When is a picture not a picture?
What is really in a Random Tandem?

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Abstract

Random Tandems allow hidden pictures. They are a pair of overlaid random dot images. The hidden picture is revealed to a person in the right place at the right time allowing a private viewing experience. Sometimes there is a delight in not showing the viewer the whole picture right away, and as it were tiptoeing up behind him and saying "Boo!". Random dots allow you to do something special.

Introduction

I was looking at random numbers and it struck me that I had never hidden an elephant. But magicians do that sort of thing all the time. I realized that if I cut the elephant in half, and painted it with random numbers, it could genuinely disappear. I could then move the elephant into another room and make it reappear. In Figure 1 below I show you my elephant before and after it disappeared.

This was my first Random Tandem (RT) picture.

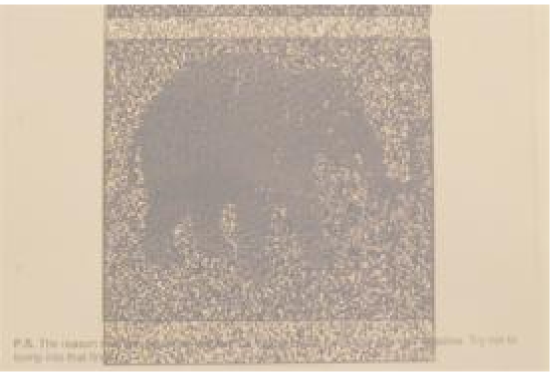


Figure 1a: *The first Random Tandem of the elephant*

Figure 1b: *A slight movement and the elephant is gone.*

Explaining The Magic

The pictures in Figure 1a and Figure 1b are of the same object. They are very nearly identical but to the observer appear very different. How can this be? Both pictures are of the same Random Tandem. The only difference is that in Figure 1a you can see the elephant in the Random Tandem and in Figure 1b you cannot. The answer lies in the fact that the Random Tandem comprises two parts – a front and back.

Both parts individually appear as a set of random dots. The back part is printed on white card and the front part on a transparency. It is only when the two parts are put together in exact alignment that the elephant appears.   A slight nudge to either part and the elephant vanishes into the jungle.

One of the delights of a Random Tandem is that the pictures can only be computer generated. They are dependent on hundreds of thousands, if not millions, of accurately placed dots, each placed to within a fraction of a millimeter. This sort of picture could not be made without accurate printers.

Figure 2 shows another example of a Random Tandem, in this case with each part printed on a transparency. This illustrates how each part individually contains no trace of the hidden picture – which only becomes visible when the two random parts are combined together.

Figure 2a: *Two transparencies of a small Random Tandem.*

Figure 2b: *The two transparencies aligned*

Variations

Having had some fun with the original Random Tandem concept, I realized that there was further potential to develop some variations that might be of interest in the wider world. The Random Tandem variations that I have investigated so far are explained briefly below.

Basic Random Tandem.   In the basic Random Tandem once the two parts are correctly aligned the picture can be seen from any angle by an observer. The examples illustrated above in Figure 1 and Figure 2 are Basic Random Tandems.

Simple Parallax Random Tandem.   In a Simple Parallax Random Tandem the picture can only be seen by an observer who is standing at a specific angle to the Random Tandem.   The picture can be seen from almost any distance so long as you are exactly in line with the axis.

Figure 3 shows an example of a Simple Parallax Random Tandem. I made a frame which holds the two parts of the Random Tandem some 3cm apart. A slight difference of position by the observer and the image disappears.

Figure 3a: *Now you see it!*

Figure 3b: *Now you don't!*

Attaching the two parts of a Random Tandem to either side of a pane of glass would make a Plain Parallax Random Tandem and can be used artistically within a building.

Advanced Parallax Random Tandem. In an Advanced Parallax Random Tandem the whole picture can only be seen by an observer who is standing at a specific angle *and* a specific distance from the Random Tandem.

This is achieved by setting the near half of the Random Tandem to be smaller than the back part. There will be only one position from which you can see the whole picture. If you are too close, or too far away, then at best only part of the picture can be seen. This means that only one person at a time will be able to see the whole picture.

Figure 4 shows the detail from an Advanced Parallax Random Tandem. It shows the two image layer – in this case about 40mm apart.

Figure 4: *Looking at the picture from an extreme angle.*

The spacing between the two layers is important when setting the relative sizes of the two images, as this defines the distance at which the whole picture is visible.

Viewing a larger picture

Figure 5: *Bridge over troubled teapots*

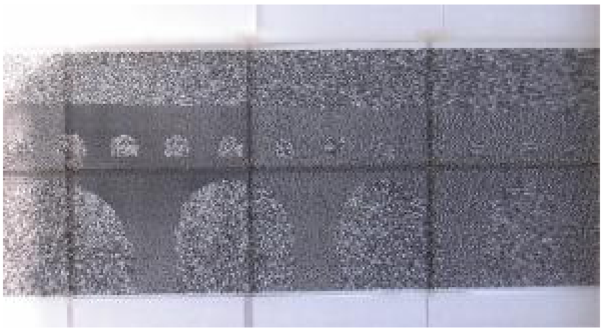
Here is an example of an Advanced Parallax Random Tandem (**Figure 5**) – a bridge for Bridges. This is a picture of the Pont du Gard in Southern France. Built approximately 1950 years ago, this bridge has three levels of arches, and here we see the top two levels. This image seems particularly suited to this talk. Firstly it is a bridge upon a bridge upon a bridge, exactly as we build our knowledge.

This is a larger picture made up of several panels. As you can see, this allows me to produce pictures to almost any size. This picture is about 4 feet across (1.2m) (The teapot provides an idea of scale).

This picture is made up of a transparency at the front and a black on white picture at the back. It could equally have been made up of two transparencies. However, there is no advantage to this as the image could not be seen from the other side (due to the smaller size of the front part). These pictures can be viewed in various ways, with ambient light from the front, or being lit from behind. It helps that the images have about the same amount of light falling on them.

There are various characteristics that are visible in the larger pictures that are not noticeable in the smaller ones. This picture is designed to be seen in its entirety from a distance of 16 feet (5m) as in Figure 5. At any other distance, and in the wrong place, the picture is either partially or totally invisible, as you can see in the later pictures.

If you are too close to the bridge picture then you might only be able to see a piece of the bridge that is on the side that you are on. See Figure 6a and Figure 6b. These are images as seen when walking from left to right of the picture.



Figures 6a : *A close up view reduces visibility*

Figures 6b: *Invisibility with an angled view*

In **Figure 6a** the photograph is taken from about 2m away from the picture and only part of the bridge is visible. As one walks past, the visible part of the image moves with one. However if you are further away than the 16ft (5m) focal point, and walk past, then the bridge starts off invisible, (as in **Figure 6b**), and appears from the other end and rushes past in the other direction.

It should be noted that an Advanced Parallax Random Tandem can be programmed to be visible for its entirety at almost any reasonable distance by adjusting the spacing between the two parts and the relative sizing of the two parts.

Multiple Parallax Random Tandem. Multiple pictures can be included within any Parallax Random Tandem. For example, I could put an elephant under one of the arches of the bridge. From one view point the observer would see the bridge and from another position he could see the elephant – but never the two at the same time.

What Can You Do With Random Tandems?

Apart from the fun to be had from making elephants appear, the concept of Random Tandems has potential for much larger construction within buildings and glass structures.

The first idea that comes to mind for this process is to print on windows or glass roofs. Double glazing lends itself to images becoming visible and invisible again as one walks past. The spacing of the two plates of glass is at a nearly ideal distance for Random Tandems.

Think of the fun that could be had with a tiger image included within the wall of a glass bus shelter.

With glass roofs one could embed images of birds flying over.

The Technical Bit

These pictures are of mathematical interest due to the random nature of the dots, which means that either one of the random dot images **on its own** contains **no** information. Hence when the two random images are separated the picture is perfectly encrypted.

Given that one starts with a truly random set of dots in the first image, here is the **proof**:

> The first sheet cannot hold any relevant information because it is a set of random dots.
>
> The picture to be viewed is independent of the random dots, because the dots are random.
>
> Transforming the random dots using the picture as a transform must create a set of dots that have the same chance of existing independently as the original random sheet of dots.
>
> So without the other sheet either sheet is a random image and hence cannot have any relevant information in it.

But who believes that mathemagical stuff? So I asked someone to run a Fourier Transformation on both images and sure enough, there is nothing there.

Moving Dots

There are several interesting phenomena that can be seen with large areas of random dots, and especially the Random Tandems. The black dot is one of them.

For example, if you have one random sheet and its negative image, then holding them together without a spacing creates a complete blackout. However, if you rotate one of the sheets by only a few degrees, then a black dot appears, and the rest of the image is reasonably transparent. The black dot is where the two random dot patterns perfectly overlap and still create a blackout.

“So what!” I hear you cry. Well, that is not the exciting part, the exciting part is seen when you move the sheets relative to one another. Moving the sheet left makes the dot move up, and moving the sheet up moves the dot to the right. There should always be a blackout point, because the negative image is effectively a map of the original random dots, and the Fixed Point Theorem states that there will always be one point where the map maps to the point it is mapping.