CHAPTER 2

PROBLEM STATEMENT AND OBJECTIVES

2.1 INTRODUCTION

Creative thinking and invention heuristics are today practised by companies and individuals across the world. Despite their apparent popularity and the proliferation of creativity consultants, there continues to be a number of obstacles as far as their understanding and application are concerned. The following sections will highlight some of these deficiencies and on the basis of these, define the objectives and the benefits to be derived from this work.

2.2 PROBLEM AREAS

2.2.1 Novelty vs Guidance

Creative thinking and invention heuristics have developed as essentially independent fields of practice and research in different parts of the world. Whilst most of the leaders in creative thinking have been working in the United States and Europe, invention heuristics such as TRIZ have been developed in the ex-Soviet Union and only until fairly recently was not really known or applied in the west. In addition, the two fields have also developed in different directions: whilst creative thinking has been targeted to a significant extent towards the pro-active exploring of new ideas in open-ended problem situations, invention heuristics, by their very nature, focused on solving defined problems in which specific outcomes are sought.

Today still, little reference is made in each as to the existence of, and advantages offered by, the other. In the case of invention heuristics, one of these advantages is for instance the fact that it is based on years of experience in solving particular types of problems, for example, as defined by contradictions. It thus offers the inventor or problem solver a fair amount of guidance in solving similar problems. However, this strength is at the same time also one of its weaknesses. It essentially describes in engineering terms only 'what has been done before, and done so most frequently'.

For a new principle to become a TRIZ heuristic and thus to be reflected in a particular cell in the contradiction matrix, it must recur in many high-level patents in a number of engineering fields. Whilst there is currently not consensus on the number of such inventions required, the lowest appears to be 10 and the highest 500, and TRIZniks (expert practitioners of the methodology) generally tend to use their own interpretation of what is sufficient and what is not (Savransky 2000: 221). Often, these 'best practices' are already implemented by leading technological companies and therefore would tend to generate solutions that they already have. These companies are thus unlikely to benefit from the potentially novel, or additional, solutions that could be created by utilising a wider range of creative options. As mentioned in Chapter 1, recent research (Mann 2002) has for instance put the overall *effectiveness* of the classic CM to be around 48%, a figure which appears to be representative of the average success rate of the matrix.

Whilst more experienced users would probably have developed, over time, a better intuition for which principles to test first (regardless of the order, i.e. frequency of use, in which they are recommended), inexperienced users could find the effort quite laborious and frustrating.

On the other side of the coin, whilst there are many creative thinking techniques in existence (also see the following Section), there appears to be no consistent structure that can point problem solvers or inventors in potentially useful directions. The lateral thinking techniques for instance request problem solvers to make off-the-wall statements 'boldly and without thinking' in order to try and deliberately provoke new ways of thinking. As shown in the following Figure, integrating the potential novelty offered by a wide range of creative thinking mechanisms with the more tangible pointers provided by invention heuristics could therefore yield significant benefits as far as inventive ideation is concerned.

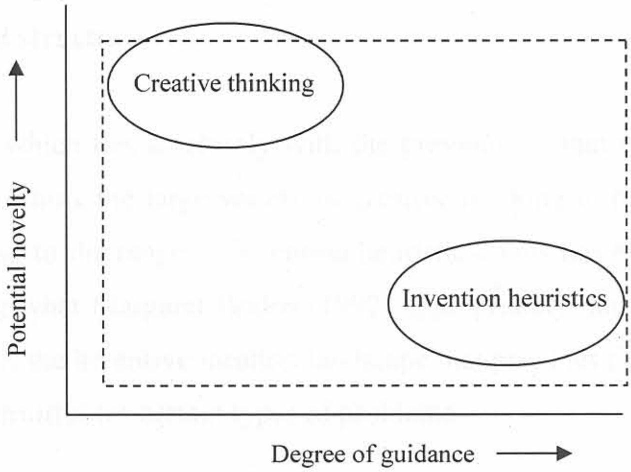

Figure 2.1 Benefits to be derived from integrating creative thinking with invention heuristics (suggested by broken line).

2.2.2 Number and diversity

Anyone researching creative thinking is left with a lasting impression of the plethora of techniques that exist. For example, in the *Whole Brain Business Book*, Herrmann (1996) categorises 77 'creative processes' on the basis of how they relate to four styles of thinking preferences. Michael Michalko (1991), in *Thinkertoys*, describes 34 'linear' (structured) and intuitive techniques, Souder & Ziegler (1977) cover 20 operational techniques, and several more may be found in *101 Creative Problem Solving Techniques : The Handbook of New Ideas for Business* (Higgins 1994).

However, this oversupply creates a dilemma for the creative problem solver as to which technique to use, and how to go about making the choice. Each technique offers a specific way of approaching the problem, a particular route to a potential solution. Therefore, unless the problem solver has an in-depth knowledge of creative thinking, he/she is most likely to be confused or overwhelmed by the sheer number and diversity of techniques. This is probably one of the key reasons for brainstorming being the preferred option for inventive ideation - people opt for the simpler and more 'general' approach to problem solving.

2.2.3 Mechanisms and structure

The third observation, which ties in closely with the previous, is that there appears to be a limited understanding of how the large variety of creative thinking techniques relate to each other, and secondly, also to the range of invention heuristics. This has been one of the major obstacles in developing what Margaret Boden (1992) appropriately alludes to as a 'signpost' model, namely, a map of the inventive ideation landscape that provides pointers to the creative paths most likely to be fruitful for certain types of problems.

This gap in a fundamental understanding of the basic principles also seems to have resulted in, amongst others, a duplication of techniques. Whilst they have the same structure and use the same mechanisms, they are often known by different names. The Filament technique (DeBono 1993), for example, extracts a number of key features of the problem and then uses association to create a number of concepts that conform to the particular criteria of each feature. The resulting concepts are then re-arranged in different combinations to create new ideas. The same approach also forms the basis of the Morphological Synthesis technique and Attribute Analogy Chains (Koberg & Bagnall 1976).

Another example of the seemingly unchecked proliferation of techniques is the fact that Word association, Random input, Synectics and Excursion, are all versions of the same creative thinking mechanism, namely creating a remote or unrelated analogy that are then explored for possible links or commonalities with the problem. In this regard, it therefore appears that there is considerable scope for simplifying and improving the usefulness of creative thinking by appropriate grouping of similar, or the same, techniques.

2.2.4 Completeness of thinking

A key aspect of creative thinking, and brainstorming in particular, is the notion of deferring judgement and building on the ideas of others, i.e. 'putting quantity before quality'. Alex Osborn's 'quantity breeds quality' is quoted as often as Linus Pauling's 'in order to have a good idea, you need many ideas' and Emile Chartier's 'nothing is as dangerous as a good idea, if it's the only one you have.'

But, just how much is many ? It is normally relatively easy to measure the ideas that have been created in a brainstorming session against the objectives, if these have been defined properly. However, very scant, if any, regard is normally given to assessing aspects of the problem space that may not yet have been explored. As such, areas in which further thinking could potentially reap rewards are seldom, if ever, identified.

2.2.5 'Logical design' vs 'Off-the-wall'

A claim of lateral thinking, in particular the random input technique, is that is 'very good for producing ideas that would never have been reached by any sort of logical design or analytical process' (De Bono 1993: 180). These ideas are claimed to be 'logical in hindsight only'. For example, in *Serious Creativity*, the technique is illustrated in developing new ideas for cigarettes. For this purpose, the word 'traffic light' was chosen as random analogy. The idea that originated from this was to print a red band close to the butt of the cigarette, indicating where it becomes (even more) dangerous to smoke further. Like the red light stops traffic, the red band would stop the smoker.

Whilst this approach appears to be novel, there is a lingering doubt as to how representative such examples are of reality. There is still a perception that, although popular and intriguing, little practical value has ever come out of deliberate idea-generating efforts. The value of 'serious creativity' is questioned in view of the 'absence of documented evidence of either spectacular successes, or spectacular failures, having been achieved this way':

One of the problems with ever-popular self-help books on how to be creative is that they all encourage 'off-the-wall' thinking (under such slogans as lateral thinking, conceptual blockbusting, getting whacked on the head) while glossing over the fact that most off-the-wall connections are of very little worth and that one could waste lifetimes just toying with ideas in that way..... Frantic striving to be original will usually get you nowhere.... The most reliable kinds of genuine insight comes from strong analogies in which one experience can be mapped onto another in a pleasing way. The tighter the fit, the deeper the insight, generally speaking.' (Hofstadter 1982).

This theme is echoed by Robinson & Stern (1997: 52):

'Although there are many creative problem-solving methods, and the lure of the perfect recipe will no doubt lead to others, the evidence is overwhelming that none of them really works. In companies, creativity does not happen magically when people are taken out of their workplace and a procedure is invoked to set up a special environment where creativity might flourish. The workplace itself is alive with the unexpected; when employees interact with it, it yields provocations no one can possibly expect..... Despite popularity, they [creativity techniques] *are not effective in taking companies where they were not already expecting to go.'*

The question here is therefore to what extent a 'logical design' – applying a systematic procedure - could produce the ideas produced by these 'off-the-wall' techniques more directly. This would make the process more attractive to engineers and technologists, who normally prefer a more structured way of considering options. A better understanding of the types of problems to which some process of logical design may be applicable will also put in perspective the value that is really to be derived from these 'off-the-wall' techniques.

2.3 OBJECTIVES AND CONTRIBUTIONS

It is the contention of this thesis that a better understanding of the mechanisms that are used for inventive ideation, as well as the way in which they are used and interact, will contribute significantly to addressing the above problem areas as well as build the theory of the field.

Such understanding could be embodied in a generic model which, when integrated with one that is specific to the type of problem being targeted, would provide a detailed map of the problem space and thus highlight the potential inventive options. In the context of this work, the model would be tailored specifically for application to physico-mechanical systems, *viz* situations in which a group of interacting, interrelated, or interdependent elements form a complex whole.

The main objective of the work was therefore stated as follows:

"To develop a generic model that improves the understanding of the mechanisms that underpin inventive ideation techniques, as well as their use and relationships. The model should be tailored for application to physico-mechanical problems and demonstrate its worth as a tool that enhances inventive ideation in such a context."

Specific benefits that stand to be realised from such a model are as follows:

2.3.1 Theory building

The major contribution of the work would be in expanding the theory of inventive ideation techniques, by elucidating the mechanisms involved in creative thinking and invention heuristics, as well as their use and relationships. Such a model would also form a basis of understanding that future studies in this area could draw from.

As far as the ability of the model to enhance inventive ideation is concerned, the following benefits are foreseen:

2.3.2 Ideation Strategies

By highlighting the application of different mechanisms, the model would enable the problem solver or group to select a suitable range of mechanisms to suit particular types of problem. For example, engineers may opt for the more 'incremental' or most frequently used mechanisms, interspersed with one 'intuitive' mechanism where relevant. Furthermore, on the basis of successful strategies, a portfolio of preferred approaches could feasibly be developed.

2.3.3 Ideation Domains

The model would provide a detailed view of Ideation Domains (IDs), i.e. the various ways in which the attributes of a physico-mechanical system could be manipulated by the inventive mechanisms. Re-classifying the 40 IPs in terms of these IDs would therefore establish groups of IPs that could effect similar inventive outcomes, and thus alert an inventor using a particular IP to others that could be useful in the same context. By highlighting the ways in which a particular mechanism can be applied to different system attributes, the inventor focusing on a certain attribute would also be provided with potentially useful analogies derived from the others to which the same mechanism may be applicable. Most importantly, the IDs could lead to a simplified and more efficient use of the CM, as well as increasing the quantity and novelty of ideas.

2.3.4 Auditing

Since it would provide a detailed map of the various ways in which a physico-mechanical problem space could be traversed, the model could be used to audit the ideas generated during inventive ideation (brainstorming) sessions. On the basis of such an audit, areas of the problem space that have not been explored and where additional thinking could reap rewards, can be identified. The model could then be used in a systematic fashion to generate ideas in these areas.

2.3.5 Value of Random stimulation

Finally, the work would provide a better idea of the types of problem in which Random stimulation could offer real advantages over a structured, more systematic approach. This could make creative thinking more accessible to people that prefer to 'extend the known' in a systematic fashion rather than clutching at random, 'off –the-wall' type of inputs.

2.4 RESEARCH PROCESS

In order to achieve these objectives, the following research process was followed:

1. Identify the mechanisms used in inventive ideation (Chapter 3).

This was accomplished by analysing a wide and diverse range of the more popular and well-known creative thinking techniques, TRIZ invention heuristics, as well as historical examples of inventions and discoveries, shown in Figure 1.5. The range of creative thinking techniques included simple ones in which the problem space is explored incrementally via single-step manipulations, to more complex situations in which the thinking is removed from the problem space and/or various features of the problem are manipulated in parallel.

2. Construct a generic model of the mechanisms, highlighting their use and relationships (Chapter 4).

An analysis was made of the frequency with which the various mechanisms are applied to different types of problems, as well as their impact on the thinking process, e.g. how far they removed the thinking from the problem. This allowed the various mechanisms to be grouped into conceptually distinct entities or 'themes' that were represented graphically as a holistic 'map' of the inventive ideation landscape.

3. Tailor the generic model to a physico-mechanical context by integrating it with a systems model (Chapter 4).

In order to make the generic model applicable to physico-mechanical problems, i.e. that are typically encountered in engineering environments, it was integrated with a simple systems model that describes the physical, temporal and spatial aspects of objects and their environment. It was subsequently used in a systematic fashion to establish, in detail, the full range of inventive ideation options that exist within the defined system and thus can be used to solve problems.

4. Practically demonstrate the ability of the integrated model to enhance inventive ideation (Chapter 5).

The practical benefit of the integrated model to enhance the inventive ideation capability in physico-mechanical environments was demonstrated by examples sourced from the inventive problem solving literature. This included: (1) the development of a simplified (contradictionless) version of the TRIZ CM, (2) the auditing of ideas generated during brainstorming, and (3) the generation of novel ideas in a systematic fashion.