CHAPTER 3

ANALYSIS

The focus of this chapter is to establish the inventive mechanisms, i.e. the different ways in which attributes or features of a problem can be manipulated, that are used during the Ideation stage of the inventive problem solving process. This was accomplished by an analysis of (1) a diverse and broad range of creative thinking techniques, (2) the inventive principles that are captured in the TRIZ invention heuristics and (3) a number of historical examples from three sources of inventive ideation, *viz* Experimentation, Serendipity and Intervention.

3.1 CREATIVE THINKING TECHNIQUES

Table 3.1 shows, in alphabetical order, the range of techniques that were included in the analysis. The term 'technique' is used here in its broadest sense, as in several cases it consists of only one step at a time (e.g. Osborn's checklist). In other cases, techniques involve a number of steps, used for instance in parallel, e.g. Morphological Synthesis and Synectics.

A number of considerations dictated the selection of the techniques:

1) In order to make the model of inventive ideation widely applicable, the techniques have been chosen to be as representative as possible of the wide spectrum of applications and thinking strategies encountered in the literature. They ranged from the relatively simple techniques in which the thinking is constrained to the problem space and in which single-step, incremental manipulations are made sequentially, to the more complex cases in which the thinking is deliberately removed as far as possible from the problem space or where a number of attributes are manipulated in parallel. In the techniques that constrain the thinking to the

problem space, the merit or value of a manipulation is mostly immediately evident (*Would round tables be better than square ones ?*). However, in the cases where the thinking is removed from the immediate problem space by deliberate provocation (*What if cars did not have steering wheels ?*) and random or remote analogies (Random Stimulation and Synectics being good examples), creative intuition and flexibility of thinking are required to create ideas.

Table 3.1 List of techniques that were analysed.

No.	Technique	References [1)]
	Analogies	
1	Personal	Michalko, 1991; Nolan, 1987
2	Direct	
3	Symbolic	
4	Attribute analogy chains	Koberg & Bagnall, 1976
5	Attribute listing	Koberg & Bagnall, 1976; Souder & Ziegler, 1977
6	Attribute splitting (Fractionation)	Michalko, 1991
7	Brainstorming	Nolan, 1987; Michalko, 1991
8	Excursion technique	Higgins, 1996; Nolan, 1987
9	Forced connections / relationships	Michalko, 1991; Souder & Ziegler, 1977
10	Free (word) association	Nolan, 1987; Souder & Ziegler, 1977
	Lateral thinking:	
11	Reversal	De Bono, 1993
12	Elimination	
13	Exaggerate	
14	Filament technique	
15	Stratals	
16	Matrix method	Michalko, 1991
17	Morphological synthesis / analysis	Souder & Ziegler, 1977; Higgins, 1996; Cox, 1995
	Osborn's checklist / SCAMPER:	
18	Substitute	Osborn, 1979; Michalko, 1991; Higgins, 1994
19	Combine	
20	Adapt	
21	Modify / magnify	
22	Put to Other Use	
23	Eliminate / minify	
24	Reverse / re-arrange	
25	Random stimulation	Michalko, 1991; DeBono, 1993
26	Synectics	Nolan, 1987; Twiss, 1986
27	TRIZ 40 Inventive Principles	Altshuller, 1986; Tate & Domb, 1997; Savransky, 2000

[1)] The references listed here were chosen on the basis that they provide informative descriptions and examples of the particular technique(s). It does not imply that the author(s) necessarily endorses it or supports its use.

2) A second consideration was that the techniques capture an as wide as possible range of inventive mechanisms, i.e. systematic ways in which the problem attributes can be

manipulated. Of secondary importance was the structure of the technique or the process that is being followed. For instance, techniques such as Storyboarding, the Lotus Blossom (Higgins 1994: 373 and 378) and the Nominal Group Technique (NGT) all use *brainstorming* as the method to generate new ideas, and were thus excluded from the analysis since the same inventive mechanisms are used (brainstorming already being one of the selected techniques).

3) Also playing a role was the consideration that the techniques could be used easily by creative thinking groups and individuals alike, and in a 'manual' format, i.e. not necessarily computerised or for instance requiring extensive facilitation by a professional. Whilst the focus was on techniques that could be applied to 'hardware' type of problems, it was found that the same mechanisms also underpin the 'aesthetic' creativity associated with the arts and the novelty normally associated with advertising.

4) As stated in Chapter 1, the conditioning and organising methods were excluded from the scope of this work as they do not involve the systematic use of inventive mechanisms (as defined within the context of this work).

3.1.1 Classification

In order to ensure a sample of techniques that were as representative as possible of the spectrum of applications and thinking strategies encountered in the literature, they have been categorised on the basis of the following related parameters, *viz*:

1. The **metaphorical distance** that they take the thinker away from the problem, and hence the degree of creative intuition that is required to create an idea.

A technique such as Attribute Listing for instance tweaks the parameters of the problem within the problem space and the realms of reality. Thus, their potential value or relevance to the problem is immediately obvious and directly assessable. On the other hand, Random stimulation creates analogies that fall outside the problem space and are metaphorically as far removed as possible from the problem. In such a case, a more 'winding' route that opens up more options is followed to a solution. It is often assumed that a greater metaphorical distance

could result in ideas with greater novelty, although no evidence could be found where this has been proven conclusively.

2. The **number of steps** involved in creating the idea, and whether they occur **in parallel** or **in sequence**. This excludes the final step of judgement or assessment, qualitatively or quantitatively, of the idea.

In the context of this work, a technique using deliberate provocation is for instance regarded as a multi-step process. Even though the provocation is made in one step, subsequent mental 'movement' is required to move from this mental 'stepping stone' to a new idea. Different possibilities have to be tried out, some parameters have to be adjusted, others have to be challenged, etc.

On the basis of these parameters, the creative thinking techniques have been categorised into three groups:

Group A

These 'play-it-safe' techniques typically involve the incremental tweaking of one parameter of the problem at a time. This is done mostly within a range that promises value and/or where the value can be assessed more or less directly, e.g. changing the shape of a table from square to round to triangular.

Group B

The major feature that distinguishes these techniques from those in Group A lies in the type of manipulation made. This is mostly in the form of analogies or associations, thus taking the thinker further away from the immediate details of the problem. Some techniques also involve the manipulation of more than one attribute at a time, and the resulting concepts therefore also need to be re-arranged in order to converge to an idea. Thus, it requires more intuitive skills and experience from the problem solver.

Group C

The Group C techniques re-organise information in ways that help the problem solver break away from normally accepted or reasonable perspectives on the problem. This is often done by generating remote or random analogies that serve as stepping stones, also known as 'intermediate impossibles' or 'random juxtapositions' (e.g. in Synectics (Nolan 1987) or the deliberate use of provocation to provide new angles, e.g. lateral thinking). The latter is normally followed by some form of 'movement' (De Bono 1993), such as for instance:

(a) extracting the key principle suggested by the provocation,
(b) focusing on the differences between the normal and distorted situations,
(c) looking for ideas by visualising the distortion being implemented in a 'moment-to-moment' fashion,
(d) establishing the circumstances under which the provocation could be made to work, and
(e) identifying any direct value offered by the provocation.

The degree of provocation also depends on the way or the context in which a technique is applied. Most notable in this regard is the technique of Reversal, which for instance is included in Table 3.1 in Group A (Osborn's checklist) as well as Group C (Lateral thinking). The reason for this distinction is that, in the former case, the technique is mainly used to explore possibilities in solving a problem (re-actively), whilst in the latter it is a means of deliberate provocation to create new ideas (pro-actively).

As shown in **Table 3.2**, the sample of techniques were evenly spread between the three groups, *viz* Group A (10), Group B (11) and Group C (11). The suite of Analogies and Brainstorming have been included in more than one group, since they typically involve thinking at different distances from the problem area. Whilst the Personal and Symbolic analogies involve mostly Group C thinking because of the forced remoteness of the analogy, in Direct analogy the link between the problem and the analogy is clearer (as a result of the particular problem attribute being targeted) and therefore the thinking happens mainly in Group B. Although a free flow of radical ideas is encouraged during brainstorming, peer pressure and the absence of a structured development of remote analogies (such as for instance

in Synectics) cause the thinking to happen predominantly in Groups A and B. However, brainstorming sessions also often contain elements of radical provocation - typically reversal, elimination and exaggeration - and for this reason it also includes Group C thinking.

Table 3.2 Classification of techniques.

No.	Technique	Group	No.	Technique	Group
	Analogies				
1	Personal	B / C	15	Stratals	B
2	Direct	B / C	16	Matrix method	B
3	Symbolic	B / C	17	Morphological synthesis	B
4	Attribute analogy chains	B		Osborn's checklist (SCAMPER):	
5	Attribute listing	A	18	Substitute	A
6	Attribute splitting (Fractionation)	B	19	Combine	A
7	Brainstorming	A / B / C	20	Adapt	A
8	Excursion technique	C	21	Modify / magnify	A
9	Forced connections / relationships	B	22	Put to Other Use	A
10	Free (word) association	C	23	Eliminate / minify	A
	Lateral thinking:		24	Reverse / re-arrange	A
11	Reversal	C	25	Random stimulation	C
12	Elimination	C	26	Synectics	C
13	Exaggerate	C	27	TRIZ 40 Inventive Principles	A
14	Filament technique	B			

3.1.2 Mechanisms

Having provided a framework for classifying the various techniques, the next step in the analysis was to identify the mechanisms that are used by each, and the ways in which they are applied to create 'stepping stones' and new ideas. The way in which the various mechanisms are applied imparts to each technique a unique structure, or 'fingerprint', and understanding this was important in identifying them.

The following examples, one from each of the three groups, will serve to illustrate the approach that was followed. A more detailed description of the various mechanisms and the motivation for classifying and grouping them in certain ways is given in Section 3.4.

Group A: Attribute Listing

Attribute Listing is one of the most simple creative thinking techniques, in that only one attribute of the problem is picked at a time and explored for ways to change or improve it. These changes should not affect the original function of the object.

In the following example from Souder & Ziegler (1977), Attribute Listing is used to generate new ideas for a picture frame.

Shape	Instead of rectangular, the picture frame could be round, oval, triangular etc.
Material	Instead of being covered with glass, it could be covered with perspex, a plastic film, not covered (i.e. no material), or a drawn (plastic) shade. Instead of being wood, it could be aluminium, plastic, no frame, or built-in.
Action	Instead of hanging by wire, it could be using suction cups, hooks over a ledge, or a magnetic holder.
Dimension	Instead of two-dimensional, it could be three-dimensional.

Graphically, the Attribute Listing technique can therefore be represented as shown in **Figure 3.1**. The shaded node represents the attribute or feature that is chosen as the focus point, or beacon, for the thinking. Subsequent nodes represent the new concepts that arise as a result of applying the stated mechanism.

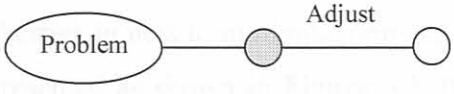

Figure 3.1 Structure of the Attribute Listing technique.

Group B: Attribute Splitting

Attribute Splitting, also known as Fractionation, is a good example of a Group B technique in that it involves the development, in parallel, of a number of problem attributes. It is applied as follows (Michalko 1991: 60):

1. The essence of the problem is stated in two words, normally in the form of a noun and a verb.
2. Each of these is split into two related ones, i.e. that are in some way *associated* with it.
3. This process is continued until there is sufficient material to work with. Normally, this does not extend over more than three or four levels.
4. Each expanded list is examined or the concepts *re-assembled* for new ideas.

The problem chosen as example was posed as follows: A farmer requires new methods to harvest cherries (Michalko 1991: 60). The two keywords for this open-ended problem were chosen as 'cherry' (noun) and 'picking' (verb).

Cherry	Delicate	Damaged
		Blemished
	Separate	Selecting
		Closeness to each other
Picking	Remove	Touch and hold
		Picking
	Transport	Ground
		Boxes

Selecting one attribute, for example 'delicate', gives the idea to create a new type of cherry with stronger skin, to better withstand handling. Re-assembling 'blemished', 'closeness' and 'transport', one might look for a way of satisfying these three attributes. One idea may be to shake the tree and catch the cherries in nets to minimise bruising. The structure of Attribute Splitting therefore can be represented as shown in **Figure 3.2,** the mechanisms used by this technique being identified as Associate and Re-arrange.

Group C: Random Stimulation

The Random Stimulation technique is found in several forms. Although being given different names, they all conform to the basic principle of providing a stepping stone(s) or random juxtaposition(s), i.e. something that, at first, seem to have nothing directly in common with the problem. Links are then sought between this unrelated concept and the problem. Some of the most common forms of Random Stimulation are:

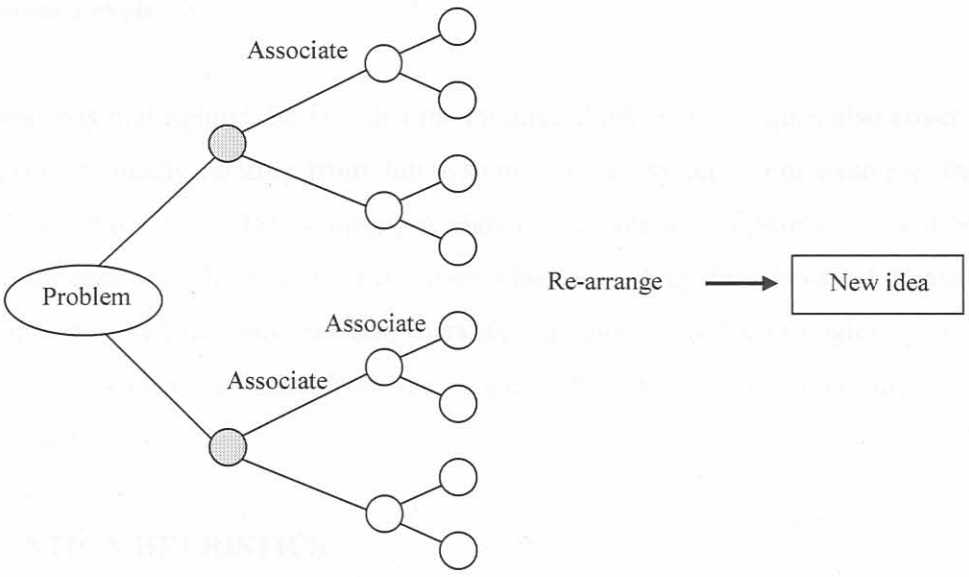

Figure 3.2 Structure of the Attribute Splitting (Fractionation) technique.

1. Words or pictures, obtained from a list or randomly selected from books, dictionaries, newspapers, encyclopaedias etc.
2. Excursion techniques - career , street or example excursion (Nolan 1989).
3. Word association – a number of successive associations are used to move away from the focus of the problem.
4. Drawing or writing sentences with random images or words as starting points.

For this example, the technique of Word Association (Nolan 1989: 46) was used. One feature of the problem is chosen and free association is used to make a number of mental leaps, normally from three to five. Links that are potentially useful are then sought between the final concept (i.e. the random analogy) and the problem.

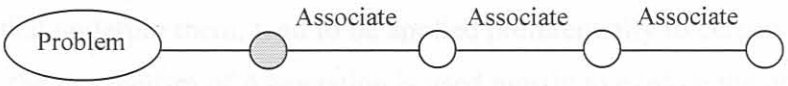

Figure 3.3 Structure of the Word Association technique.

3.1.3 System Levels

The analysis has highlighted the fact that the creative thinking techniques also cover different system levels, typically ranging from sub-system to super-system. For example, the Matrix method (Michalko 1991: 145) is simply a higher-level version of Morphological Synthesis, tailored to the task of understanding a company's business. Key descriptors (dimensions) used in this regard are Products and services, Markets, Functions and Technologies. The aspect of system levels has been excluded from the scope of this study as the same mechanisms are applied in each case.

3.2 INVENTION HEURISTICS

Invention heuristics guide problem solvers and inventors to potential solutions for particular types of problems. As such, in contrast to many of the creative thinking techniques, they always are applied to one feature of the problem at a time and therefore can be classified as Group A techniques. Since it was apparent that different mechanisms are used in each of the 40 IPs, each of the sub-principles was analysed individually. In other words, rather than for instance considering IP10 (Preliminary action) as a whole, sub-principles 10A and 10B were examined individually.

3.3 HISTORICAL EVENTS

Table 3.3 shows the historical examples sourced from the creativity and invention literature that were also analysed. Being technical or scientific in nature, these excluded the Inspiration domain but covered all other three and involved a range of inventive mechanisms.

A key aspect that emerged from the analysis was the fact that the techniques, and therefore the mechanisms that underpin them, tend to be applied preferentially to certain types of problems. For example, the mechanism of Association is used mostly to explore the physical and sensory attributes of objects, such as colour, action, function and size.

Table 3.3 Historical events in science and technology.

Example	Type [1)]	Reference
Einstein: Relativity	Experimentation	Robinson & Stern (1992)
Kekule: Benzene ring	Intervention	Boden (1992)
Pilkington: Plate glass process	Intervention	Weisberg (1992)
Goodyear: Vulcanisation	Intervention	Boden (1992)
Fry: Post-It Notes	Serendipity	Weisberg (1992)
De Mestral: Velcro	Serendipity	Robinson & Stern (1997)
Lands: Instamatic camera	Serendipity	Robinson & Stern (1997)
Plunkett: Teflon	Serendipity	Robinson & Stern (1997)

[1)] Refer to Section 1.3 for a more detailed description.

In the analysis, note was therefore made of the different problem attributes and their application, in order to identify those that would be needed to formulate a representative systems model. More detail on this is provided in the following Chapter.

3.4 MECHANISMS

3.4.1 Function and relationships

Once the analysis of all three areas was complete, the mechanisms were grouped into conceptually distinct entities; this process resulted in a group consisting of ten mechanisms (shown in **Table 3.4**). These mechanisms, which can also be interpreted as 'keywords' that collectively encompass all the techniques, could be grouped into five 'themes' that describe the basic manner in which the attributes of the matter, time and space dimensions can be manipulated. Explanatory notes regarding the classification and grouping of the mechanisms are provided in the following Section.

Examples and typical manipulative verbs are also supplied for the reader to clearly understand the content of each theme and mechanism, and the way in which they were derived. It is of course possible that the mechanisms and their classification can be interpreted or grouped differently; for instance, the Transform mechanism could be regarded as another form of remote Association, albeit in a different domain. This is one of the inevitable problems when

dealing with a topic as non-exact as inventive ideation, but in any event should not detract from the validity of the mechanisms as presented.

Table 3.5 shows how the various techniques relate to each other in terms of their key mechanisms. Rather than the subjective categorisation of techniques into the four quadrants of the Whole Brain model (Herrmann 1996), describing how various techniques might be preferred or used by people with different thinking dominances, grouping them on the basis of their dominant mechanisms highlights the types of outcome that might be expected from the various groups.

It also suggests that no single technique describes all the possible inventive approaches that can be taken on a problem, and that a more holistic understanding as presented here might therefore aid the completeness of inventive thinking. Whilst Osborn's checklist and the TRIZ invention heuristics span the broadest range of mechanisms, they both cover only half of the total possibilities. Furthermore, since they involve only sequential manipulation of individual problem attributes (i.e. both being Group A techniques), the additional ideas that may be realised by manipulation, in parallel, of more than one problem attribute (for instance by a Group B technique such as Morphological Synthesis) are not catered for explicitly.

Table 3.4 The generic mechanisms of inventive ideation.

Theme	Mechanism ('keyword')	Function	Examples	Manipulative verbs
Separate	1. Segment	1. Break something down into smaller, more flexible or independent parts or functions. 2. Make something segmentable, accentuate borders.	Mainframe computer vs PC, truck and trailer, modular furniture, Venetian blinds.	Separate, divide, segregate, dissect
	2. Re-move-ment	1. Remove: Extract useful / interfering property / part or discard / dissolve used or waste parts. 2. Move/ movement: Make something movable; allow for, or restrict, movement.	1. Play a tape of a barking dog as theft deterrent. Fibre optics producing (cold) light. Dissolving capsules. 2. Mobile banking vans. Allow parts to find their own optimum conditions.	Eliminate, subtract, take out
Change	3. Adjust	Change (increase, decrease, reverse, invert, re-orientate etc) or make adjustable, one or more attributes of the problem, satisfying a certain requirement.	In Pointilism, dots rather than linear brushstrokes are used to produce a painting. Would triangular picture frames have any value over rectangular ones ?	Adapt, reverse, submerge, alter, invert, subdue, magnify, accelerate, stretch, squeeze, freeze, rotate
	4. Distort	Deliberately provoke new directions or angles of thinking by eliminating, reversing or changing beyond normal limits, key parts, function of property of an object or process.	'Square wheels' give the idea of tyres that can change to the topography of the ground.	Provoke, reverse, exaggerate, eliminate
Copy	5. Associate	Find or develop an analogy (something that shares a specific feature(s) with the problem or meet certain criteria), copy aspects to solve or apply to the problem.	The plate glass process was born after Pilkington saw a layer of grease form on the surface of dishwashing water.	Compare, copy, borrow, analogy
	6. Random stimulation	Introduce or develop a concept totally unrelated to the problem to stimulate the thinking and provide new perspectives.	What features of an orchestra can be used to solve the problem of recruiting quality staff quickly ?	Randomise, chance, accidental

Table 3.4 (contd). The generic mechanisms of inventive ideation.

Combine	7. Re-arrange	1. Re-assemble or reconstitute parts or fragments of the problem or object in new and useful ways. 2. Pre-arrange objects or parts in the best locations or most convenient ways.	Assembling fragments of a TV screen gives the idea of a screen with multiple channels being watched simultaneously.	Re-assemble, regroup, reconfigure
	8. Add	1. Group, merge or integrate objects or features with that of others. 2. Introduce something new or multiply existing.	Boat + ski = Hydrofoil. Glass + burglarproofing = Safety glass. Combine a bookshop and coffee shop, double hull of catamaran.	Unify, integrate, interact, multiply, converge, complement, merge
Convert	9. Other - Use	1. Other Use: Use something for a purpose, or in a context, different to what it was designed or intended for. 2. Use: Exploit available or natural phenomena or energy to good effect. 3. Use Other: Use anOther (practical) format of something.	1. Dump old tyres in the ocean to form artificial reefs, use a screwdriver to open a paint tin. 2. Use phase transitions, resonant frequency or thermal conductivity. 3. Use copies instead of the real thing, use a bicycle instead of a car.	Put to Other Use
	10. Transform	Explore the problem or aspects in a different (often, dream) domain, change the medium or 'flavour' to gain fresh perspectives.	What does the colour smell like ? What clothes does the company wear ? What colour is the wind ? (Zen koan)	Transpose, symbolise, abstract, fantasy questions

Table 3.5 The mechanisms of inventive ideation – analysis of examples [1].

Theme	Mechanism	Creative thinking technique	Historical events [2]
Separate	1. Segment	-	-
	2. Re-move-ment	Osborn's checklist (eliminate)	-
Change	3. Adjust	Attribute listing Osborn's checklist (adapt, modify/magnify, reverse) Stratals Morphological synthesis Filament technique	-
	4. Distort	Lateral thinking (reverse, eliminate, exaggerate)	Lands
Copy	5. Associate	Attribute splitting Attribute analogy chains Stratals Morphological synthesis Filament technique Direct analogy	Pilkington Kekule Archimedes
	6. Random stimulation	Excursion Random stimulation Word association Forced connections Synectics	-
Combine	7. Re-arrange	Attribute analogy chains Attribute splitting Filament technique Morphological synthesis Osborn's checklist (re-arrange)	-
	8. Add	Osborn's checklist (combine) Forced connections	-
Convert	9. Other - Use	Put to Other Use Osborn's checklist (Substitute, Other Use)	Fry De Mestral Plunkett
	10. Transform	Personal analogy Symbolic analogy	Einstein

[1] The TRIZ Inventive Principles covered by each mechanism are presented in Table 4.2.
[2] Inventors as per Table 3.3.

3.4.2 Explanatory notes on Mechanisms

Separate (Segment and Re-move-ment)

The function of the Segment mechanism can be stated as a process of *physical* separation, in which the resultant parts remain in the same place. This is for instance done by increasing the modularity of an object or making it segmentable. As indicated by the hyphenated term, the second part of the theme constitutes two sub-mechanisms, namely Remove and Movement. These are both used in the sense of *spatially* separating parts or processes, either by removing them completely (eliminate), partly or temporarily from an object or their normal environment. The Movement mechanism better qualifies the process of spatial separation.

Change (Adjust and Distort)

The Change theme contains two mechanisms, the distinction between them often depending on the context or the way in which they are applied. The Adjust mechanism was named such to reflect the fact that it is used mostly to incrementally change the problem attributes, exploring the options that exist around key problem parameters. For example, the Shape of an object could be changed from round to square or rectangular, the Colour could be changed from yellow to red or blue and green. The purpose of the mechanism is to create options that can be evaluated or judged for potential benefit, and thus the thinking takes place within the immediate domain of the problem.

The Distort mechanism is a more extreme version of Adjust, and used to deliberately change parameters to outside of their normal, or 'taken-for-granted', range in order to provoke the thinking. Unlike the Adjust mechanism, the purpose is to create stepping stones or 'intermediate impossibles', i.e. the apparent outcome of the provocation must be impossible or absurd and not simply a realistic option that can be evaluated. The Distort mechanism is popular especially in lateral thinking, and although a distinction is made there between various techniques (escape, reversal, exaggeration and distort) they are all based on the same principle

of upsetting the equilibrium to such an extent that the thinking is snapped out of routine ways and forced to follow new directions.

Copy (Associate and Random stimulation)

As the name suggests, the function of both mechanisms in the Copy theme is to produce alternative concepts (analogies) that have certain features that can be copied or borrowed in order to solve the problem. In most cases, these analogies are generated directly by applying Association to key features of the problem. Random (also referred to as 'remote') analogies can be viewed as a more extreme version of the direct analogies and are used in a number of techniques to provide fresh input or new perspectives on the problem. It can be generated in several ways, including for instance free association, imaginary excursions, and randomly selected words or pictures. A more detailed analysis of Random stimulation is provided in Section 4.6.

Combine (Add and Rearrange)

Rearrangement forms a key part of all the techniques in which parameters are explored in parallel, normally by either Adjustment or Association. Its main function is to form new combinations or changing the traditional relationships that exist between parts of an object, but also to stimulate new ideas by (mentally) fragmenting things and re-assembling the fragments in new ways.

The Add mechanism can be regarded as the opposite of Remove, combining existing things, introducing new things or adding features or functions. It is also used to describe actions such as converging or bringing together, merging and integrating.

Convert (Other-Use and Transform)

Like the Change and Copy themes, the Convert theme also consists of two versions. However, whereas in the former two cases the one version can be regarded as a more extreme

version of the other, in this case, the one is practically-orientated whilst the other is directed at heightening sensory awareness or stimulating non-ordinary or fantasy ideas. With regard to the first, the analysis has suggested that the original Put to Other Use technique of Osborn's checklist is manifested in three different ways, *viz* (1) Other Use, (2) Use and (3) Use Other.

Although the distinction may at first appear to be of academic interest only, the examples presented in Table 3.4 illustrate that it involves different 'directions' of application. Whilst Other Use *removes* the object from its normal environment to fulfill a *different* function (e.g. old tyres being dumped in the ocean to form artificial reefs), Use Other *introduces* something new into the environment that could provide a *similar* function (e.g. a bicycle instead of a car for transport). In contrast, the Use mechanism is directed at providing *a* function by something *within* the problem environment.

As indicated in Table 3.4, the Transform mechanism is related to random or remote analogies in that it stimulates awareness of elements and features that fall outside the immediate scope of the problem. It transforms the problem or its elements to a different domain in which novel insights may be gained that can subsequently be applied to solve the problem.

Replace/ Substitute

The terms Substitute and/or Replace often occur in the creativity literature and are also used in some techniques, e.g. Osborn's Checklist (Osborn 1979). Normally this is in the context of exchanging something with another that can fulfill a function better, faster or cheaper. It is also used to convey a message in an associated or analogous way, e.g. replace the heel pad with a firemen's safety net in the Nike Air running shoe advert (Goldenberg 1999a).

In the context of this research these terms were deemed to represent the generic *outcome* of creative thinking rather than methods or mechanisms to *effect* the changes. They are conceptually not sufficiently constrained and thus were not considered as separate mechanisms. For example, the Replacement of steam by hot milk to melt out-of-specification butter patties (as used by Goldenberg *et al.* 1999b) can be described in terms of the inventive

mechanisms as Using anOther thing to do the melting, or conversely, putting (the readily available) hot milk to Other Use. Similarly, but less preferable, it could be construed as Removing the steam and Adding hot milk instead. The same applies to other elements of systems or steps in a process.

The definition of mechanisms is important from the point of view of categorising them and establishing a consistent framework of understanding. Any differences in their interpretation should initiate further investigation and debate to reach consensus amongst the researchers and practitioners in the field.