Thinking outside the box in engineering designs
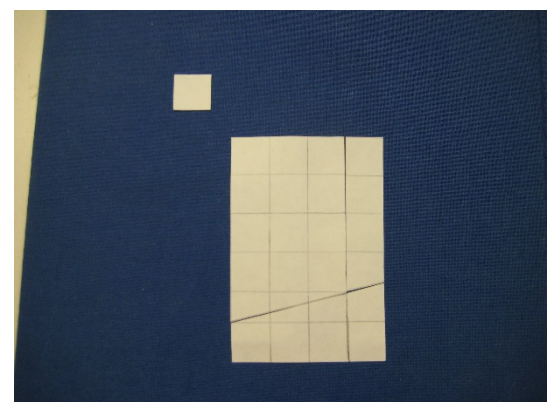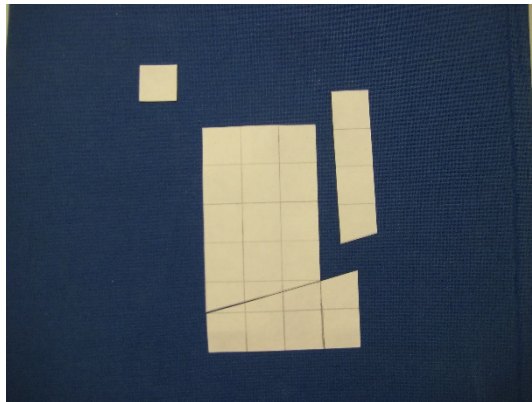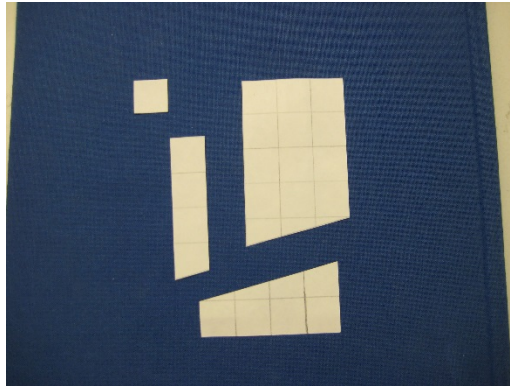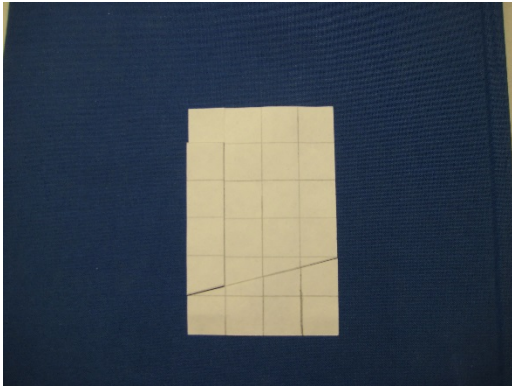
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http://www.engin.brown.edu/courses/en193-194s7/PDFs/engine90-crawford-CREATIVE-print.pdf

Thinking outside the box:

- False assumptions
- Artificially added limitation
- Bounded by traditional thinking
- …

Exercise 1:

Exercise 2:

A truck was driven into an opening under a viaduct. It was too high for the opening and became wedged so tight that the driver was not able to back the truck out. A little boy came along and asked, "When are you going to get the truck out?" The frustrated driver said, "As soon as I figure out how to do it." The boy said he did not think it was a big problem, and the man replied, " If you are so smart, how would you do it?"

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The boy replied, "I would let the air out of the tires until it was low enough to drive out."

Exercice 3 :

A manufacturer of golf carts developed a new model. Soon after its introduction, the company began receiving reports that the model tipped over if placed on a sharp slope. Alterations suggested by engineers at R&D were found to be excessively expensive. When the West Coast representative demanded that someone from the manufacturer visit his area so he could show the company was working on the problem, a new employee from R&D was sent out.

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The new R&D employee took one look at the problematic
cart and asked to get it on a trailer so he could transport it.
He took the cart to a nearby farm machinery dealership and
asked a service worker if he could put water into the large
rear tires. The service worker answered " yes," and the R&D
employee asked him to fill the tires half full. After
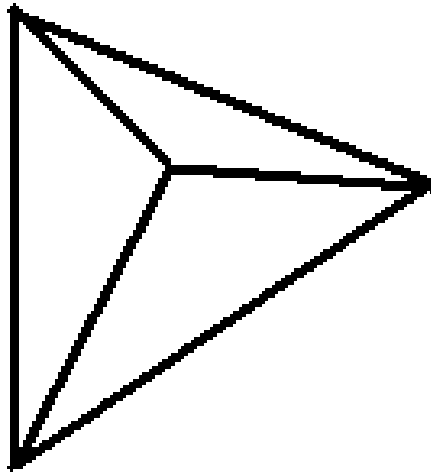that, it was almost impossible to tip over the cart.
Water was a solution.

Exercise 4:
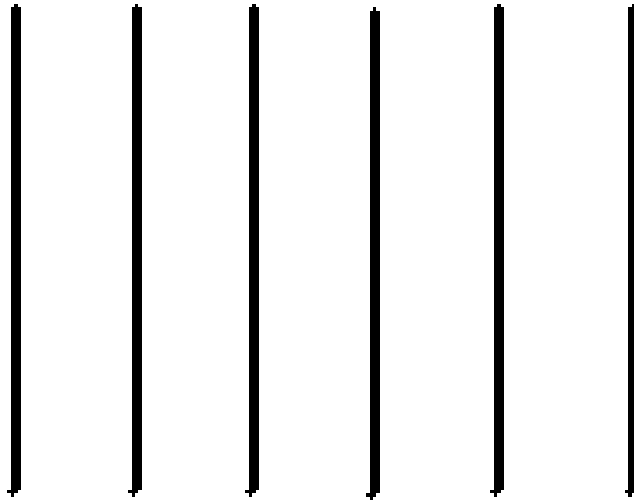
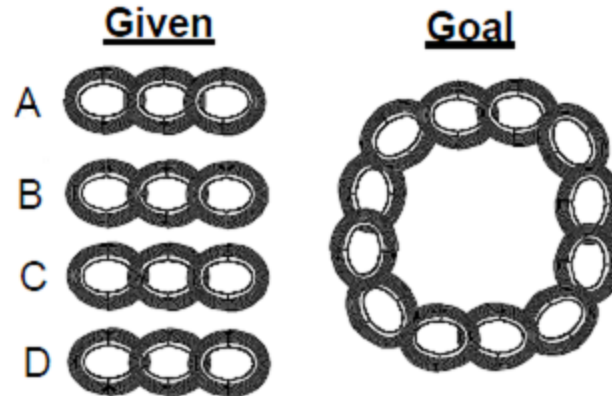Connect 6 toothpicks so that one end of each toothpick attaching to the ends of other two toothpicks.

Why were you unsuccessful?
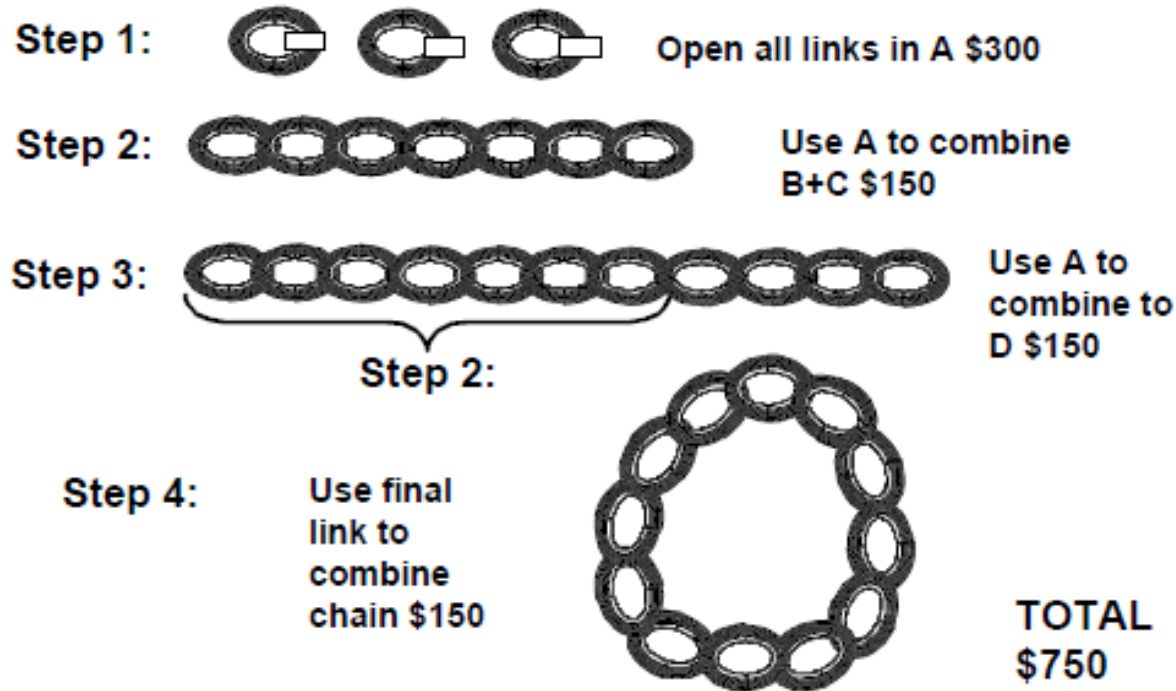

Limit yourself into a two dimensional space.

Exercise 5:

You have 4 separate pieces of chains. It costs $100 to open a link and $150 to close a link. All links are closed at the beginning.
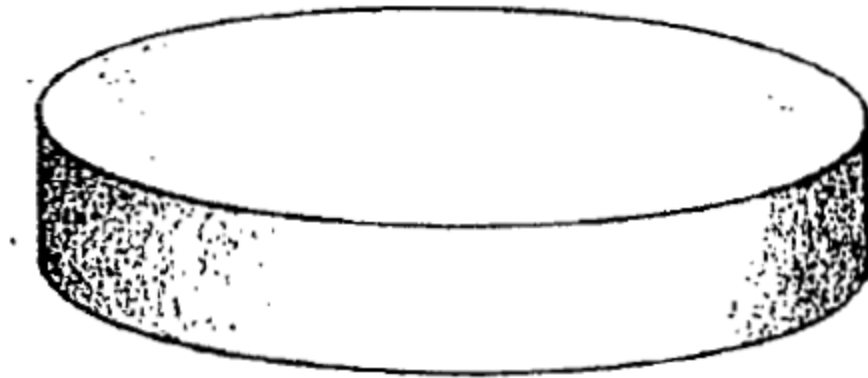
Join all 12 links into a single chain circle with total budget no more than $750.

Why were you unsuccessful?

Step 1: Open all links in A $300

Step 2: Use A to combine B+C $150

Step 3: Use A to combine to D $150

Step 2:

Step 4: Use final link to combine chain $150

TOTAL $750

False assumption: limited to inserting only one link into one opening.
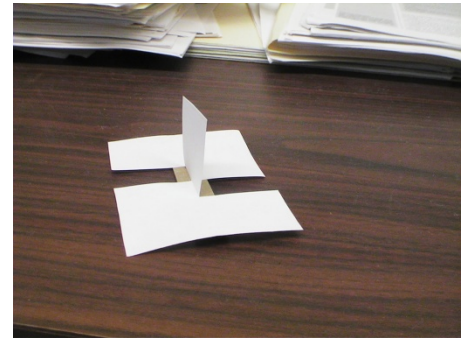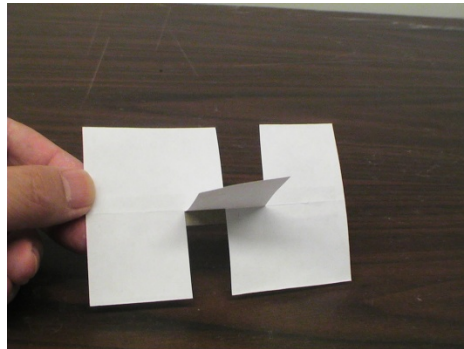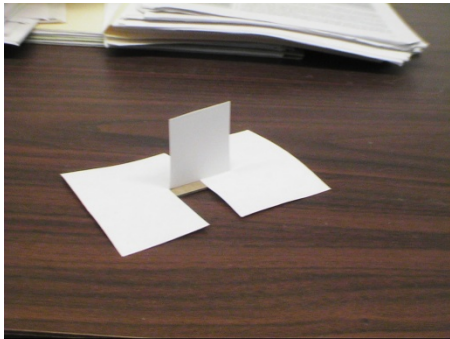
Exercise 6:

Cut a plain circular cake into eight portions, as equal as possible, by three straight cuts of a knife.

Why were you unsuccessful?
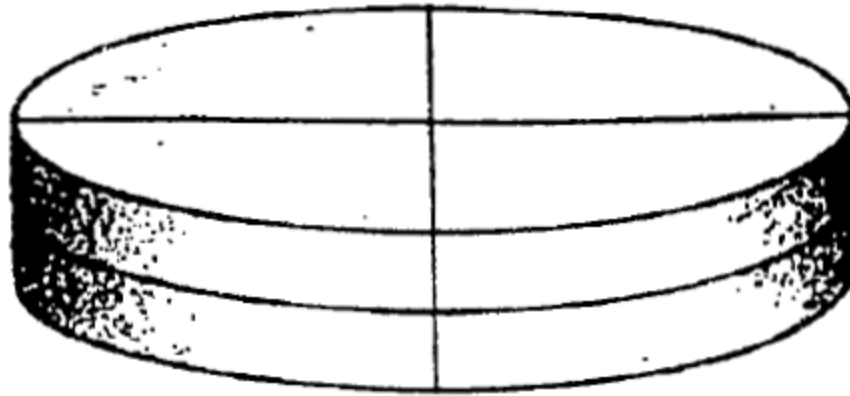
Constraint yourself to vertical cuts.

An in-class exercise: How to make…?

A successful story: Google's

Boolean search engines: For example,

car and *maintenance*

returns all documents that use both words in the title.
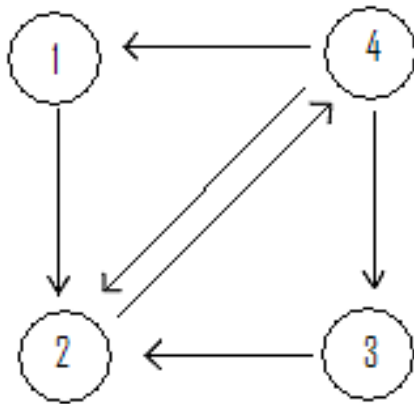How to rank them is up to you.

PageRank: Each wepage is assigned a numerical value which determines its ranking.

What seems to be important?

- More links
- Links to more important webpages
- …

Idea:

$$A = \begin{pmatrix} 0 & 0 & 0 & 1/3 \\ 1 & 0 & 1 & 1/3 \\ 0 & 0 & 0 & 1/3 \\ 0 & 1 & 0 & 0 \end{pmatrix}$$

A web is now a directed graph represented by a matrix.

Let $\quad x(0) = \begin{pmatrix} 1/4 \\ 1/4 \\ 1/4 \\ 1/4 \end{pmatrix} \quad$ and $\quad x(1) = Ax(0)$

The meaning is that a search starts at any page with an equal probability. Then, the ith entry of x(1) is the likelihood that a search ends at the ith page after one iteration. Now,

$$x(k+1) = Ax(k) \Rightarrow x(k) \rightarrow x^{*}$$

The sequence converges to a vector (PageRank) whose ith component is the likelihood of a search ended at the ith page, an indication of the importance of the page.

This was a revolutionary idea (thinking outside the box) that placed Google's in an absolutely dominant position in search engines.

Summary:

- Assumptions may eliminate solutions.
- Often, the optimal solution is missed because it was never considered.
- View a problem broadly.
- Be carful of your assumptions.
- Stay alert and be creative!

Some good qualities:

Flexible
Risk taking
Courageous
Focused
Independent
Dedicated
Patient
Persistent
Proactive
Intuitive
Imaginative
Curious & playful

Slicing and dicing the old boxes not enough.