Innovation Cycle

“The mere formulation of a problem is far more often essential than its solution, which may be merely a matter of mathematical or experimental skill”

Albert Einstein
What is Design Thinking?

- Human-Centered
- Collaborative
- Experimental
- Optimistic
Basic Components of the Design Process

Abstraction and Synthesis

Analysis

Problem Formulation

Implementation

Needs Assessment

Healthy Tolerance For Failure
The Design Process

**Ideation**
- Problem or Opportunity
- Discovery
- Interpretation
- Ideation
- Experimentation
- Evolution

**Traditional Design**
- Problem Definition
- Conceptual Design
- Preliminary Design
- Detailed Design
- Design Communication

**Solution**
- Final Design
Discovery: Define the Challenge

1. Understand the challenge
   a) Collect thoughts
   b) Establish constraints
   c) Frame the challenge
   d) Create visible reminders

2. Define your audience
   a) List immediate contacts
   b) Think more broadly, add people or groups
   c) Build an overview
   d) Create a visible reminder

3. Build a team
   a) Share who you are
   b) Define individual and team goals
   c) Agree on roles
   d) Give feedback

4. Share what you know
   a) Share what you know
   b) Define what you don’t know
   c) Build on your knowledge and fill in the gaps
Discovery: Prepare Research

1. Make a Plan
   a) Sketch a calendar
   b) Form agreements
   c) Create a visual reminder

2. Identify Sources of Inspiration
   a) Imagine interesting people to meet
   b) Think of extremes
   c) Make a list of activities you want to do

3. Invite Research Participants
   a) Describe the people you want to meet
   b) Plan the interaction and logistics
   c) Invite participants
   d) Track your recruiting progress
4. **Build a Question Guide**  
   a) Identify topics  
   b) Develop questions  
   c) Organize your questions  
   d) Build tangible conversation starters  
5. **Prepare for fieldwork**  
   a) Confirm your plans  
   b) Prepare your equipment  
   c) Assign roles  
6. **Practice Research Techniques**  
   a) Establish trust with participants  
   b) Get the most out of your interactions  
   c) Know what to look for  
   d) Capture what you see
Discovery: Gather Inspiration

1. Immerse yourself in context
   a) Plan your observations
   b) Explore and take notes
   c) Capture what you have seen

2. Learn from individuals
   a) Create a trusted atmosphere
   b) Pay attention to the environment
   c) Capture our immediate observations
   d) Get continuous feedback

3. Learn from groups
   a) Choose the participants
   b) Plan an agenda with activities
   c) Set up for a conversational atmosphere
   d) Listen to the group’s conversation
   e) Capture your immediate observations
   f) Get continuous feedback
Discovery: 
Gather Inspiration 

4. Learn from Experts
   a) Choose the participants
   b) Set up for a productive conversation
5. Learn from peers observing peers
   a) Select your research partners
   b) Decide on compensation
   c) Guide their research
   d) Meet frequently
6. Learn from peoples’ self-documentation
   a) Plan the documentation activities
   b) Invite and instruct participants
   c) Review with participants
7. Seek Inspiration in new places
   a) Think of analogies that connect with our challenge
   b) Make arrangements for your activities
   c) Absorb the experience
Interpretation

Interpretation

Tell Stories

Search for Meaning

Frame Opportunities
Interpretation: Tell Stories

1. Capture your learning
   a) Find a space and time
   b) Share your impressions
   c) Document your thoughts

2. Share inspiring stories
   a) Set up a space
   b) Take turns
   c) Actively listen
   d) Capture the information in small places
   e) Surround yourself with stories
Interpretation: Search for Meaning

1. Find Themes
   a) Cluster related information
   b) Find headlines
   c) Turn headlines into statements

2. Make sense of findings
   a) Look for links between themes
   b) Dig deeper
   c) Get input from the outside
   d) Be prepared to let go

3. Define insights
   a) Select what surprised you
   b) Reconnect the learning to your challenge
   c) Craft your insights
   d) Get an outside perspective
Interpretation: Frame Opportunities

1. Create a visual reminder
   a) Experiment with various visualizations
   b) Test your framework

2. Make Insights Actionable
   a) Develop “how might we” statements
   b) Choose brainstorming questions
Ideation

- Ideation
  - Generate Ideas
  - Refine ideas

Flowchart:
- Discovery
- Interpretation
- Ideation
- Experimentation
- Evolution
**Ideation: Generating Ideas**

1. **Prepare for Brainstorming**
   a) Start with a well defined topic
   b) Choose an appropriate space
   c) Provide tools to capture ideas
   d) Invite a diverse group of people
   e) Plan for 45-60 minutes

2. **Facilitate Brainstorming**
   a) Select a facilitator
   b) Present your topic
   c) Introduce the rules of brainstorming
   d) Equip everyone for participation
   e) Start with a warm-up
   f) Move one by one
   g) Keep the energy high

3. **Select Promising Ideas**
   a) Cluster the ideas
   b) Vote for favorite ideas
   c) Discuss the results

4. **Build to Think**
   a) Pick an idea
   b) Build a prototype
   c) Share back
Ideation: Refine Ideas

1. Do a Reality Check
   a) Find out what your idea really is about
   b) List constraints
   c) Brainstorm new solutions
   d) Evolve your idea
   e) Archive ideas

2. Describe Your Idea
   a) Capture your thoughts
   b) Evolve your summary
Experimentation

Experimentation

Make Prototypes

Get Feedback

Discovery

Interpretation

Ideation

Experimentation

Evolution
Experimentation: Make Prototypes

1. Create a prototype
   a) Create a storyboard
   b) Create a diagram
   c) Create a story
   d) Create an ad
   e) Create a mock-up
   f) Create a model
   g) Create a role-play
Experimentation: Get Feedback

1. Make a test Plan
   a) Define what to test
   b) Build a prototype to share

2. Identify sources for feedback
   a) Consider the setting
   b) Define feedback activities

3. Invite Feedback Participants
   a) Decide on who to involve
   b) Plan the interaction and logistics
   c) Invite participants
   d) Track your recruiting progress

4. Make a test Plan
   a) Define what to test
   b) Build a prototype to share

5. Facilitate Feedback Conversations
   a) Invite honesty and openness
   b) Provide multiple prototypes
   c) Stay neutral
   d) Adapt on the fly

6. Capture Feedback Learning
   a) Find a space and time
   b) Share your impressions
   c) Capture your ideas and design interactions
Evolution

Evolution

Evaluate Learning

Build the Experience
Traditional Design Process

1. Clarify Objectives
2. Establish User Requirements
3. Identify Constraints
4. Establish Functions

5. Establish Design Specifications
6. Generate Alternatives

7. Model or Analyze Design
8. Test and Evaluate Design

9. Refine and Optimize Design

10. Document Design

Problem Definition

Conceptual Design

Preliminary Design

Detailed Design

Final Design

Design Communication

Client Statement (Need)
Market: Formulating the Real Problem

- Client (Customer) v. End User
- Focus upon the function(s) to be performed by any viable solution
  - Avoid becoming too specific
- Formulating the Real Problem
  - Initial statement too vague
  - Initial statement ill-conceived
  - Initial statement simply incorrect
- Using heuristics for accurate problem formulation
  - Statement-Restatement
  - Determining the Source and Cause
  - Present State and Desired State via Duncker Diagrams
Client Statement: Heuristics
Statement v. Restatement

1. Determine the Real Problem (in Contrast to the Stated Problem)
   a. Varying the emphasis placed on certain words and phrases
   b. Substituting explicit definitions of certain terms
   c. Changing positive terms to negatives and vice versa
   d. Replacing persuasive and/or implied words

2. Determine the actual constraints or boundaries (in contrast to the given or inferred boundaries)
   a. Relax given constraints

3. Identify meaningful goals (in contrast to a set of given or inferred goals)

4. Identify relationships between inputs, outputs, and any unknowns
Client Statement: Heuristics
Determine the Source and the Cause

1. Can the source explain how the problem statement was developed
   a. Person
   b. Journal article
   c. Data

2. Is the focus of the problem statement the source/cause of the problem or merely its symptoms?
Client Statement: Heuristics
Present State and Desired State

1. Specify the Problem Statement (present state)

2. Specify the Desire Statement (wanted)

3. Modify Either until there is a Satisfactory Correlation

4. Explore Possible Solution Paths Leading from the Problem Statement to the Desire Statement

5. Is the focus of the problem statement the source/cause of the problem or merely its symptoms?
Client Statement: Heuristics
Dunker Diagrams

Graphical Tool that can be used to Develop a set of Matching Problem and Desire Statements

Developing Solutions at Three Levels
1. General Solution-Two Types
   a. Action to be taken to achieve Desired State
   b. Actions that transform the Desired State until it matches the Problem Statement

2. Functional Solution
   a. Consider any and all possibilities
   b. Feasibility not considered

3. Specific Solutions – What is Feasible
## Client Statement: Heuristics

### Kepner-Tregoe Problem Analysis

<table>
<thead>
<tr>
<th><strong>Is</strong></th>
<th><strong>Is Not</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>What is known?</td>
<td>What is NOT Known?</td>
</tr>
<tr>
<td>What was observed?</td>
<td>What was NOT observed?</td>
</tr>
<tr>
<td>What are the constraints?</td>
<td>What are NOT constraints?</td>
</tr>
<tr>
<td>What is important?</td>
<td>What is NOT important?</td>
</tr>
<tr>
<td>What are the goals/objectives?</td>
<td>What are NOT goals/objectives?</td>
</tr>
<tr>
<td>What can be expected?</td>
<td>What IS NOT expected?</td>
</tr>
<tr>
<td>When did the problem occur?</td>
<td>When did the problem NOT occur?</td>
</tr>
<tr>
<td>When must solution be implemented?</td>
<td>When is solution NOT needed</td>
</tr>
<tr>
<td>When did changes occur?</td>
<td>When did changes NOT occur?</td>
</tr>
<tr>
<td>When were instruments calibrated?</td>
<td>When were instruments NOT calibrated?</td>
</tr>
<tr>
<td>Who can provide more information?</td>
<td>Who can NOT provide more information?</td>
</tr>
<tr>
<td>Who is the customer/end user?</td>
<td>Who is NOT the customer/end user?</td>
</tr>
<tr>
<td>Who performed (each) task?</td>
<td>Who did NOT performed (each) task?</td>
</tr>
<tr>
<td>Who is source of information?</td>
<td>Who is NOT the source of information?</td>
</tr>
<tr>
<td>Who is affected by problem?</td>
<td>Who is NOT affected by problem?</td>
</tr>
</tbody>
</table>
# Client Statement: Heuristics

Kepner-Tregoe Problem Analysis Continued

<table>
<thead>
<tr>
<th>Is</th>
<th>Is Not</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where did the problem occur?</td>
<td>Where did the problem NOT occur?</td>
</tr>
<tr>
<td>Where are input sources located?</td>
<td>Where are input sources NOT located?</td>
</tr>
<tr>
<td>Where is equipment located?</td>
<td>Where is equipment NOT located?</td>
</tr>
<tr>
<td>Where are products shipped?</td>
<td>Where are products NOT shipped?</td>
</tr>
<tr>
<td>Where is customer/end user located?</td>
<td>Where is customer/end user NOT located?</td>
</tr>
<tr>
<td>Why is problem important?</td>
<td>Why is problem NOT important?</td>
</tr>
<tr>
<td>Why does solution work?</td>
<td>Why does solution NOT work?</td>
</tr>
<tr>
<td>Why is there a problem?</td>
<td>Why is there NOT a problem?</td>
</tr>
<tr>
<td>How is problem related to other problems?</td>
<td>How is problem NOT related to other problems?</td>
</tr>
<tr>
<td>How can a task be performed?</td>
<td>How can a task NOT be performed?</td>
</tr>
<tr>
<td>How did problem develop?</td>
<td>How did problem NOT develop?</td>
</tr>
</tbody>
</table>
Problem Definition

**Input:** Client Statement

**Sources:**
- Literature on state-of-the-art
- Experts
- Codes and regulations

**Tasks:**
- Clarifying objectives for the designer
- Establishing user requirements
- Identifying constraints
- Establishing functions

**Output:**
- Revised problem statement
- Detailed (weighted) objectives
- Constraints
- User requirements
- Functions
Conceptual Design

Input: Revised problem statement
      Detailed (weighted) objectives
      Constraints
      User requirements
      Functions

Sources: Competitive products

Tasks: Establish design specifications
       Generate design alternatives

Output: Conceptual design(s) or scheme(s)
        Design specifications
Preliminary Design

**Input:** Conceptual design(s) or scheme(s)  
Design specifications

**Sources:** Heuristics (rules of thumb)  
Simple models  
Known physical relationships

**Tasks:** Model and analyze the conceptual design alternatives.  
Test and evaluate the conceptual design alternatives.

**Output:** Selected Design  
Test-and-evaluation results
Detailed Design

Input: Selected Design
Test-and-evaluation results

Sources: Design codes
Handbooks
Local laws and regulations
Suppliers’ component specifications

Tasks: Refine and optimize the chosen design alternatives.

Output: Proposed fabrication specifications.
Final design review and presentation to client.
Design Communication

Input: Fabrication specifications

Sources: Feedback from clients and users
Required deliverables

Tasks: Document the complete design

Output: Report to client
1. fabrication specifications
2. justification for fabrication spec’s
Ground Rule for Design Notebook

- Number and date every page
- Never tear out a page
- Leave no blank pages between used pages. Draw a slash between blank pages
- Include all your data, descriptions, sketches, calculations, notes, and so forth
- Put an index on the first page
- Write everything in real time.
- Write in ink
- Paste in external figures
- Write as though you know someone else will read it
- Document team meetings.