Case Studies In TRIZ: Child Safety Stairgate

The ‘Child Safety Stairgate’ by Ann and John Hirst won the national Dyson Product Innovation Award in the UK in February 1999.

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Introduction

This article discusses the Child Safety Stairgate conceived by John and Ann Hirst of Team Innovation in Bath. The inspiration for the design came initially from the traumatic personal experience of watching powerless as their son fell from the top of a flight of stairs.

The fall started a search for a suitable product which would prevent a recurrence. The search proved largely fruitless.

Current safety gate variants suffer from a number of common problems. First and foremost is the way in which they are secured into position. On most stairgates, the method of securing uses highly unsatisfactory friction-based methods, and on designs where a positive fixture location is provided, the user is expected to make unsightly drillings into an appropriate piece of wall.

Other problems, then relate to lack of adaptability of the designs; for example ability to cope with different staircase widths, or the scenario, after the child has learned to open the gate, where the inconvenience of a path-blocking obstruction is no longer required, but a ‘tumble-stopper’ function - stopping children, from falling all the way down the staircase - would be a valuable feature.

This brief article examines the Team Innovation Stairgate design from a TRIZ perspective; looking at how the staircase safety problem was defined, how the design makes use of existing resources, and how, in the case of the ‘tumble-stopper’, the design successfully eliminates a physical contradiction.

Problem Definition

Effective problem definition provides the foundation upon which successful designs are built. Effective problem definition means capturing the ‘right’ set of customer requirements and translating them into parameters useable by designers.

While recognising that in many instances, customers don’t know what ‘right’ is until they’ve seen it, it would be fair to say that current stair-gate designs have done little to explore what ‘right’ ought to mean.

Current stair-gate designs are based around a relatively small number of functional requirements (FRs - see Reference 1, 2):-

- provide an effective barrier to prevent babies from falling down stairs
- allow access to adults and old children
- ability to cope with different stair widths
- low unit cost
- (ease of attachment)
- (attractive appearance)

Consistent with the trend identified in Reference 1, that designs generally evolve to include greater numbers of customer benefits - and hence Functional Requirements - over time, it may be expected that there is scope, relative the above list, to improve the design of the stair-gate.

A potent aid to help with the comprehensive definition of functional requirements is the TRIZ System Operator concept (Reference 3, 4, Figure 1). The concept forces designers to view the system under consideration from the perspective of a) it's interactions with sub and super-systems, and, b) how it might be affected by time - either implications from the past, or possible implications governing future use.

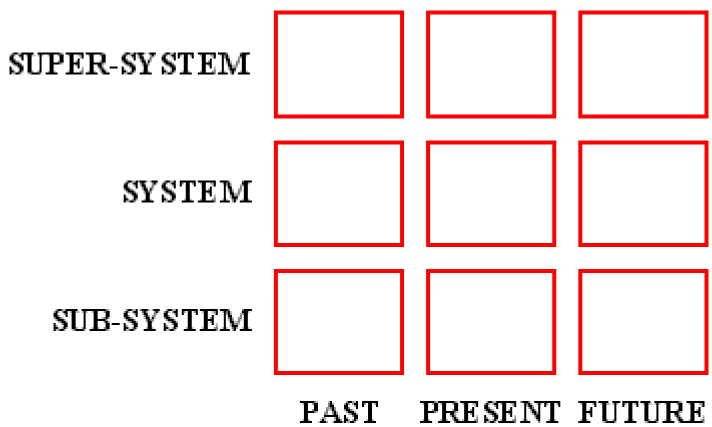

Figure 1: TRIZ 'System Operator' Problem Viewing Tool

Although traditionally used as a means of focusing the problem definition and problem solution processes - see Reference 4 in particular - we see here that the System Operator tool has been used in a somewhat different manner, in that rather than being used to identify a single problem, it has been used as a systematic means of identifying a whole cluster of problem definitions.

The multi problem identification concept was used in three specific instances during the conception of the new stair-gate design:-

SUPER-SYSTEM-PAST - before the stair-gate is fitted, current positive attachment systems require the drilling of location holes into the walls on either side of the stairway. A functional requirement for 'ease of attachment', suggests that pre-drilling operations should be eliminated if possible.

SYSTEM-FUTURE - in current designs, as soon as the infant being protected by the stair-gate becomes suitably mobile, the gate is usually removed. This despite the potential risk that youngsters will fall down stairs. Thinking about possible uses for the stair-gate system beyond it's traditional life expectancy saw the emergence of the new 'tumble-stopper' function described later.

SUPER-SYSTEM-FUTURE - examination of this scenario saw the emergence of the scene in which the stair-gate is dismantled and leaves behind an unsightly mark on the wall where the fastening was positioned. This window saw the emergence of a Function Requirement 'ease of dis-attachment'.

The full list of Functional Requirements for the new stair-gate, therefore, grew to look like:-

- provide an effective barrier to prevent babies from falling down stairs
- allow access to adults and old children
- ability to cope with different stair widths
- low unit cost
- (ease of attachment)
- (attractive appearance)
- (ease of dis-attachment)
- (future use as 'tumble-stopper')

Use Of Resources

With a finalised list of FRs, the new stair-gate design began to emerge. Because low unit cost was recognised as a primary consideration, maximum use of available resources was then going to be a key factor if the design was to be commercially viable.

A schematic of the eventual prize winning design is illustrated in Figure 2.

Figure 2: Child Safety Stairgate

(gate held in 'closed position by spring-loaded positive-location catch - not shown)

Important resource related issues arising during the design process, then, included:-

a. Ease of Attachment: With unsightly wall attachments and friction-based attachment solutions forbidden (non-positive attachment fails to adequately meet the ‘effective barrier’ FR), it was then important to identify other - essentially invisible - means of positively securing the stair-gate to the supporting super-system. The ‘existing resource’ in these circumstances are then the staircase and the stair-gate. The figure shows how the two are utilised together to provide a simple and effective securing method.
b. Simultaneous provision of gate and ability to cater for different staircase widths. The non-hinged part of the gate is made telescopic in order to allow a range of staircase widths to be accommodated. (Incidentally, the telescopic construction idea mimics the very common ‘nested doll’ inventive solution to length-volume technical contradictions.)
c. Tumble-stopper. The tumble-stopper function is somewhat different to the stair-gate function. The resource minimisation task here was to ensure that the same basic set of components could be utilised in both applications. Figure 3 in the next section illustrates how this was achieved.

‘Tumble-Stopper’ Physical Contradiction

Multi-functionality was one of the key functional requirements for the stairgate stated during its conception and design phase.

In its role as a ‘tumble-stopper’, the Stairgate is required to solve a physical contradiction. The contradiction may be expressed as a need for the stairgate to both BLOCK the stairway (to prevent injury causing falls) AND to NOT BLOCK the stairway (to allow ease of passage up or down the stairway).

Physical Contradictions are solved using one of three strategies:-

- Separation in Space or Time
- Satisfying the contradiction, or,
- Use of Alternative Ways - transition to sub-, super-, alternative, or inverse system.

Likely as not, the tumble-stopper could have employed any of the three methods.

Separation in time would have tended to imply use of some kind of moving component to solve the contradiction. This is in fact the method used to solve the problem when the gate is in ‘stair-gate’ mode - where anyone wishing to pass through the gate has to open and close the hinged gate. For the ‘tumble-stopper’ mode, however, the functional desire is for a system which seeks to minimise user intervention. In this case, ‘Separation in Space’ is often a more attractive solution option.

Inventive Principles most amenable to solution of ‘Separation in Space’ contradictions are:-

Segmentation	Taking Out
Local Quality	Asymmetry
Nested Doll	Another Dimension
Intermediary	Copying
Flexible Shells/Thin Films	

And from these, ‘Segmentation’ and ‘Another Dimension’ were elegantly combined to produce the tumble-stopper solution illustrated in Figure 2.

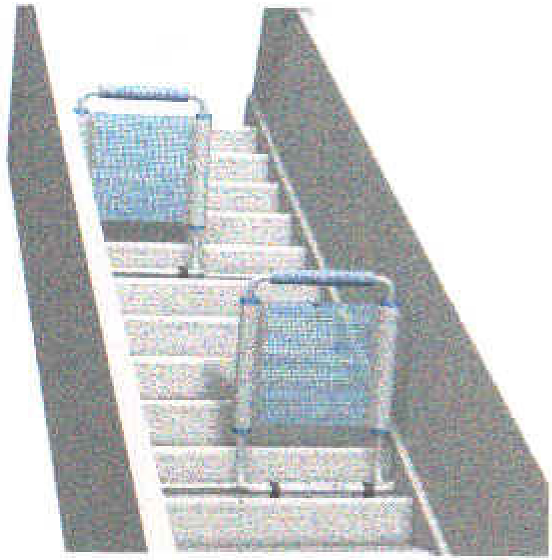

Figure 2: Child Safety Stairgate in 'Tumble-Stopper' Position

Conclusions

1. The Team Innovation Stairgate provides a useful demonstration of the combination of TRIZ and 'Functional Requirement' definition principles during problem definition and problem solution stages.
2. The TRIZ System Operator concept offers a useful tool through which to define a comprehensive list of Functional Requirements; which in turn can **collectively** often - as in this case - offer new design perspectives and ultimately better products.
3. By solving a Physical Contradiction, the Team Innovation stairgate presents an elegant, multi-functional design which offers customers distinct advantages over traditional stair-gate designs.

References

1. Mann, D.L., 'Axiomatic Design And TRIZ: Compatibilities And Contradictions, Part 1', TRIZ Journal, June 1999, and Part II, July 1999.
2. Suh, N., 'The Principles of Design', Oxford University Press, 1990.
3. Altshuller, G., 'Creativity As An Exact Science', (New York, Gordon And Breach, 1988).
4. Frenklach, G., 'Efficient Use Of The System Operator', TRIZ Journal, January 1998.

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