

Case Studies In TRIZ: Anti Red-Eye Flash Photography

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Introduction

Anyone who has taken photographs using flash photography will be aware of the phenomenon known as 'red-eye' - Figure 1 illustrates a typical example. Although there are several well known 'solutions' to the red-eye problem, the phenomenon has by no means completely disappeared.



Figure 1: Red-Eye Phenomenon

This article sets out to do three things; firstly it provides a tutorial example on use of the TRIZ Contradiction Matrix and how it can be used to (re-)generate existing and some new solutions to the red-eye problem, secondly it follows-up an earlier article on 'Contradiction Chains' (Reference 1) in order to illustrate the importance of looking to repeatedly seek out and 'remove' contradictions, and thirdly, it seeks to follow up on last months article examining the gap between TRIZ 'generic' and 'specific' solutions (Reference 2) by demonstrating a process to generate new anti red-eye conceptual solutions using the Contradiction tools.

Problem Definition - The Mechanics of Red-Eye

Red-eye is a flash photography phenomenon. It is caused by light reflected off the subject's retina. Research has shown that if the angle of reflection is less than 2.5 degree, red eye will occur - Figure 2.

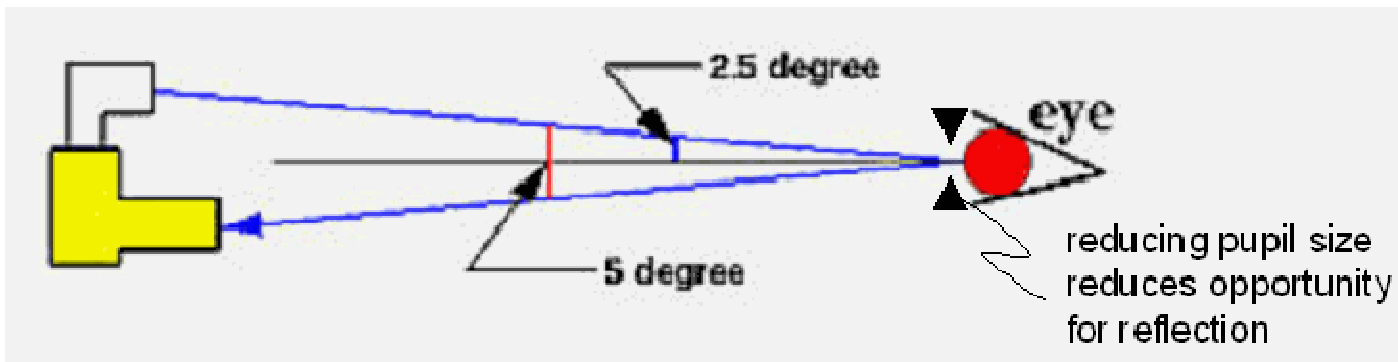


Figure 2: Red-Eye Phenomenon

There are several known means to remove the red-eye problem. The basic mechanism for overcoming the effect is to ensure that the angle of reflection will be larger than 2.5 degrees. This can be achieved by moving closer to the subject, or by increasing the distance between flash and lens. Another well known means to achieve the 2.5 degrees or better requirement is to encourage the subject's iris to reduce in size (typically the pupil opening will be large prior to the photograph being taken as there will be little light around (hence the need for flash! - Ideality would tell us of course that ultimately the red-eye problem will disappear because the need for flash will disappear)). The size of the pupil is mainly governed relative to the amount of light present.

Red-Eye Contradictions

Effective use of the TRIZ Contradiction Matrix demands a sound definition of the contradictions present. It is usually advantageous to conduct this definition in a number of separate stages (as previously described in Reference 2 for example);

1. define the elements of the design that are required to be improved
2. map these into the terms of the 39 parameters of the Matrix
3. identify the solution directions that will help remove the problem
4. identify which of these elements is in contradiction with the feature to be improved
5. map these into the terms of the 39 parameters of the Matrix to get pairs of improving-worsening features.

From this red-eye example, we might follow these stages as follows:-

Elements to be improved - red-eye

Mapping 'red-eye' on the Matrix - 'Object Affected Harmful Factor'

Solution directions

- reduce distance between subject and camera
- increase separation between flash and lens
- change the amount of light

Identify whether these are in contradiction:

distance - reducing distance between camera and subject means the shot has to be re-framed and not as much of the subject can be included; so distance *is* something that gets worse as red-eye is improved

separation - increased separation means the camera and lens may no longer be able to be mounted together, or there may be synchronisation problems, or the flash may generate unwanted shadows; so this too may be seen as a worsening feature in contradiction with red-eye improvement

amount of light - increasing the amount of flash light present would tend to worsen red-eye and so is not seen here as a useful solution direction. On the other hand, reducing the amount of light would improve red-eye, but we can't do this because if we do, there will no longer be sufficient light to make the photograph. Hence the amount of light is in contradiction with our desire to improve red-eye.

Map these onto the Matrix -

distance → 'Length' ('of Moving Object' - because there is relative movement between camera and subject)

separation → 'Length' again, although this time we might chose to use 'stationary object' because there is currently no relative movement between lens and flash unit.

amount of light → 'Illumination Intensity'

In total, then, these contradictions give us a number of Inventive Principle solution triggers:-

Object Affected versus Length of Moving - 17, 1, 39, 4

Object Affected versus Length of Stationary - 1, 18

Object Affected versus Illumination Intensity - 1, 19, 32, 13

We may immediately see the relevance of these Inventive Principle solution triggers to some well established remedies to the red-eye problem.



Figure 3: Anti-Red-Eye Pens

Inventive Principles 32, Colour Changes, is perhaps not so useful, but does suggest use of black and white photography, or points towards the plethora of after-the-event remedies like anti-red-eye pens for touching up photographs (Figure 3) or, for digital photography, anti-red-eye features in photo manipulation software. There are also one or two patented solutions where the 'colour

change' is remedied by software processing within the camera when the photograph is being taken (undoubtedly clever, and an effective transition from a mechanical to a field based solution to the problem).

Inventive Principle 1, Segmentation occurs several times and thus should suggest it is likely to be highly relevant to the problem at hand. The most obvious interpretation of the trigger is the solution adopted by most professional photographers; that of segmenting the camera and flash (and, in fact, also segmenting the flash to utilise several flashes). More practically from the perspective of the amateur photographer are patents in which the segmentation between camera and flash occurs more locally - pop-up flashes, flash units driven away from the camera body using linear motors, and even velcro-attachable flashes are all available or patented solutions.

Principle 1 might also suggest the idea of segmenting the light emerging from the flash, which in turn relates to the next solution trigger:

Inventive Principle 19, Periodic Action, emerging specifically from the contradiction associated with illumination intensity, offers a direct lead into the anti-red-eye flash solutions incorporated into the majority of current integral camera designs. This is the idea of a double (or more) flash action - in which the first flash prompts the pupil to contract such that when the second flash is fired to coincide with the taking of the picture, the pupil is usually small enough to allow the 2.5 degree rule to be satisfied.

So, the Matrix may be seen to be offering clearly appropriate solution directions for the red-eye problem.

Of course, the method always recommends that we don't just satisfy ourselves with the first group of solutions that emerge. Our brains tend to fight this direction particularly if it looks like the emerging solution - e.g. the now prevalent double flash idea - possesses a high degree of elegance, and so we usually have to force ourselves to remember that '*if the solution exists, it contains contradictions*', and to look to tackle the remaining or emerging contradictions after we have solved the first one - as discussed in the 'contradiction chains' article (Reference 1).

In the case of the double-flash idea, any user of this solution will be clearly aware of other contradictions that have emerged as a result of solving the red-eye problem. New problems relate to the phenomenon that we tend to find dilated pupils more attractive than small ones, and, more seriously from a practical point of view, to the fact that when we press the shutter to take a photograph, the timing of the double flash means there is a delay of up to a second between action and the resulting photographic image - in other words we're not taking the photo we intend to take.

Translating this particular new problem into the terms of the Contradiction Matrix, we may see the 'duration of action' as a definite feature we would like to improve. We could thus repeat the TRIZ process for contradictions related to this situation.

Rather than doing this, however, we will take another direction as a way of highlighting another important feature about using the Contradictions part of TRIZ. This feature we will call 'solution mapping'.

In many senses, the double-flash idea has been seen as so attractive a solution in the compact camera market that it has provoked the whole industry along the same direction (see the large range of highly similar patents in the area on the patent database). Solution mapping gets us to remember that there are other solution routes available and to question whether solving the next round of problems with the double-flash is the right thing to do relative to travelling along one or

more of the other available routes. In other words, it gets us to question whether the double flash idea is actually an evolutionary cul-de-sac.

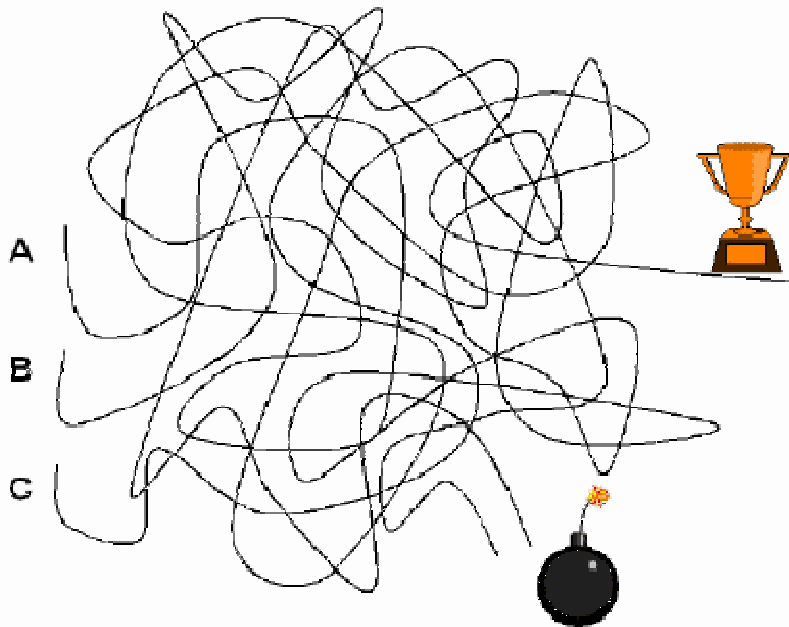


Figure 4: Which Thread Leads To The Treasure?

One way of thinking about the solution map is the tangled string game found in children's puzzle books (Figure 4). In these puzzles, the reader is asked to choose from a number of loose ends of string (usually three or four - in real life, there will be many more!) and to trace the chosen string through the tangle of other strings to hopefully reach the 'treasure' at the other end. All but one of the start points, however, ends up not leading to the treasure, but to some cul-de-sac with anything but treasure at the end of it. If we extend the analogy so that 'treasure' becomes 'ideal final result', we obtain a useful image of how systems will evolve - with lots of dead-ends and cul-de-sacs, but (at least) one route through to IFR.

(We might also note that anyone who spent any time at all playing with these puzzles during childhood, pretty soon learned it was more effective to start from the treasure and work back to the start. Back then, it was called 'cheating'; today it's called an 'IFR tool'.)

Coming back to the real world again, a partial solution map for the red-eye problem is illustrated in Figure 5.

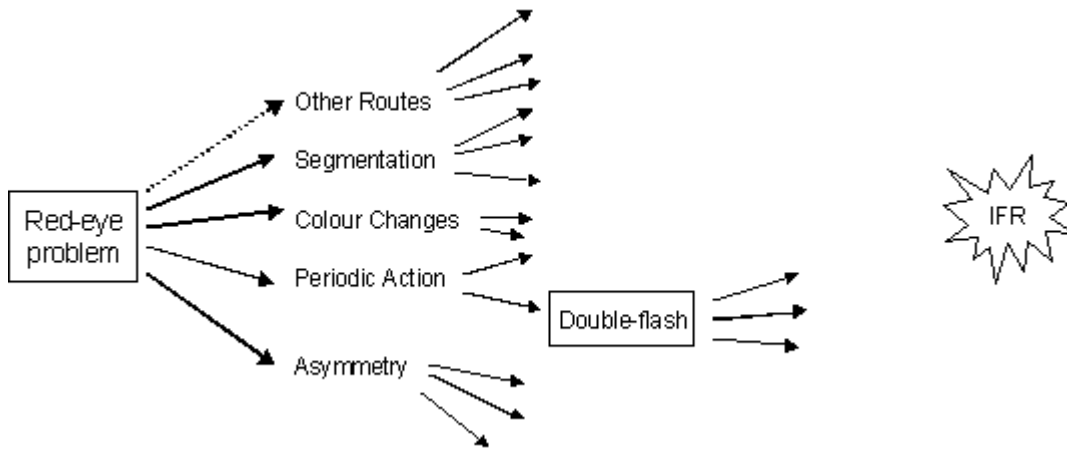


Figure 5: Partial Solution Map For 'Red-Eye' Problem

One of the questions provoked by drawing this type of picture is 'am I correct to continue down this path, or should I go back and investigate whether other paths might offer me a more effective route to ideality - including, incidentally, solutions from other parts of the TRIZ toolkit above and beyond those prompted by the Inventive Principles.

It should also be encouraging us to examine how different solution routes might be combined and distilled.

With little justification other than the desire to travel down a different route to see how to make the journey most effectively, and to see what happens along the way, we will now examine the thus far un-explored 'Asymmetry' route (from the above contradiction solution suggestions) out of the red-eye problem:

The translation of the TRIZ generic solutions like 'Asymmetry' into specific solutions to the red-eye problem is not always an obvious one. Reference 2 has discussed the gap between 'generic' and 'specific' and recommended strategies for filling the gap.

We will look now at a 3-stage strategy for generating solutions building on the Reference 2 recommendations. As in that article, if we are to be successful we need to be aware of the need to be thinking in space and time throughout the process of making connections between solution trigger and the problem.

The first of the three stages proposed here involves identification of resources in the current system upon which the 'asymmetry' solution route might be applied. This means looking for things in and around the current system space that are symmetrical, but it also means looking for asymmetries that we could make either more or less asymmetrical. We conducted this search as a systematic brainstorming session structured around the camera plus flash plus photographer plus subject space system illustrated in Figure 2. Thinking about time issues, we defined 'past' as the time before the picture is taken, when the photographer is framing the picture and the camera is warming up; 'present' as the point of pressing the shutter; and 'future' as the time immediately after the picture has been taken.

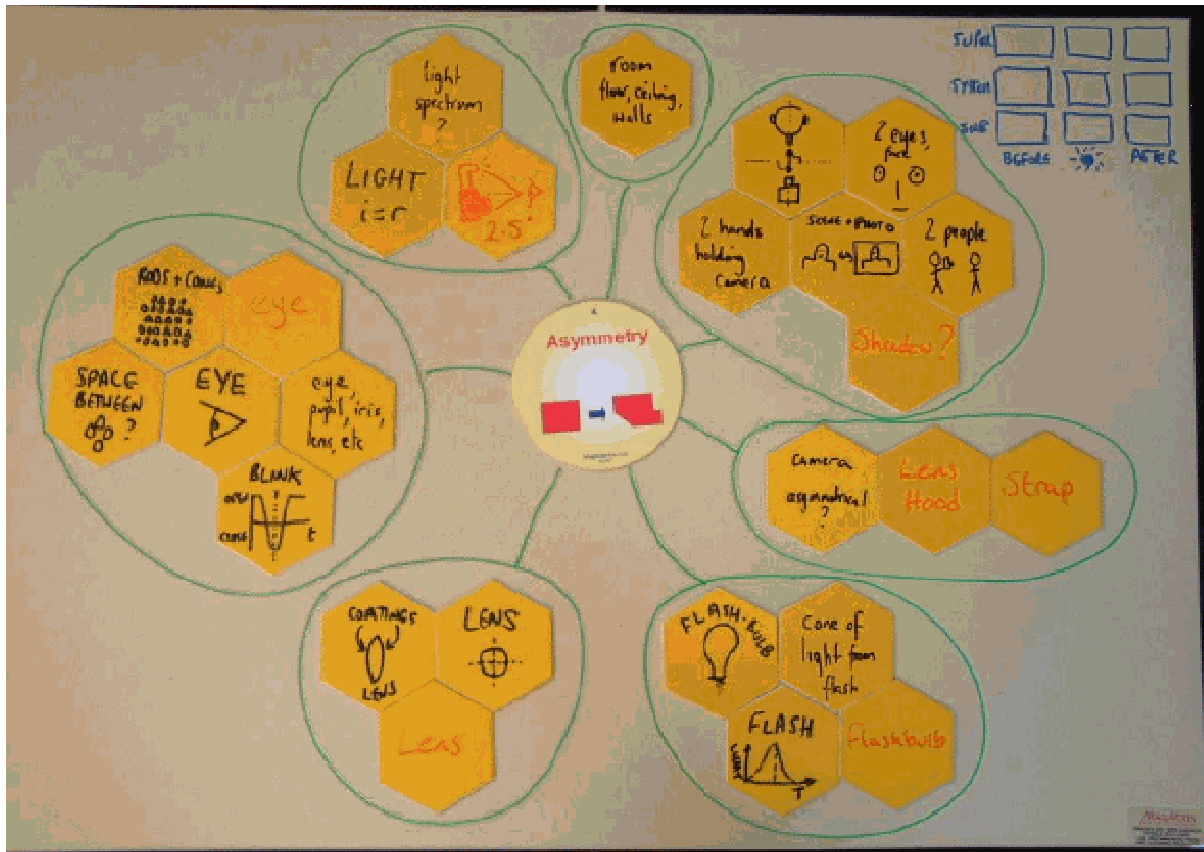


Figure 6: Clustered Brainstorm Output

The third stage of the solution process then involves taking these outputs - actually now 'resources' - i.e. they all represent opportunities to deploy the 'asymmetry solution - identified in the first stage in order to examine how the 'Asymmetry' Inventive Principle can be used to produce useful solutions. A partial picture of the output from this session - which was allowed to run for around 30 minutes and generated a new board of ideas for each of the clusters identified in Figure 5 - is reproduced in Figure 7. The figure is 'partial' because we think we generated some useful and patentable solutions on the other boards and thought it best not to include them here (readers are encouraged to see if they can find them too!). The excluded parts composed the output from attempts to link 'asymmetry' to the other opportunity clusters from Figure 6. The incompleteness shouldn't be allowed to detract from the method being demonstrated - which, after all, is the main point of the article.

If we were doing this for real of course, we would also be looking to distill good ideas being generated by different generic solutions. For example, we might make a connection between the use of an asymmetrical flash illumination profile and the earlier double-flash concept; for again there is a largely untapped resource in tailoring the flash time history to the problem.

As it was, we ended up with a total of over a hundred Magnote-recorded ideas from the session on just the Asymmetry trigger.



Figure 7: Partial Picture of 'Asymmetry' Solution Generation Session

Conclusions

This article has attempted to describe a reproducible process - or series of mini-processes - to help use the contradictions part of the TRIZ method. In it, we have seen that the Contradiction Matrix is a pretty good start point for the red-eye problem; allowing us to quickly re-generate good solutions to the problem.

More specifically, we have introduced the concept of a 'solution map', and hopefully demonstrated its importance in helping us to ensure we see that there are several solution routes to any problem and that there are times when we may be travelling down a route that is a cul-de-sac rather than a highway to increased system ideality.

Related to this, we have again seen the importance of recognising the existence of 'contradiction chains' (i.e. pre-flash is a good solution to the red-eye problem, but it comes at the expense of introducing other contradictions), and that the road to ideality involves challenging a succession of contradictions.

We have also demonstrated a three-stage ([resource identification](#), [distillation and application](#)) strategy for ensuring the most effective use of the Inventive Principles (although the same strategy will be effective with other TRIZ tools too) in filling the gap between 'generic' and 'specific' solutions

References

1. Mann, D.L., 'Contradiction Chains', TRIZ Journal, January 2000.
2. Mann, D.L., 'The Gap Between 'Generic' and 'Specific' Problem Solutions', TRIZ Journal, June 2001.
3. Blake, A., Mann, D.L., 'Making Knowledge Tangible', TRIZ Journal, November 2000.