APPENDIX 1

ACRONYMS AND DEFINITIONS

1-1 ACRONYMS

CM	Contradiction Matrix
CLM	Contradictionless Matrix
4-AM	Four-Attribute Matrix
ID	Ideation Domain
IP	Inventive Principle

1-2 DEFINITIONS AND TERMINOLOGY

Mechanism

An operator that can be applied to an *attribute,* feature or characteristic of the problem in order to create an alternative.

Ideation Domain

A conceptually distinct entity that highlights the different mechanisms that can be applied to certain system attributes to produce inventive ideas. It also groups the inventive principles on the basis of the dominant inventive mechanisms and attributes that describe them collectively.

Attribute

A key or distinguishing aspect or part of the problem, to which one or more thinking *mechanisms* are applied to arrive at inventive ideas. The term is used interchangeably with 'feature', 'aspect' or 'characteristic', and is interpreted to mean the same thing.

The term 'change *the* attribute' is used to indicate the different 'values' that the attribute can assume, for instance changing the Colour from yellow to blue to red. In contrast, the term 'change *from* one attribute to another' indicates that a different aspect of the problem is considered, e.g. focusing on Shape instead of Sound.

Empirical

Based or acting on observation or experiment, and not on theory, deriving knowledge from experience alone (Oxford Concise Dictionary)

1-3 TRIZ DEFINITIONS

The following definitions of the TRIZ engineering parameters are provided by Savransky (2000).

Weight

The mass of the subsystem, element or technique in a gravitational field. The force that the body exerts on its support or suspension, or the surface on which it rests.

Length

A geometric characteristic described by the part of a line (straight or curved and not necessarily the longest) that can be measured by any unit of linear dimension, such as meter, inch etc.

Area

A geometric characteristic described by the part of a plane enclosed by a finite continuous line that can be measured in a square unit of dimension.

Volume

A geometric characteristic described by the part of a space that can be measured in a cubic unit of dimension. The part of a space, either internal or external, occupied by the subsystem.

Speed

The velocity of the subsystem. The rate of a process or action in time that can be measured by any linear unit of length divided by a time unit.

Force

Any interaction that can change the subsystem's condition due to the interaction between subsystems.

Tension, pressure

Tension on or inside the subsystem.

Shape

The external contours or boundaries that separate the subsystem from the environment or other subsystems. The appearance of the subsystem in space.

Stability

The ability of the subsystem to keep its integrity (wholeness). Steadiness of the subsystem's elements in time. Wear, chemical decomposition, disassembly and growth or entropy are all decreases in stability.

Strength

The ability of the subsystem to resist a change in response to force, resistance to breaking.

Durability

The time during which the subsystem can perform useful and/or neutral functions. It can be estimated as the average period between failures, or the service life.

Temperature

The thermal condition of the subsystem. Includes other thermal parameters such as heat capacity and ones that affect the rate of temperature change.

Brightness

Light flux per unit area. Also any other illumination characteristics of the subsystem, such as light intensity, degree of illumination.

Energy

The subsystem's requirement (such as electricity or rotation) to perform a particular function. Often energy is provided by the technique or super-system.

Power

The time rate of energy usage due to which the functions of the subsystem are performed.

Waste of energy

Use of energy (such as heat) that does not contribute to the job being done. Reducing energy loss sometimes requires actions different to those that improve energy usage.

Waste of substance

Partial or complete, permanent or temporary loss of some of the subsystem's materials or elements.

Loss of information

Partial or complete, permanent or temporary loss of data or access to date in or by the subsystem. Frequently includes sensory data such as aroma, texture etc.

Waste of time

Time is the duration of an activity. Improving the loss of time means reducing the time taken out of the activity.

Amount of substance

The number of the subsystem's materials or elements that might be changed fully or partially, temporarily or permanently.

Reliability

The ability of the subsystem to perform its intended functions in predictable ways and conditions.

Accuracy of measurement

The closeness of the measured value to the actual value of the subsystem parameter.

Accuracy of manufacturing

The closeness of the actual characteristics of the subsystem to the specified or required characteristics that can be achieved during production of the subsystem.

Harmful factors (acting on object)

Susceptibility of the subsystem to externally generated harmful effects.

Harmful side effects

A harmful effect that is generated by the subsystem as part of its operation within the technique, and that reduces the efficiency or quality of the functioning of the subsystem or whole technique.

Manufacturability

The degree of facility, comfort, ease, or effortlessness in manufacturing or fabrication of the subsystem.

Convenience of use

Simplicity and ease of operation. The technique is not convenient if it requires many steps to operate or needs special tools, many highly skilled workers, etc.

Repairability

Quality characteristics such as convenience, comfort, simplicity, and time to repair faults, failures or defects in the subsystem.

Adaptability

The ability of the subsystem to respond positively to external changes, and the versatility of the subsystem that can be used in multiple ways under a variety of circumstances.

Complexity of system

The number and diversity of elements and interrelationships within the subsystem.

Complexity of control

Measuring or monitoring the subsystems that are difficult, costly, and require much time and labour to set up and use, that have fuzzy relationships between components, or that have components that interfere with each other.

Level of automation

The ability of the subsystem to perform its functions without human interface.

Productivity

The number of functions or operations performed by the subsystem or whole technique per unit of time.

APPENDIX 2

RELATIONSHIPS BETWEEN IPs AND INVENTIVE MECHANISMS

Table 2-1 Summary of relationships between the IPs and inventive mechanisms.

IP	Segment	Re-Move-ment	Adjust	Add	Other - Use
01	ABC				
02		A			
03	AB			C	
04			AB		
05			AB		
06				A	
07			AB		
08				AB	
09				AB	
10		AB			
11				A	
12		A			
13			ABCD		
14			ABC		
15		AB	C		
16			A		
17			ABCD		
18			ABD		C
19	A		B		
20			A	B	
21			A		
22			C	B	A
23			B	A	
24				AB	
25				AB	C
26					ABC
27	A				
28			C	BD	A
29			ACD	B	
30			AB		
31			AB		
32			AB	C	
33			A		
34		A		B	
35			ABCD		

36					A
37					AB
38			AB		
39			AB		
40			A		

APPENDIX 3

PROCEDURE TO ESTABLISH 4-ATTRIBUTE MATRIX

The major problem in compiling the 4-Attribute Matrix (4-AM), i.e. establishing the attributes that are used most frequently to improve each engineering parameter, is the fact that they comprise of different sub-IPs. Had the Contradiction Matrix suggest the specific sub-IPs that are used most frequently to solve certain contradictions, it would have been easy to determine to what extent certain attributes were associated with these parameters. However, this not being the case, and the fact that attempts by the author to obtain such information were not successful, a different approach had to be taken.

This was done by determining a cumulative score for each attribute by multiplying the frequency with which an IP is used to improve an engineering parameter with the number of times that the sub-IP appears in a particular attribute. In the absence of more detailed information, an equal weighting was allocated to all sub-IPs. For example, as shown in **Table 3-1**, to improve engineering parameter #1 (Weight of moving object), IP35 appears a total of 13 times in the classic CM. The Properties attribute contains three of the sub-IPs, *viz* 35A, 35C and 35D. The same attribute is also described by sub-principles of IP18 (one), IP40 (three), IP29 (three), and IPs 31, 36 and 37 (one each).

Thus, the following scores were calculated for the various attributes:

Table 3-1 Most frequently used IPs and attributes for engineering parameter #1 (Weight of moving object).

IP	Frequency of use	Attribute and (number of sub-IPs)
35	13	Properties (3), Concentration (1)
28	8	Environment (2), Action (1), Object (1)
26	6	Object (3)
18	7	Properties (1), Frequency (3)
02	5	Object (1)
08	3	Environment (2)
10	5	Object (1), Action (1)
15	3	Object (2), Action (1)
40	4	Properties (3)
29	6	Properties (3), Environment (1)
31	6	Properties (1), Concentration (1)
27	5	Duration (1)
34	6	Object (2)
01	4	Object (3)
36	3	Properties (1)
19	3	Frequency (1), Action (1)
06	2	Function (1)
37	3	Properties (1)
38	3	Concentration (3)

Properties : $13x3 + 7x1 + 4x3 + 6x3 + 6x1 + 3x1 + 3x1 = 88$

Object : $8x1 + 6x3 + 5x1 + 3x2 + 6x2 + 4x3 = 61$

Frequency : $7x3 + 3x1 = 24$

Environment : $8x2 + 3x2 + 6x1 = 28$

Duration : $5x1 = 5$

Function : $2x1 = 2$

Action : $8x1 + 5x1 + 3x1 + 3x1 = 19$

Concentration : $13x1 + 6x1 + 3x3 = 28$

The four attributes with the highest cumulative scores were included in the 4-AM. Therefore, in order of priority, the four attributes for improving engineering parameter #1 were: Properties (88), Object (61), Environment (28) and Concentration (28). The same process was repeated for each of the other engineering parameters.