

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

"Imagination is more important than knowledge."

- *Albert Einstein (1879-1955)*

[Einstein Thought Experiments:](#)

www.pbs.org/wgbh/nova/physics/einstein-thought-experiments.html

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”.

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.

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.