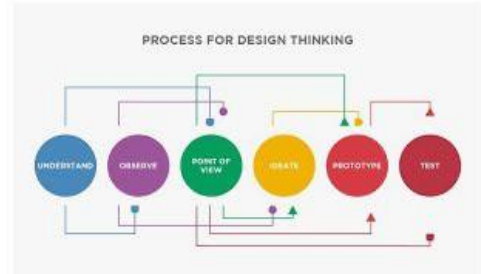
Design Thinking For Software Developers ...  
medium.com



5 Stages in the Design Thinking Process ...  
interaction-design.org



implement Design Thinking ...  
baybridgedigital.com



Design Thinking for Startups – Hacker Noon  
hackernoon.com



Design ...  
navigate

# Natural Idea Generation

## Activity 1

For 10 minutes generate ideas for the following design problem:

### **Squashed tomato challenge**

**The problem:** In Nepal, many farmers living on the mountainside grow fruit and vegetables, including tomatoes. To earn a living they need to sell these at the local market. The problem is getting to market involves a long, dangerous walk down the mountain side and over a river, at the end of which the tomatoes may well be a bit squashed.

**The challenge:** To design, [build and test] a way of transporting tomatoes down a mountain

# SHARE IDEAS & REFLECT

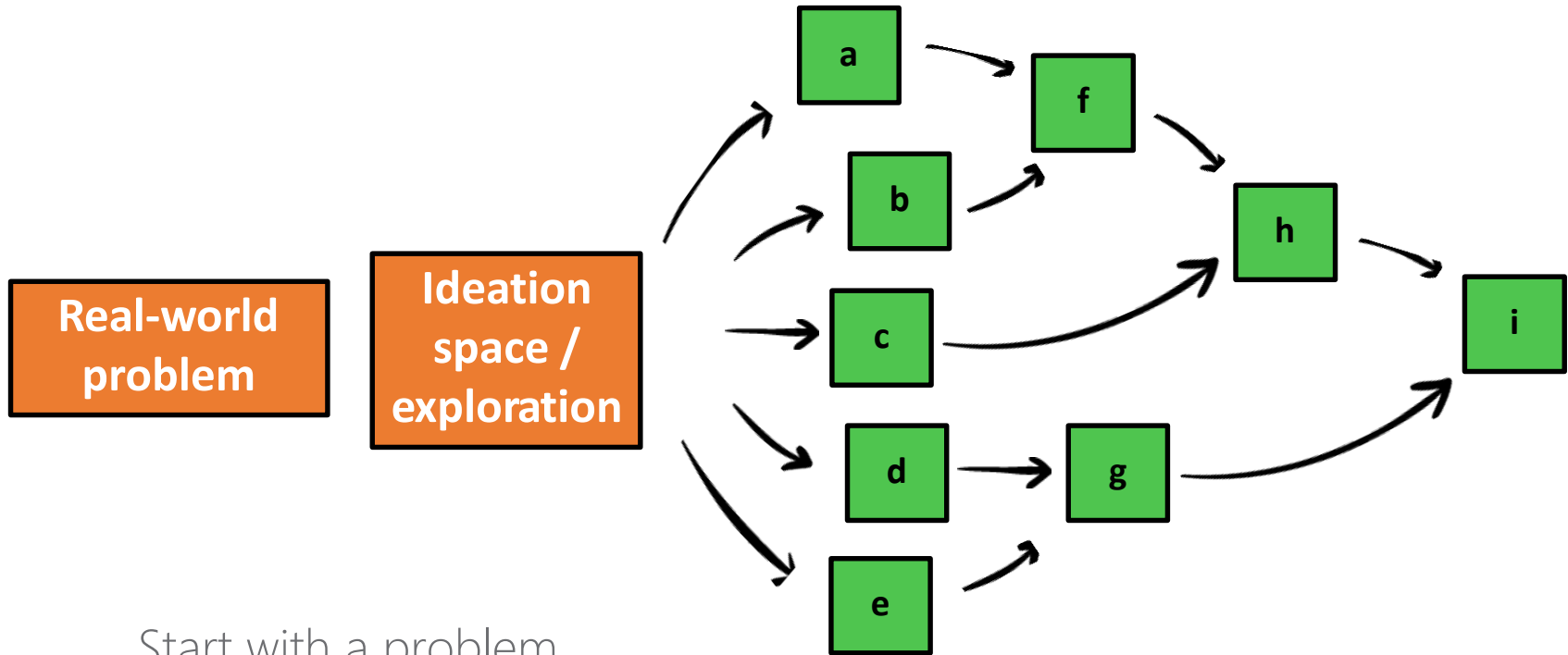
How many ideas did you generate?

How did you generating ideas?

What was easy / difficult in solving this problem?

# IDEA GENERATION LEADs TO INNOVATION

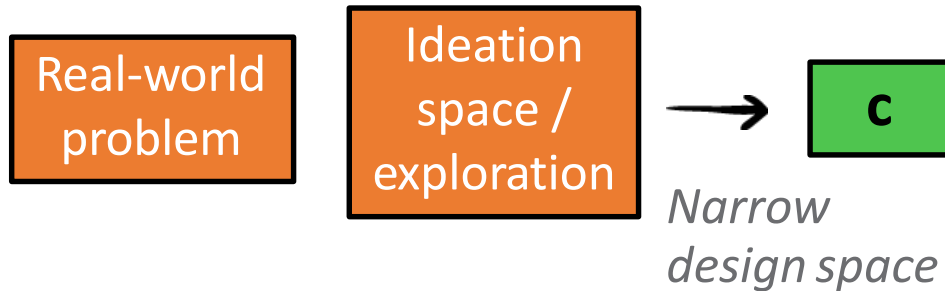




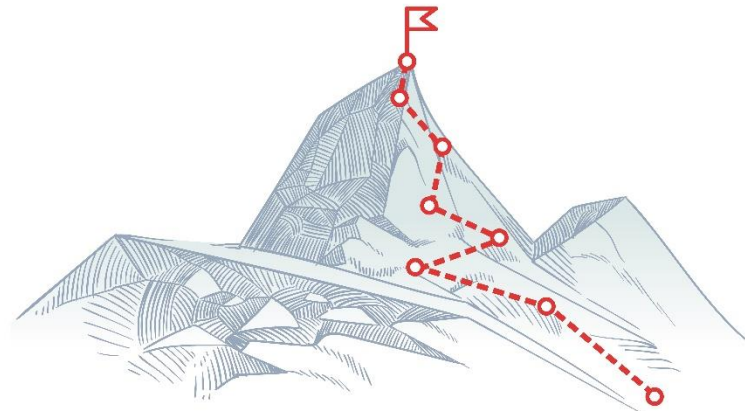
Start with a problem  
Research and gather information  
Generate ideas  
Further develop ideas



# Challenges - Creative Idea Generation



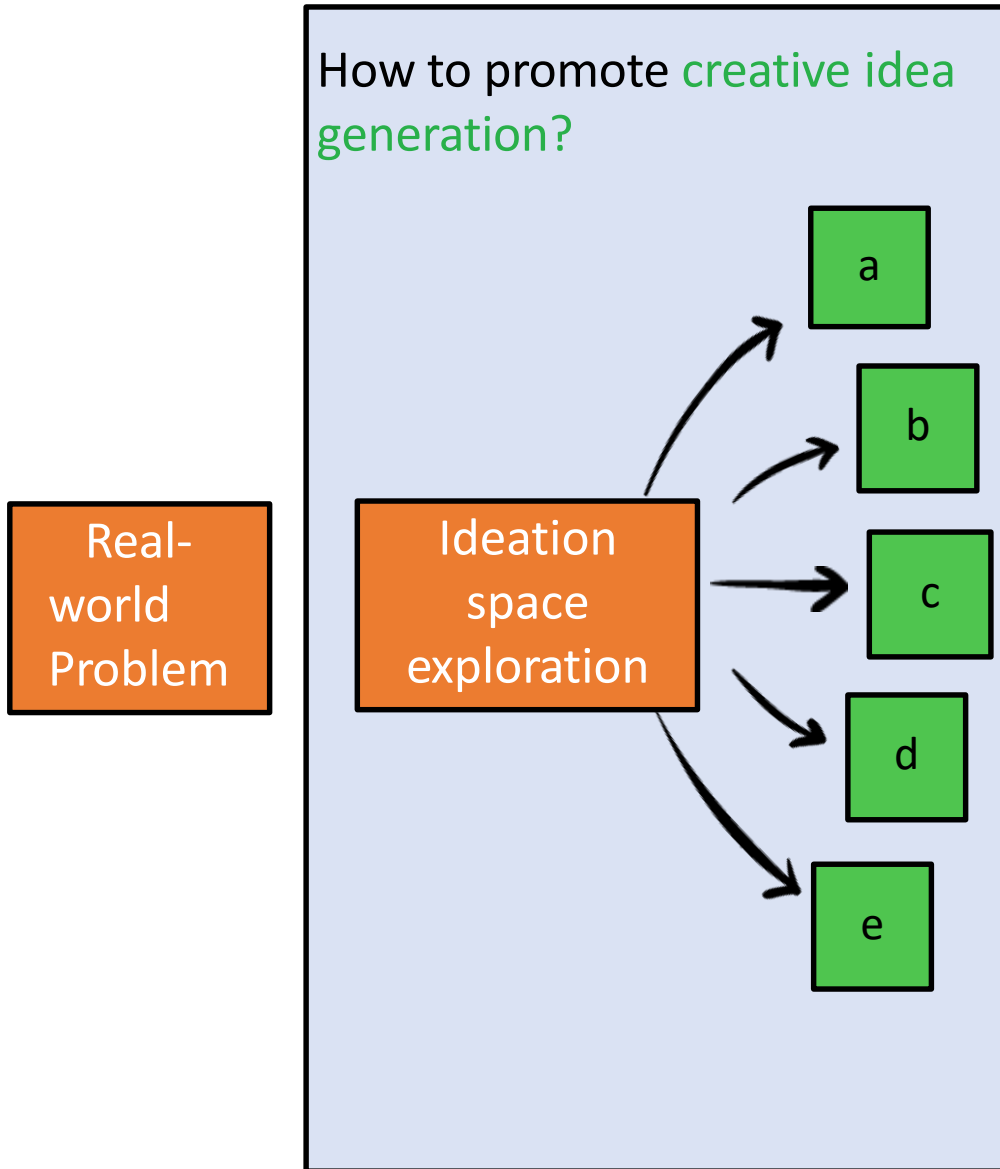
- Lack of strategies for multiple and diverse idea generation
- Fixation
  - existing products
  - previous experiences
  - first idea



# Design Fixation



*Fixation is a type of Freudian symptom whereby one person **becomes obsessed with an idea** (or person).*



### Creative Ideation fostered via:

- Design Heuristics
- SCAMPER
- 16 Squares
- Train of Thought
- Likes / Dislikes
- Ask the right questions
- Brainsketching
- Idea grid
- Random inputs
- Biomimicry

Many not empirically derived or validated

Too general, or too specific

# Cognitive heuristics

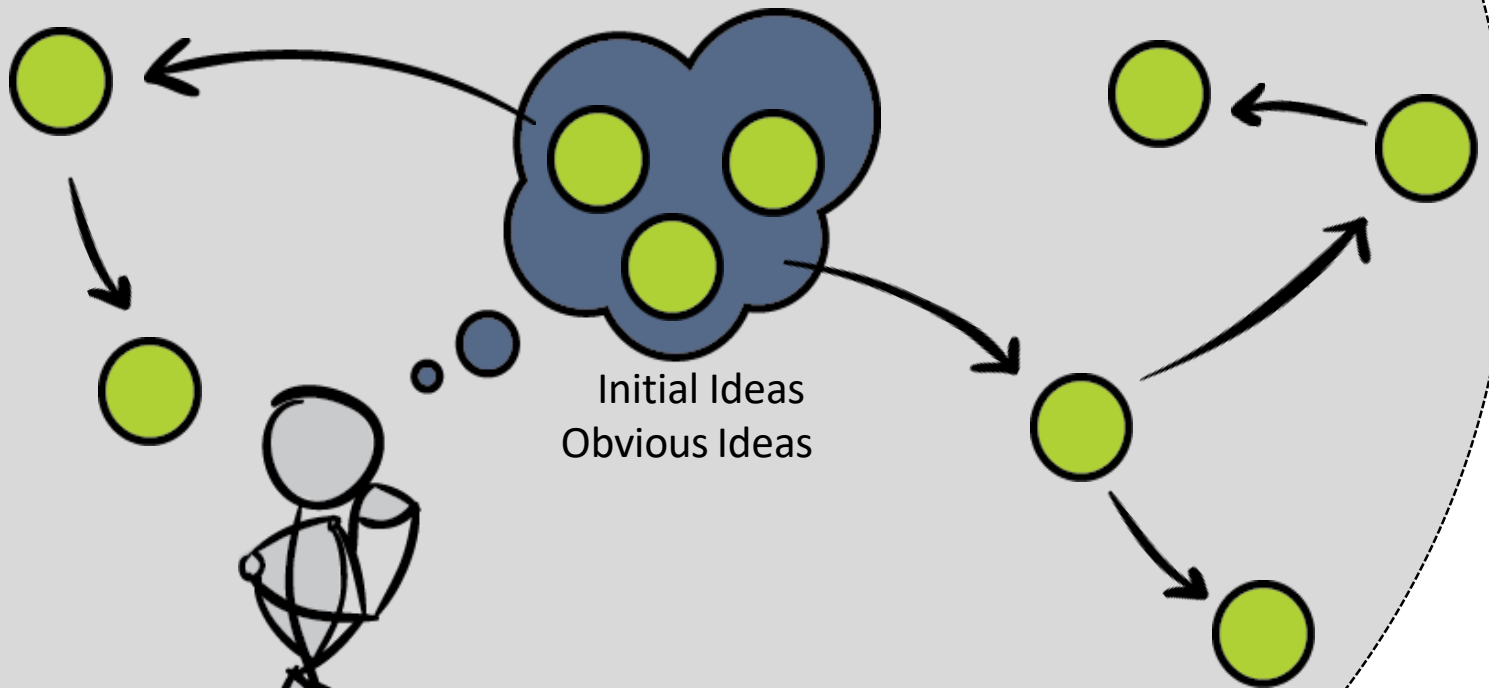
Reasoning processes that do not guarantee the best solution, but often lead to potential solutions by providing a short-cut.



# Design heuristics

Concept modifiers that quickly lead to a potential solution, providing the opportunity for a novel design to occur.

# DESIGN SOLUTION SPACE



Initial Ideas  
Obvious Ideas

**Design Heuristics** push you to more fully explore the potential solution space.

Award-winning  
Products

Think-aloud  
Design Task





















Professional  
Designer





# Product Analysis

## DESIGN HEURISTICS

1. Add a portability feature to existing solutions	2. Add motion to the product as a playful attribute (push/pull, etc.)	3. Add to existing product	4. Adjust functions according to different demographics	5. Adjust functions by moving the product's parts	6. Align components on the same base or around a center	7. Allow user to reorient	8. Animate product using human features for an approachable look	9. Apply an existing mechanism in a new way	10. Attach the product to the user
 <p>Lightweight porcelain helps to make this product easier to lift. Attaching a handle also makes it easy to carry. [1]</p>	 <p>This vacuum uses a robotic floorvac which cleans rooms by itself throughout the day. [3]</p>	 <p>This walkie-talkie device clips on to a biker's helmet to allow bikers to communicate safely and comfortably while riding. [5]</p>	 <p>This laptop is designed for children living in developing countries. The size, colors, and interface all contribute to the playfulness of the product. [7]</p>	 <p>A sliding hinge attached to the back pushes the screen to the forefront for viewing entertainment media. [9]</p>	 <p>This adjustable shower caddy organizes bathroom products by aligning two shelves on the same base. [11]</p>	 <p>This activity gym converts to a toddler keyboard and chair by flipping 90 degrees. [13]</p>	 <p>This dish soap dispenser is designed to mimic a human body with a head, neck, and body. [15]</p>	 <p>This stool takes the seat from a bicycle and applies it to a bar stool. [17]</p>	 <p>This product functions as a wellness tracker in the form of a wireless device clipped to clothing during exercise. [19]</p>
 <p>This lantern can be used as a table lamp, as well as a light that can be carried to different locations. [2]</p>	 <p>This alarm clock is designed to jump off a table and move. Two wheels on the sides allow it to roll while emitting a siren alarm. [4]</p>	 <p>This product attaches to an existing dining chair to turn it into a high chair for children. Using spring-loaded arms, it can securely hold any dining chair. [6]</p>	 <p>With laces extending to the soles, these shoes respond to the unique movements essential to the urban sport Le Parkour. [8]</p>	 <p>This design features a folding top that flips up or down, allowing the table to be used as room dividers. [10]</p>	 <p>This design allows for six audio devices to be shared at one time. All the components are collected in the center, and the six input jacks are placed around it. [12]</p>	 <p>This product provides three seating options. By turning the chair seat upside down, a baby seat becomes a toddler seat or recliner. [14]</p>	 <p>These shakers hug each other, abstracting human figures. The black and white colors also suggest balance and harmony. [16]</p>	 <p>This desk organizer uses brush bristles to hold pens, pencils, and business cards. [18]</p>	 <p>This vegetable peeler functions as an extension of the hand. It is slipped onto the finger like a ring. [20]</p>



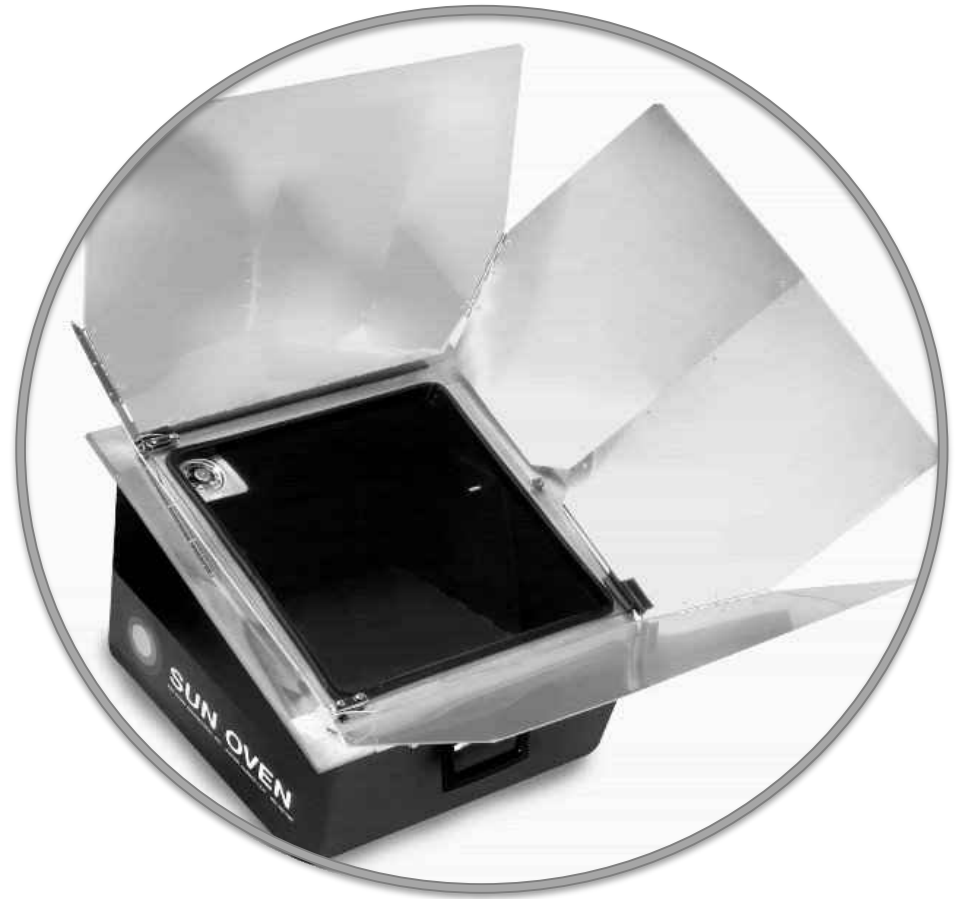
# Think Aloud Experiment: Grand Challenges Design Task

Engineering students and  
practitioners

Varying  
experience levels

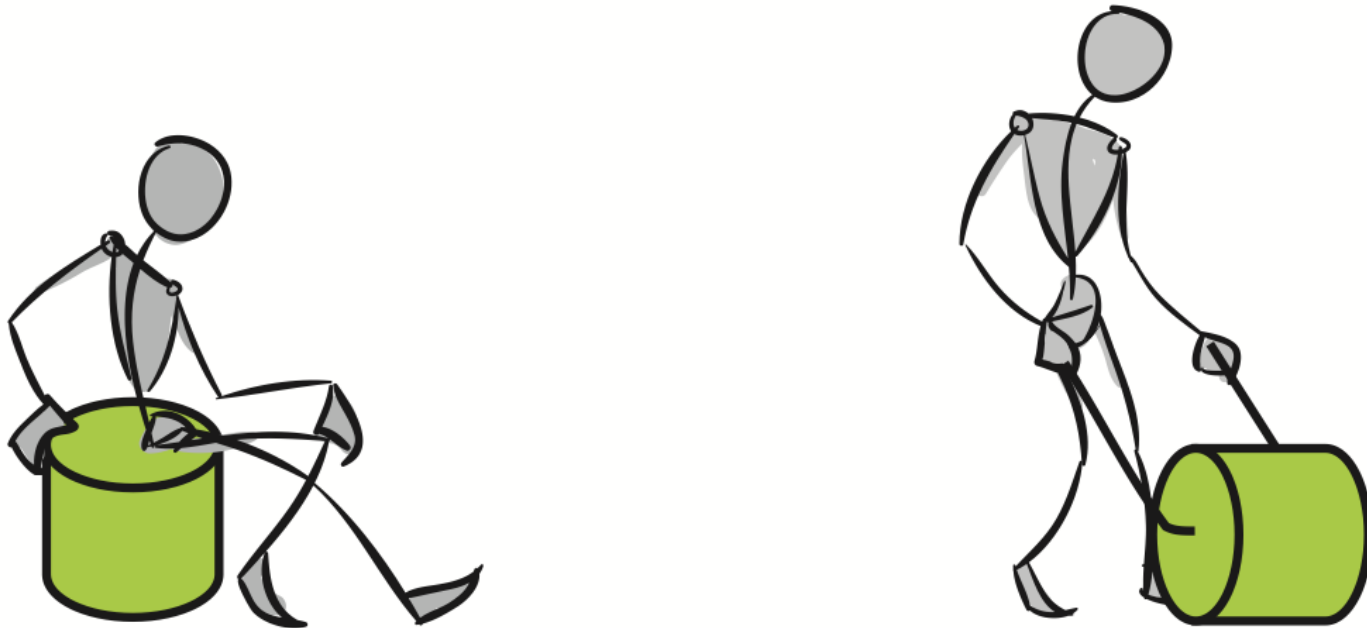
## DESIGN PROBLEM

DESIGN A SOLAR POWERED  
COOKING DEVICE



# APPLY EXISTING MECHANISM IN NEW WAY

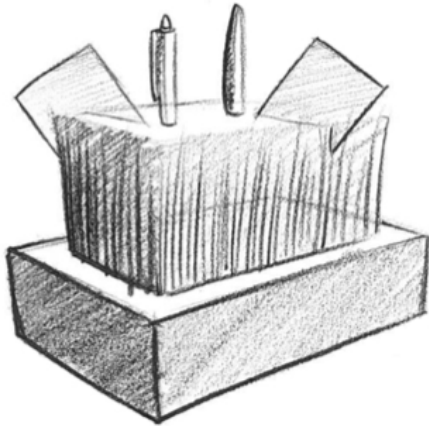
# 13



Consider whether existing products or their components can fulfill the desired function. This can facilitate reuse of existing products, make the design process more efficient, and expand the pool of options.

# APPLY EXISTING MECHANISM IN NEW WAY

# 13



## PRATONZOLO

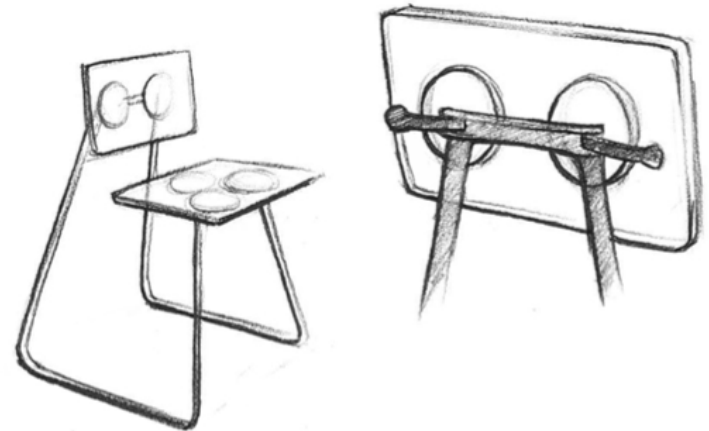
*Max Battaglia*

This desk organizer uses brush bristles to hold pens, pencils, and business cards.

## WANTUZ

*Reha Erdogan*

Hand vacuum cups are used to transport large sheets of glass. Here, they are used to hold the seat and back of this chair in place.





# IDEAShub



TOOLS FOR CREATIVE IDEAS



## 46 Design Heuristics: Creativity Unfolded

# 46 Design Heuristics: Creativity Unfolded

**UTILISE INNER SPACE**

Make use of the inside of the design.

DH17

**UTILISE OPPOSITE SURFACE**

Make use of another side/surface of the design.

DH18

**ADJUST FUNCTIONS FOR SPECIFIC USERS**

Change the design based on the needs of the user.

DH19

**ALLOW USER TO ASSEMBLE**

Allow the user put the design together.

DH20

**ALLOW USER TO CUSTOMISE**

Let the user personalise part of the design.

DH21

**ALLOW USER TO REARRANGE**

Let the user move/rearrange parts of the design.

DH22

**ATTACH PRODUCT TO USER**

Join the user and the design.

DH23

**INCORPORATE USER INPUT**

Include the user's wants and wishes.

DH24

**PROVIDE SENSORY FEEDBACK**

Allow the design to guide the user by giving feedback.

DH25

**APPLY EXISTING MECHANISM IN A NEW WAY**

Use an existing design in a new way.

DH26

**CONVERT FOR SECOND FUNCTION**

Change the design so it has more than one use.

DH27

**CREATE SYSTEM**

Develop a set of designs that work together.

DH28

**SEPARATE FUNCTIONS**

Divide the use(s) of the design.

DH29

**ADD MOTION**

Make the design move in some way.

DH30

**ROTATE**

Move part of the design around another part.

DH31

**SLIDE**

Move one part across another part.

DH32

**CONVERT 2-D MATERIAL INTO A 3-D OBJECT**

Change the design so it could be made from a flat surface.

DH33

**EXPOSE INTERIOR**

Show the inside of the design.

DH34

**HOLLOW OUT**

Remove the inside of the design's parts.

DH35

**MAKE COMPONENTS ATTACHABLE/DETACHABLE**

Join or take apart the design.

DH36

**MIRROR/ARRAY**

Start or continue a pattern.

DH37

**OFFER OPTIONAL COMPONENTS**

Add choice of parts.

DH38

**REPEAT**

Copy a part of the design.

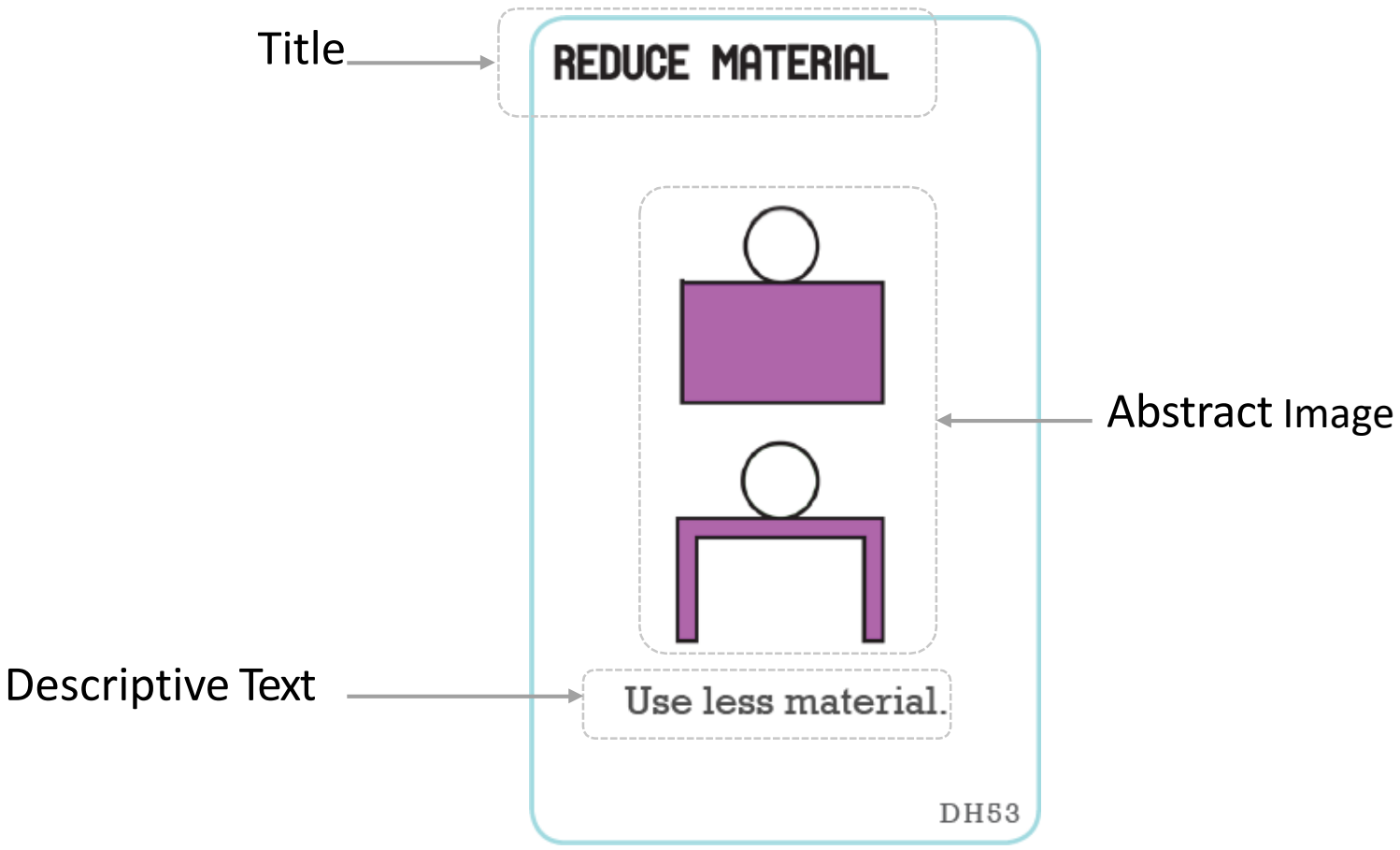
DH39

**USE COMMON BASE TO HOLD COMPONENTS**

Add a base that support other parts.

DH40

# Example of one Design Heuristic



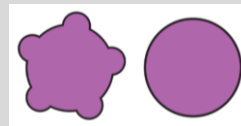
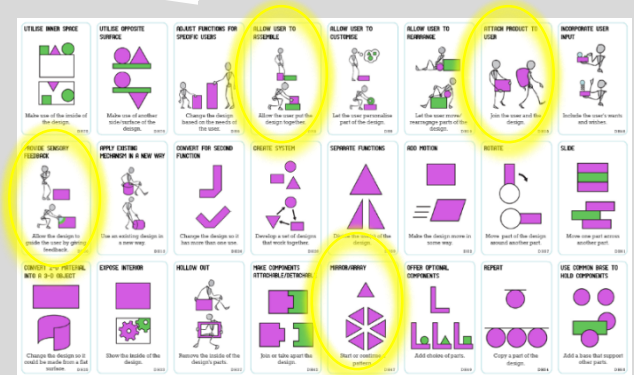
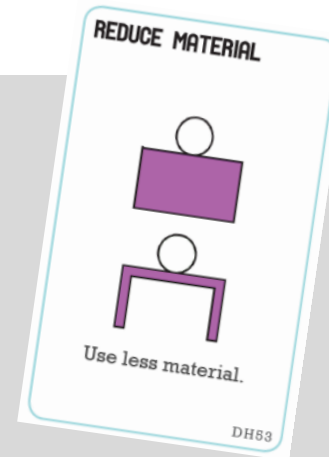
# Ways to use the Design Heuristics

There are no rules!

*Use one card to generate many ideas.*

*Use many cards to generate one idea.*

*Use any feature of a card; title, image, or descriptive text.*



# 46 Design Heuristics: Creativity Unfolded

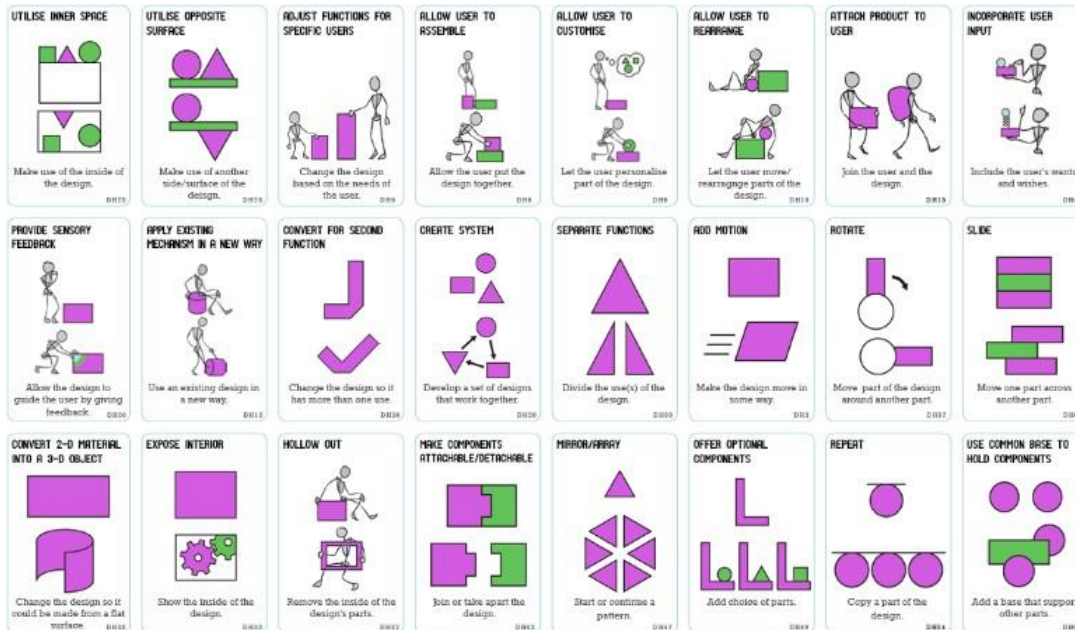


## Guidelines for use:

Use any aspect of the handout, such as:

- Heuristic title
- Images
- Description

- To generate or inspire an idea
- Transform an idea by applying a design heuristic to an existing idea
- Develop part of an idea by applying a design heuristic to a part of an idea



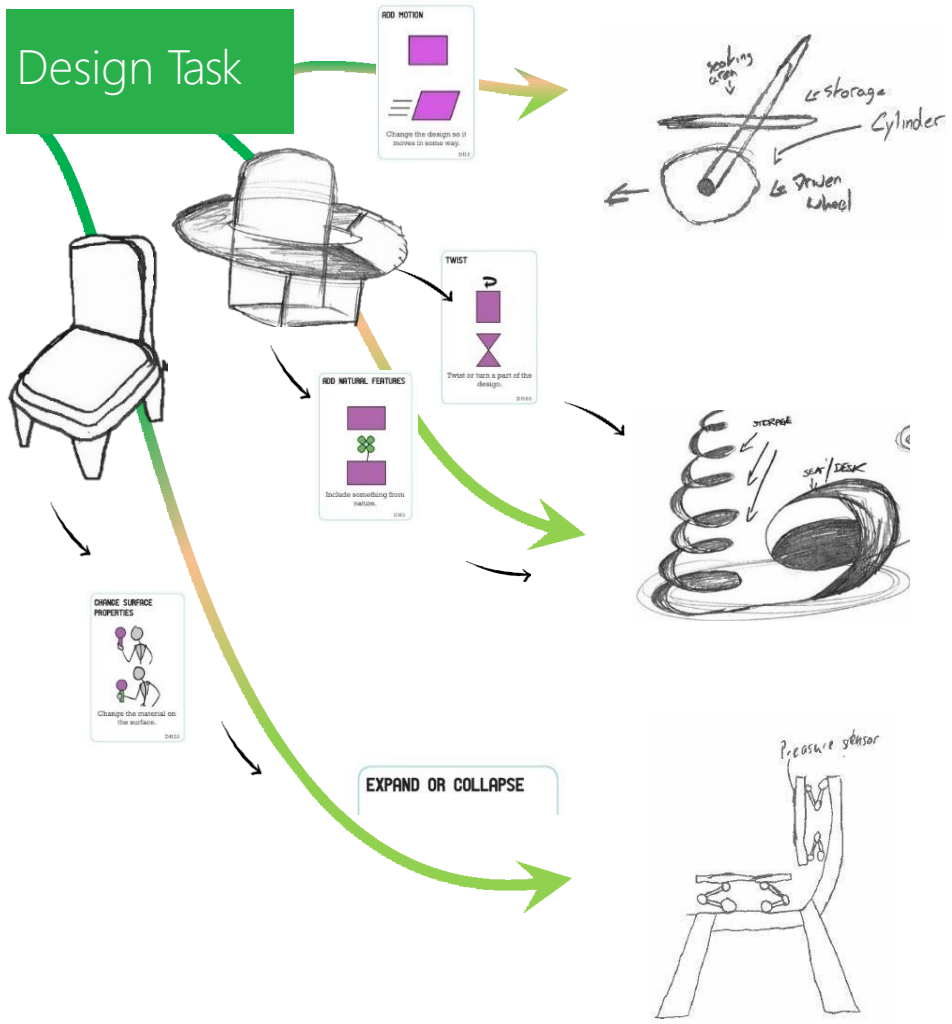


# Best Practices for Idea Generation

## BEST PRACTICES:

1. First concept generation session; Capture what is in your head!
2. Start with a subset of cards; Or one card
3. Work individually (at first); Your voice and ideas are important
4. Encourage doodles, sketches, drawings; Communication is key
5. Creativity, Diversity, and Quantity!
6. Generative → Transformative; Start with what you know, and transform from there!

# Design Heuristics evolving ideas

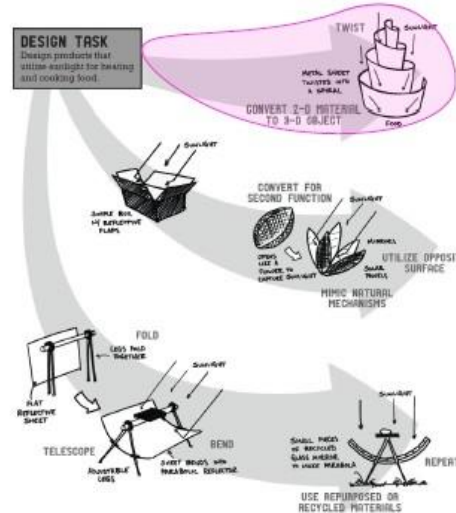


**46 Design Heuristics tool can support creativity in the context of:**

- Generate a new idea.
- Develop an existing idea
- Develop part of an existing idea.

# Using Design Heuristics

## Idea Initiation



Idea Initiation means to generate ideas.

To generate or initiate ideas...

- It can be difficult to generate ideas from the 'top of our heads'.
- We often have one idea, and find it difficult to think of more ideas.
- We often look at existing solutions or ideas to help us generate ideas.
- We often fixate (become obsessed) with:
  - Existing ideas
  - Existing solutions/products
  - Prior experience.

**Think like a designer with Design Heuristics**  
 Design Heuristics are idea modifiers, which:

- Offer an exciting means of generating a initial ideas during the idea generation process.
- Help us when we cannot think of initial ideas.
- Prompt us when we are stuck for ideas.

**Design Heuristics are represented on cards.**

- Use any part of a card to generate a new idea
- Generate new ideas by applying a card to a previous idea
- Use the abstract image to inspire ideas
- Use the title to inspire ideas
- Use the description to inspire ideas

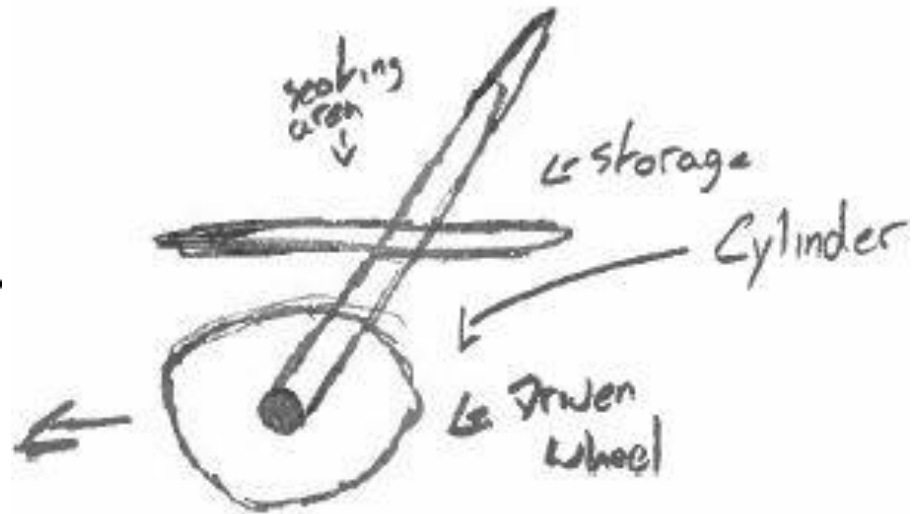
# Design Heuristics initiating an idea

## ADD MOTION



Change the design so it moves in some way.

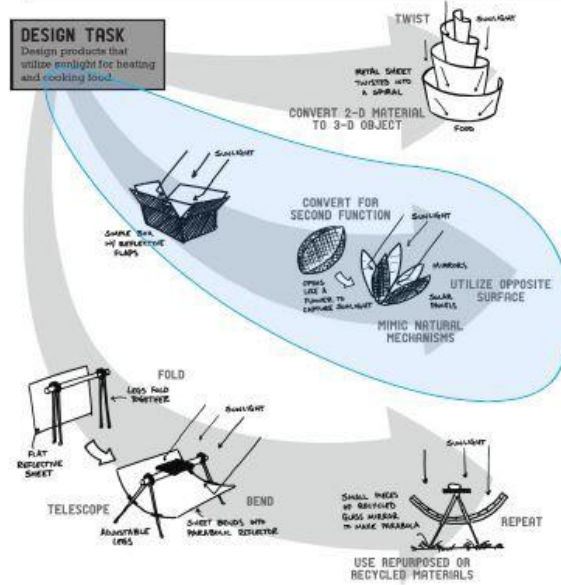
DH2



# Using Design Heuristics

To transform ideas...

## Idea Transformation



Idea transformation means to modify or alter ideas or existing solutions.

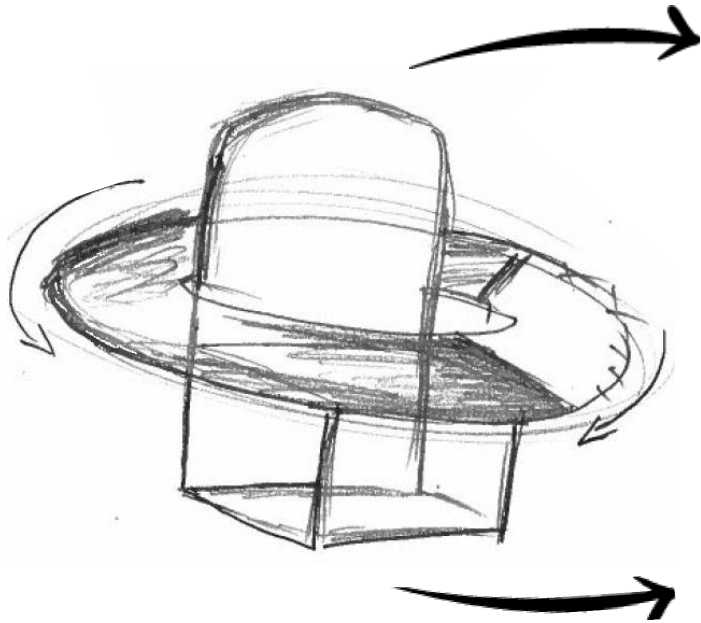
**Transformations:**

- It is very difficult to design from scratch, or from nothing.
- Many new products are developed from existing products that need to be improved for the user.
- Transform ideas by pushing your thinking a little further

**Generate multiple ideas through transformations**

Use Design Heuristics to push our ideas further

# Design Heuristic transforming an idea



## ADD NATURAL FEATURES



Include something from nature.

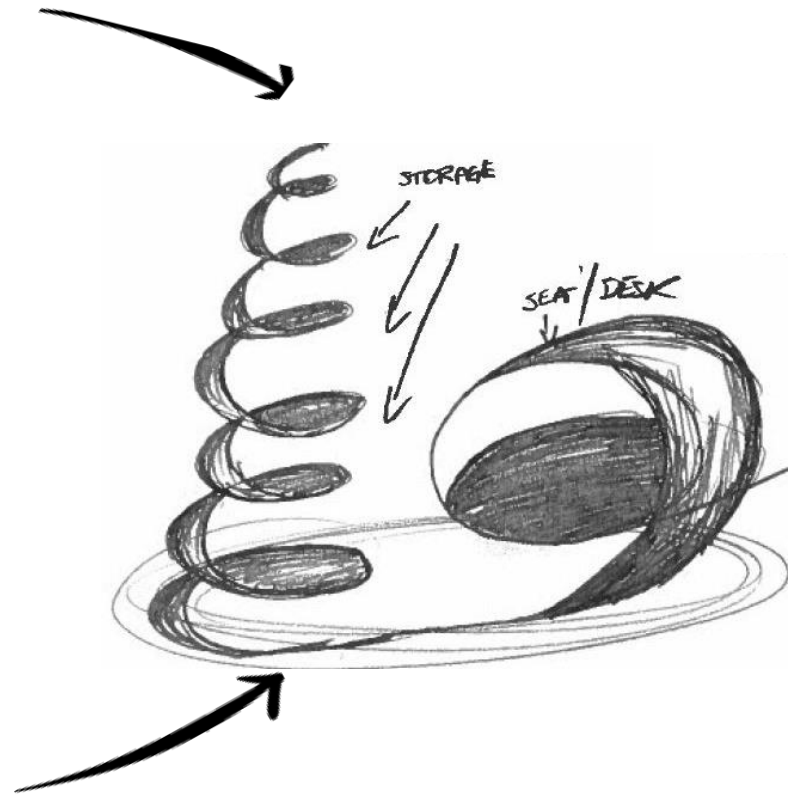
DH3

## TWIST



Twist or turn a part of the design.

DH66

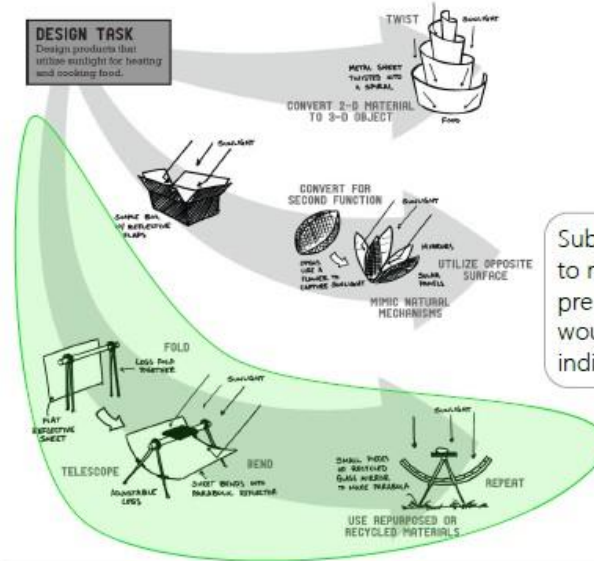


# Using Design Heuristics

## To develop subcomponents

- Decomposition
- Recomposition

## Subcomponent Design



Subcomponent design can be used to modify individual components of pre-existing whole products. This would enable designers to improve individual component(s) of a design.

### Subcomponent design

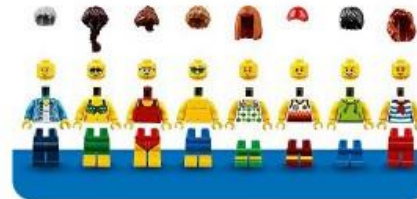
- Design by parts or components is a method which comes from engineering.
- It allows you to think of a product or idea in terms of the use of its many parts or components.



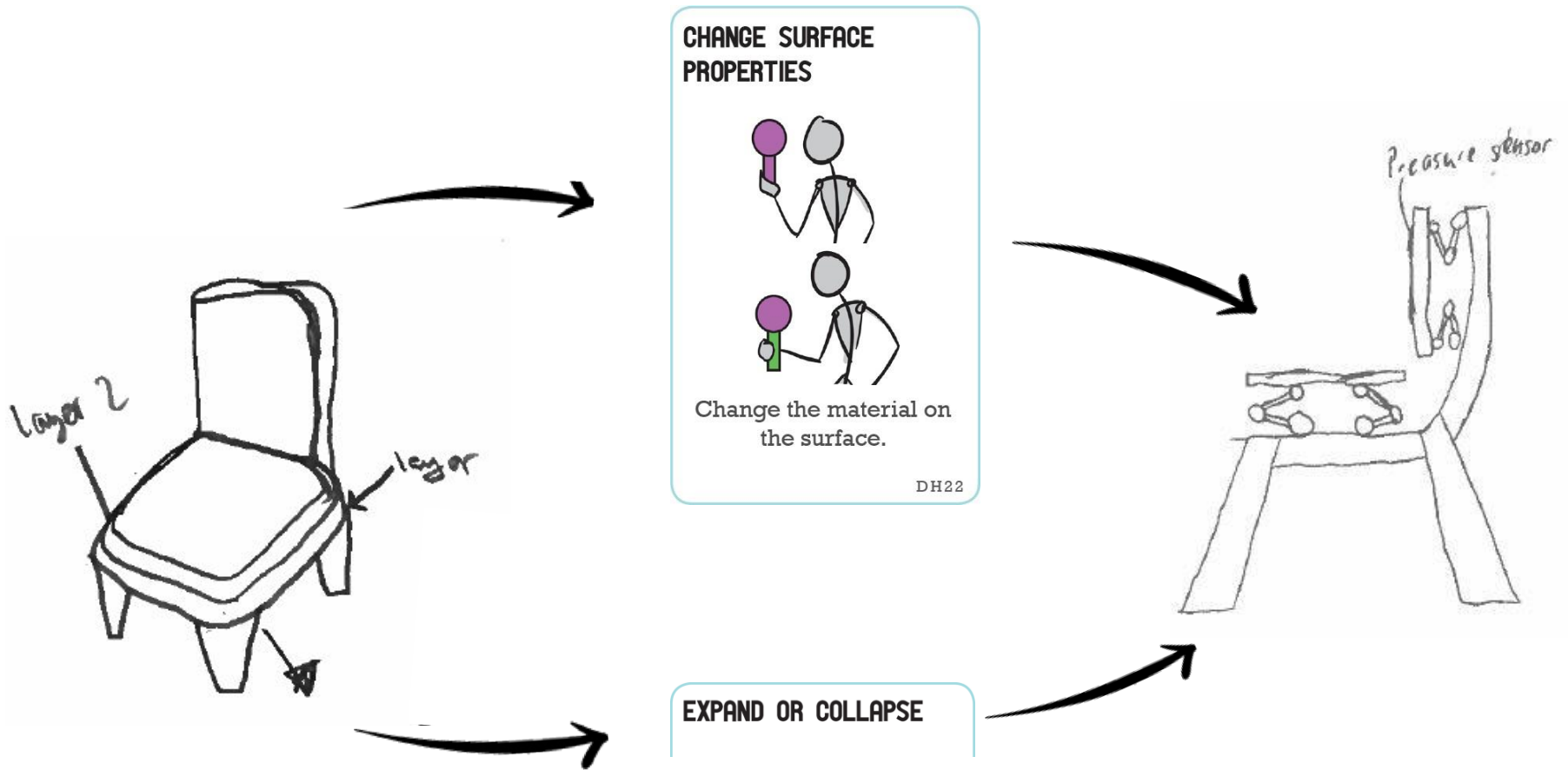
### Subcomponent design can involve two main activities:

**Decomposition** is the process of breaking something apart into smaller parts.

**Recomposition** is the process of putting the redesigned parts back together into one designed product.



# Design Heuristics developing parts of ideas







# IDEAShub



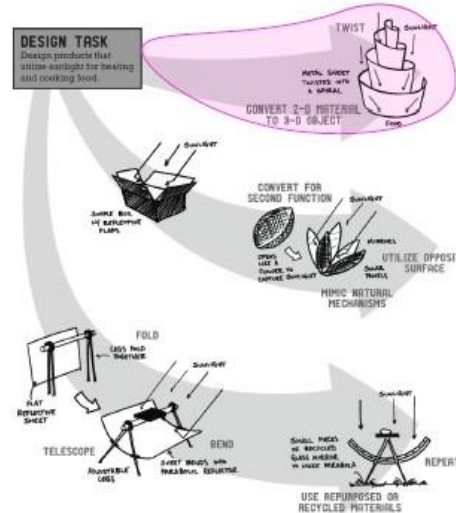
TOOLS FOR CREATIVE IDEAS



## Design Heuristics Familiarisation

# Using Design Heuristics

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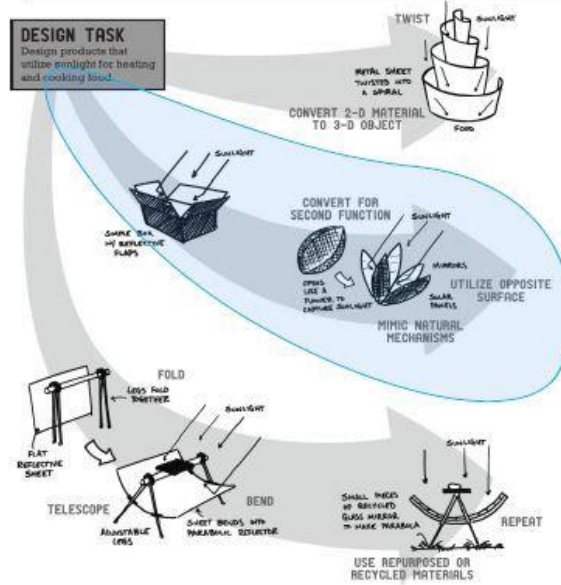
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# Using Design Heuristics

To transform ideas...

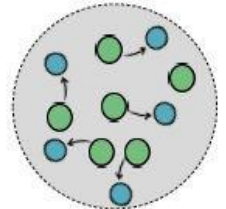
## Idea Transformation



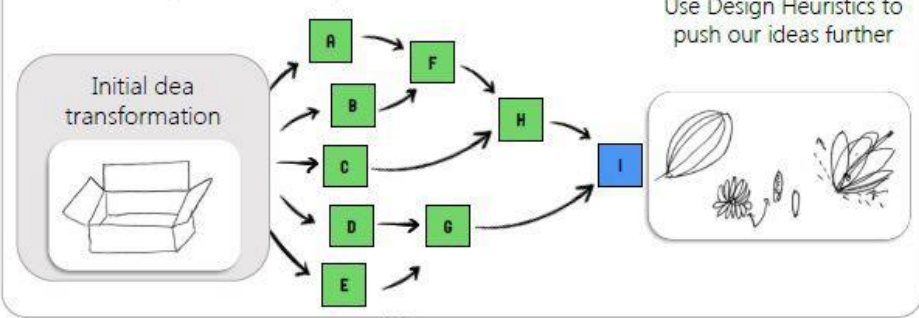
Idea transformation means to modify or alter ideas or existing solutions.

### Transformations:

- It is very difficult to design from scratch, or from nothing.
- Many new products are developed from existing products that need to be improved for the user.
- Transform ideas by pushing your thinking a little further



### Generate multiple ideas through transformations



# Using Design Heuristics for Idea Generation

## Activity 2

Spend 10 minutes generating ideas for the following design problem using the 46 Design Heuristic tool.

### **Squashed tomato challenge**

**The problem:** In Nepal, many farmers living on the mountainside grow fruit and vegetables, including tomatoes. To earn a living they need to sell these at the local market. The problem is getting to market involves a long, dangerous walk down the mountain side and over a river, at the end of which the tomatoes may well be a bit squashed.

**The challenge:** To design, [build and test] a way of transporting tomatoes down a mountain

# SHARE IDEAS & REFLECT

How many ideas did you generate?

How did use Design Heuristics to generate ideas?

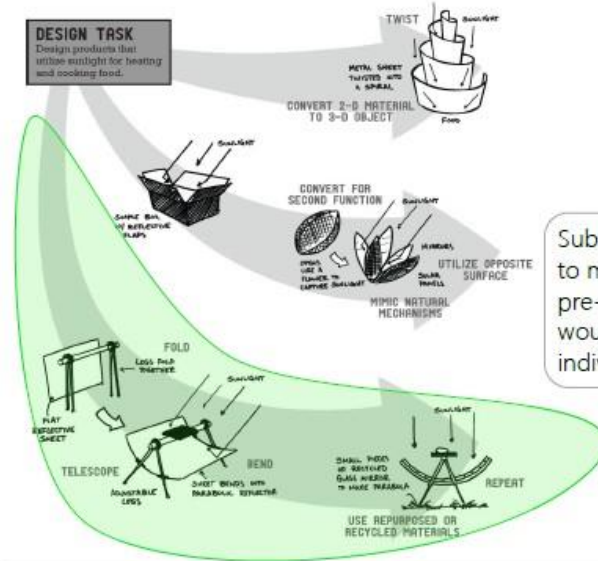
What was easy / difficult in solving this problem?

# Using Design Heuristics

## To develop subcomponents

- Decomposition
- Recomposition

## Subcomponent Design



Subcomponent design can be used to modify individual components of pre-existing whole products. This would enable designers to improve individual component(s) of a design.

### Subcomponent design

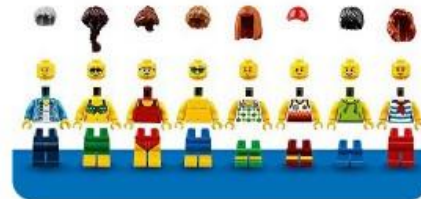
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### Subcomponent design can involve two main activities:

**Decomposition** is the process of breaking something apart into smaller parts.

**Recomposition** is the process of putting the redesigned parts back together into one designed product.



# Understanding Subcomponent Design

## Lesson 7: Subcomponent Design



### Activity 4 – Superhero redesign

Design a superhero using subcomponent design. Using the Design Heuristics, design the decomposed individual components of your favourite superhero. Then use Recomposition to generate numerous superheroes.



Subcomponent: Outfit

Subcomponent: Superpower

Subcomponent: Footwear

Subcomponent: \_\_\_\_\_

Recomposition: Using the decomposed ideas for the various parts of a superhero, recombine various parts to generate numerous superheroes.

Has your superhero changed since Lesson 5? \_\_\_\_\_

If so, explain how: \_\_\_\_\_

How did the Design Heuristics support you? \_\_\_\_\_

\_\_\_\_\_

# Using Design Heuristics

## Activity 3

Spend 10 minutes generating ideas for the following design problem using the 46 Design Heuristic tool.

### **Squashed tomato challenge**

**The problem:** In Nepal, many farmers living on the mountainside grow fruit and vegetables, including tomatoes. To earn a living they need to sell these at the local market. The problem is getting to market involves a long, dangerous walk down the mountain side and over a river, at the end of which the tomatoes may well be a bit squashed.

**The challenge:** To design, [build and test] a way of transporting tomatoes down a mountain



# SHARE IDEAS & REFLECT

How many ideas did you generate?

How did use Design Heuristics to generate ideas?

What was easy / difficult in solving this problem?



# IDEAShub



TOOLS FOR CREATIVE IDEAS



## Resources



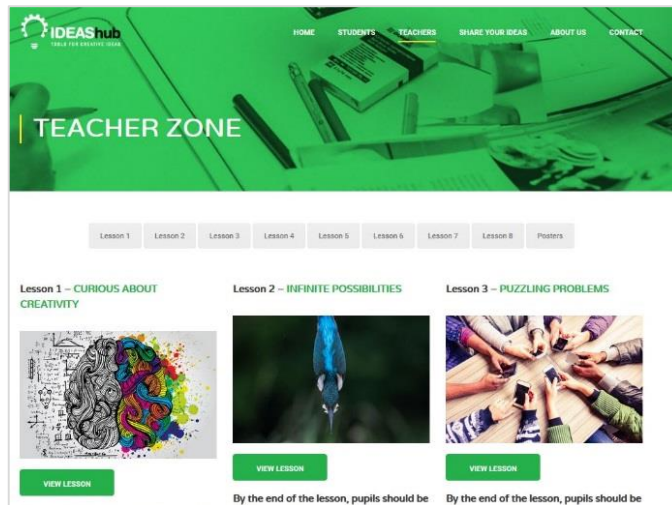


IDEAS hub is an educational programme, aimed at Primary and Post-Primary school teachers, and pupils, aged between 5-17 years.

IDEAS hub informs teachers and educates pupils on idea generation for enhancing creativity and innovation.

# IDEAS hub – www.ideashub.eu

## Teacher Zone

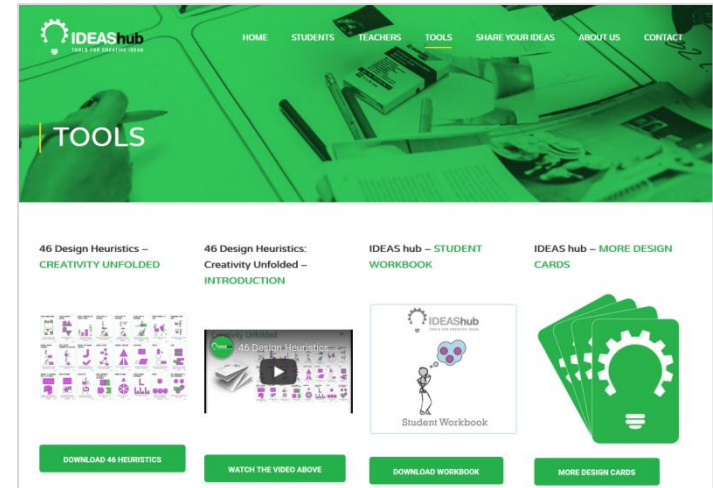


Teachers can access all resource material, including:

- Lesson plans
- Activity sheets
- Presentations
- Posters

All content is free to download and 100% adaptable.

## Tools



Teachers can access Tools from the website:

- The 46 Design Heuristics: Creativity Unfolded
- Explanation Video for students
- Student Activity Workbook
- Access to even more tools.

# IDEAS hub - Resources

## Activities

## Posters

## Lesson Plans

**Lesson 2: Infinite Possibilities**  
Activity 1

Q1: What do you think the role of a designer is?

Q2: List 5 challenges that caused you to be creative in the last week?

Q3: Show below are examples Sketching Activity. Try it for you buds. (Lateral thinking)

**Lesson 2: Infinite Possibilities**  
Activity 2: Biomimicry

Can you use any of the silhouettes below

**Lesson 7: Subcomponent Design**  
Activity 1

Spend 10 minutes generating ideas for the following design problem:  
Use one or more of the Design Heuristics cards to redesign some of the subcomponents of a bicycle.

Before we engage with idea Generation, we should:

1. Understand the Problem
2. Develop a Plan
3. Solve the Problem

Break down the problem

- Analyse the problem
- Research the problem
- Define your goals
- Highlight the issues
- Determine the facts
- Educate yourself
- Interpret the Problem
- Investigate

**Decomposition Activity:** Break down the components and list 5 subcomponents you would like to redesign.

1. Subcomponent Name: \_\_\_\_\_

2. Subcomponent Name: \_\_\_\_\_

3. Subcomponent Name: \_\_\_\_\_

4. Subcomponent Name: \_\_\_\_\_

5. Subcomponent Name: \_\_\_\_\_

### Idea Generation Techniques

**Fixation**

- An obsessive interest in or feeling about someone or something.
- The action or process of fixing or being fixed.
- Inability to see Alternative Solutions.

**Product Invention**

- Expanding your domain knowledge
- Adjust
- Support

**Natural Idea Generation**

- Involves generating ideas straight from the mind's eye.
- Brainstorm
- Spider Diagrams
- Mind Mapping

**Scamper**

You can use the Acronym SCAMPER to push your ideas naturally

**Introduction to Design Heuristics**

They capture how experienced designers think.

Primarily they have three main uses:

1. Generating initial ideas
2. Transforming ideas
3. Modifying parts of ideas

### Lesson 5: Design Heuristics and Idea Initiation

**Overview**

By the end of the lesson, pupils should be able to:

- Understand the uses of the DH cards.
- Understand how the Design Heuristics cards can be used to generate initial ideas if they have none.
- Use the design heuristic cards to generate initial ideas.

**Class Length:** 40 minutes  
**Year Group:** All ages  
**Resources:** Computer, projector, printed handouts, pens.

**Lesson Structure**

1. Introduction to Design Heuristics
  - Students should understand that we are all working within scope of the design process: Idea Generation.
  - It is still important to generate ideas naturally, and to always document ideas first.
  - Design Heuristics are a tool that can help you have initial ideas.
  - Using any part of a card to generate a new idea
  - Generate new ideas by applying a card to a previous idea
  - Use the abstract image to inspire ideas
  - Use the title to inspire ideas
  - Use the description to inspire ideas
2. Design Heuristics Guidelines
  - Using any part of a card to generate a new idea
  - Generate new ideas by applying a card to a previous idea
  - Use the abstract image to inspire ideas
  - Use the title to inspire ideas
  - Use the description to inspire ideas
3. Subcomponent Design
  - It can often be difficult to generate problem solutions without taking them off existing solutions. The cards offer an exciting means of generating initial ideas during the idea generation process.

**Lesson Activities**

**Activity 1:81**  
Purpose: Which this lesson looks at idea initiation through Design Heuristics, it is still important to give pupils the opportunity to generate their own ideas first.  
Suppliers - Natural Idea Generation: The first part of this activity will push the students to generate their own ideas naturally by asking them to design a new subcomponent for a novel camera.

**Activity 1:82**  
Purpose: This activity allows the students to develop more initial ideas using the Design Heuristics cards, pushing them deeper into the solution space.  
Suppliers - Idea Initiation: The students will then use the cards for assistance in generating initial ideas.

**Lesson Notes**

## Presentations

### Design Heuristics Recap

1. Idea Initiation
2. Idea Transformation
3. Subcomponent Design

**DESIGN TASK**  
Design problems that require insight for finding the best solution.

**CONVERT 2-D OBJECT TO 3-D OBJECT**  
TWIST

**CONVERT FOR SCALING / FUNCTION**  
UTILISE OPPOSITE SURFACE

**FOLD**  
FOLD

**TELESCOPE**  
BEND

**USE REINFORCED OR RECYCLED MATERIALS**  
REPEAT

# What do the lessons address?

1. Understanding Creativity
2. Understanding the role of Design and Designers
3. Understanding what a problem is and how to solve a problem
4. Idea Generation – How to generate ideas
5. Introduction to Design Heuristics – Idea Initiation
6. Idea Transformation
7. Subcomponent Design
8. More tools for Creative Idea Generation

How can the resources be used in education?

# Poster 5

## More Tools

This poster links to Lesson 8. There is a bank of tools that will help students to further develop their ideas.

# More Tools for Creative Ideas



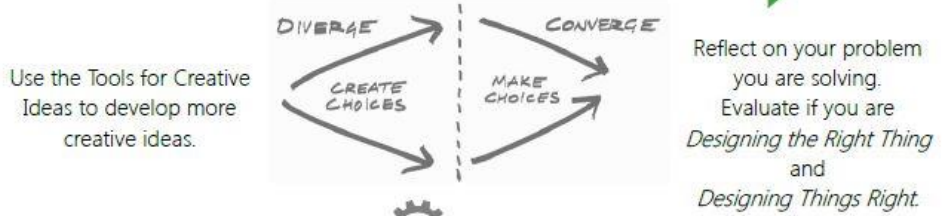
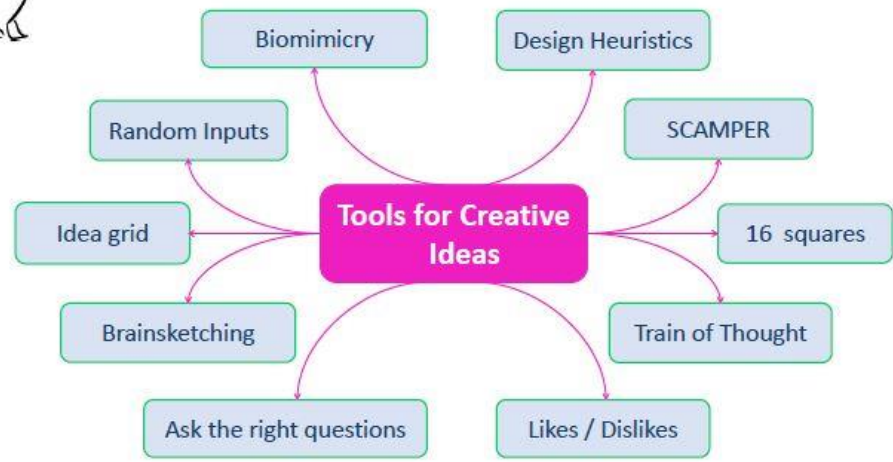
Remember your initial idea(s) - at the top of your head - are very important.



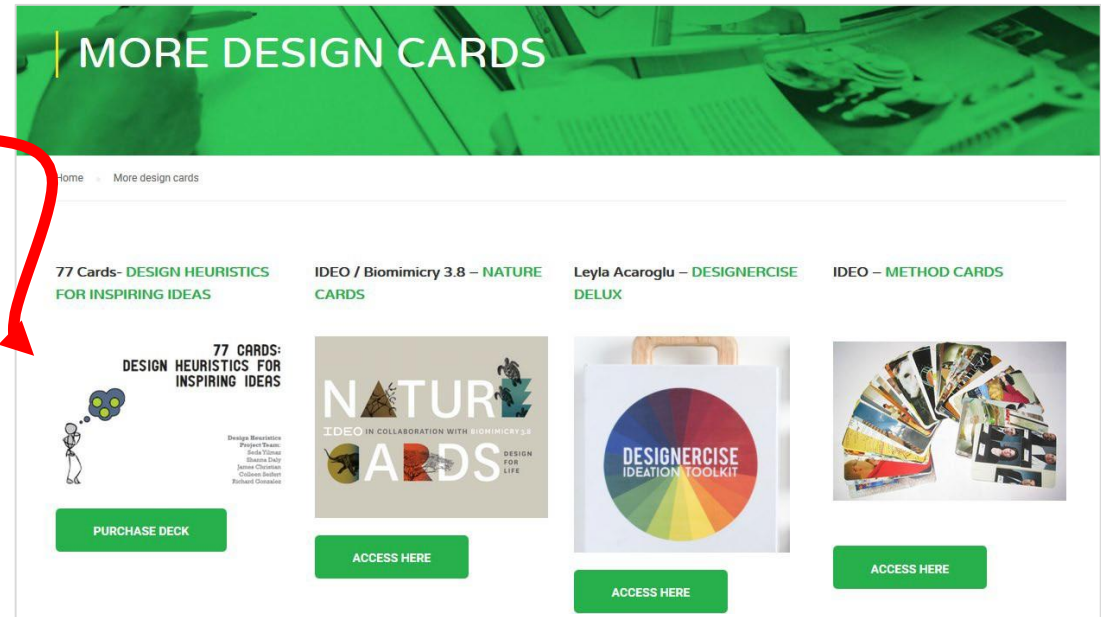
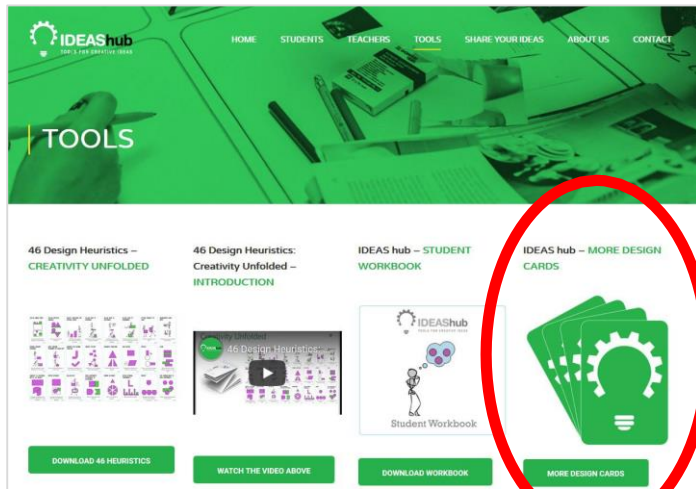
Capture them! Record them!

You may reach idea **exhaustion**; you cannot think of more ideas. Or you may experience **fixation**; unable to see past your first idea.

Use these tools to **push past** your initial idea and **diverge** to develop more creative ideas.



# www.IDEAShub.eu – More Tools







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**THANK YOU**

**QUESTIONS or COMMENTS?**

