

You have 3 jars, of sizes 11 quarts, 9 quarts, and 4 quarts. You would like to use these jars to collect 6 quarts of water in one jar. How?

| A  | B   | C  | Goal          |
|----|-----|----|---------------|
| 11 | 9   | 4  | 6 $A - B + C$ |
| 21 | 127 | 4  | 98            |
| 15 | 90  | 4  | 67            |
| 14 | 163 | 25 | 99            |
| 18 | 43  | 10 | 5             |
| 9  | 43  | 6  | 22            |
| 20 | 59  | 4  | 31            |
| 14 | 36  | 8  | 6             |
| 28 | 76  | 3  | 25            |

For most problems, people use a relevant strategy from habit.

There's an excellent reason for this: It usually works!!

Sometimes, the habit strategy is a bad match for the problem.

In this case, people can act like they are “blind” to the solution.

Example: Water jar problem.

“Einstellung” is the state of being “blind” or “tuned-in” to something.

“Functional Fixedness”: People often fail to see alternate uses to an object once they assign it a role.

People are fairly predictable in their susceptibility to functional blindness.

Awareness of the problem helps to avoid it.

This is real issue for students and in “real life”

Example: Debugging, algorithm design

“Vertical thinking” is sticking with the current approach, being rigid.

“Lateral thinking” is coming at a problem from a different (perhaps nonstandard) direction.

Often, just realizing that this should be done is enough to find a good solution (getting out of the old approach).

Of course, it can be hard to tell when you are in the trap! It helps to have a “flexible” mindset.

## Unsticking a car lock on a cold night

- Approach 1: Heat the key
- Approach 2: Unfreeze the lock (with alcohol)

## Need to iron a shirt, but no iron

- Iron with something else (a frying pan)

## Sheep in front of the truck

- Approach 1: Beep horn, try to push or scare sheep
- Approach 2: Lead the sheep behind the truck

## Brainstorming

- Generate ideas
- Usually done in groups
- Don't judge – respect crude ideas
- Quantity is important

Brainstorming is a skill that can be developed

- Skills are developed by practice

## In-the-small

There is an answer, the problem is to find it.

## In-the-large

Many possible solutions.

More complex problems -> more alternative solutions.

The goal is to pick the best solution.

The first step is to define the “right problem”.

Often the hardest/most important step

The “real problem” is often disguised.

Symptoms vs. root problem

Example 1:

Store had a rain forest health food mix.

It didn't sell.

Perceived problem: overpriced.

Real problem: badly displayed.



Flow meters in a chemical plant were being corroded and would leak.

Perceived problem: “Find materials to make meter from that will not corrode”.

After much effort, no such materials were found.

Real problem: “Keep the flow meter from leaking”.

Solution: Regularly replace (cheap) flow meters.

Oil company had underperforming oil field.

Perceived problem: “Find ways to improve the oil recovery”.

After years of effort, still no improvement.

Eventually discovered that the estimates of oil in field were wrong.

Real problem: “Learn why the well was not producing well”.

## Example: Gas from Coal

Defining the Problem 11

A coal-to-gas process was generating tar-like substances in pipes.

Perceived problem: “Improve the solvents used to dissolve the coal to avoid the tar”.

No solvent was found that worked.

Real problem (generalize): “Determine why tar deposits are forming, and avoid them”.

Solution: Increase velocity in pipes gives coal and solvent less time to react and scours pipes clean.

## Example: Irrigation Dam

Defining the Problem 12

Arid desert, but some plants grow.

Solution: Design and build a dam to divert river water for irrigation.

Very expensive dam was built.

Result: High salt concentrations were dissolved, killing both old and new plants.

How to avoid this outcome?

1. Collect and analyze information and data.
  - List every relevant thing you can think of.
  - Fill in missing gaps.
2. Talk with people familiar with the problem.
  - Look past the obvious.
  - Get clarifications when you don't understand.
3. If at all possible, view the problem first hand.
4. Confirm all findings.