

### Problem Exploration Perspectives

#	Strategy	Definition
1	Break Down the Primary Need	Analyze the primary need of the desired solution and break it into different smaller pieces. Choose one of the subcategories to focus on and detail it in the problem statement. This will help narrow the scope of the problem.
2	State the Primary Need	Determine the primary need for the desired solution that will solve the limitations of the current state. This will answer the question, "What are you trying to achieve by solving this problem?" Detail the need in the problem statement.
3	Describe the Setting	Analyze the non-natural environment in which the final solution will be implemented. Describe the conditions of the environment and the limitations that exist in the problem statement. This includes the availability of power and internet and descriptions of the social and political climate or typography. It does not include the weather (rain, snow, hail) or general climate references.
4	Elaborate on a Method/ Means	The specific details about the solution are discussed rather than leaving ideas at a conceptual level. How exactly will the device or process function and more importantly, how will it accomplish its overall goal?
5	Describe the Users' Need	Determine who the end users of the final solution will be. Define specific criteria that the solution must adhere to that will benefit these users and their experience with the final solution. This includes criteria for ease of use, ergonomics, and safety.
6	Focus Setting/ Scenario	Determine a specific situation or place for the operation of the device or solution. Rather than generalizing a solution for use in other situations or scenarios, tailor the solution to a particular use. For example, matches are a universal solution for starting fires, but not when the environment is wet. Instead, another device must be used to start a fire.
7	Describe Material Characteristics	Think about the specific material needs of the final solution and describe the necessary characteristics the material must have in the problem statement. The characteristics may include durability, elasticity, etc.
8	Detail the Operational Requirements	What conditions need to exist for the product or process to operate the way it was intended? Is it operated manually, remotely, or with the aid of the external environment? For instance, a grow toy will only grow if it is placed in water or some other liquid. On the other hand, a solar panel won't collect energy unless there is light.
9	Determine the Primary User	Determine the primary user of the device or solution. List or describe who they are in relation to the situation or scenario.
10	Utilize Existing Solutions	Instead of exploring ways to design a device the designer decided to use an existing device to solve a problem or shift the problem definition to a problem that did not require a device.
11	Describe the Desired Dimensions	Analyze the setting and the use cases of the desired solution. Determine the size of objects in the setting or of the device or solution to be designed. The designer may consider multiple factors when making decisions about actual or preferred size.
12	Integrate Mobility	Analyze the specific scenario in which the desired solution might be used and integrate the need for mobility (can be moved place to place).
13	Determine the Required Cost	Analyze the economic status of the individuals, local communities, nations, etc. that will use the final solution. Estimate final costs of the solution.
14	Break Down the Primary Stakeholder Group	Brainstorm the different groups within the initial stakeholder group you identified. Select a specific group as the new primary stakeholder to encompass more individuals and detail it in the problem statement.
15	Detail the Required Functions	Determine and describe in detail the function(s) of the device or system based on the goal, purpose, or needs of the situation.
16	Describe Environmental Conditions	Describe the environment in which the final solution will be implemented. Describe the conditions of the natural environment (weather, topography, climate, and biomes).
17	Focus on Eco-Friendly Solutions	Evaluate the environment in which the final solution will be implemented. Detail specific criteria that the solution must adhere to that will benefit the environment - the ecosystem, the resources, etc. Think about issues such as material waste, climate change, use of natural resources, etc.
18	Describe Secondary Functions	Describes additional functions beyond the primary function of the device.
19	Prioritize Use Cases	The designer decides the priority of use for the device.

From Murray, Studer, Daly, McKilligan, & Seifert (2019). Design as perspective taking: How engineers explore problems. *Journal of Engineering Education*, 108(2), 248-275.

20	Modify Existing Solutions	The designer decides not to design a device but instead alters an existing device to satisfy the needs of the current situation.
21	Incorporate More Scenarios	List additional settings and situations where the solution could solve a problem.
22	Describe the Required Maintenance Needs	Determine how the desired solution will be maintained or serviced after implementation. What tools/labor are required? The maintenance criteria should be defined to suit the environment and situation of the desired solution.
23	Describe the Desired Appearance Attributes	Describe the visual qualities needed to support the primary functions to enhance the users' experience with the outcome. This could be functional or aesthetic.
24	Describe an Existing Solution to Use as Conceptual Inspiration	An existing product serves as a metaphor, analogy, or simile for the solution.
25	Expand the Primary Stakeholder Group	Make a list of larger groups that the primary stakeholder group is a part of. Select one of these groups to encompass more individuals than the initial primary stakeholder group you identified.
26	Expand the Scope	Analyze the primary outcome of the desired solution and add scope to the goal (while still being manageable) to maximize the benefits of the final solution.
27	Add Potential Limitations	After analyzing aspects of the problem, determine possible limitations to a solution search.

### Example Application

#### Space Debris Presented Problem Statement

Space debris-the trash that orbits the earth-is a hazard to the International Space Station (ISS), active satellites, vehicles, and any object traveling from the earth's surface to or through the Low-Earth orbit region (within 1200 miles of the earth's surface). The debris left behind from rockets lifting objects to the Low-Earth orbit, inactive satellites, and collisions among satellites poses a threat to active space objects. At speeds of thousands of miles per hour, debris the size of marbles can have more energy than a bullet released from a machine gun.

The Department of Defense's Space Surveillance Network can track space debris larger than two inches (currently over 21,000 objects). The International Space Station (ISS) has debris shields to protect itself from smaller projectiles; however, recently the ISS was struck by a millimeter-sized piece of debris that left a 1 ½ inch deep pit in one of its windows. How can we fix the problem of space debris?

#### Space Debris Discovered Problem #1

##### *Detail Required Dimensions*

Space debris of less than two inches in each dimension poses a threat to active objects traveling within 1200 miles of the earth's surface because it is not visible with currently available technology. How can we track small debris?

#### Space Debris Discovered Problem #2

##### *Use Existing Solutions as Conceptual Inspiration*

On earth's surface there are ways to legally and socially deal with pollution. There are rules and regulations for those who violate laws. How can we apply what we know about pollution from other situations to resolve the current space

#### Space Debris Discovered Problem #3

##### *Detail Operational Requirements*

Develop a way to safely remove space debris from the Low-Earth orbit region. The solution should not disrupt the path of active satellites or space vehicles orbiting in the region.