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Mitigation of Rejection in Spring Manufacturing By using Triz Methods

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ABSTRACT

In this research the researcher has tried to reduce the rejection in manufacturing of spring Method applied for it is a innovative problem solving tool. Researcher collected the all process data pertaining to rejection in spring manufacturing. Data was analyzed by activity-based-costing (ABC analysis). to select the process where is most rejection, most wastage of cost occur and than applying TRIZ method in the process and suggested the manufacturer to reduce the rejection in process & improve the product rate and quality of product.

KEYWORDS: *Spring manufacturing industry, TRIZ, Rejection*

INTRODUCTION

Today many big organizations involved in producing products with least rejection .The rejection of product may be due to any such reason which had not been considered as prominent. As we do know that as a material has a structure, unit cell, atom, proton neutron, and electron. Change in the material structure may take place due to disturbance of any one of them. In the same way if we divide a big problem in to number of small problem and solve them in a sequel then we have a solution of a big and complicated problem. Researcher did the same thing to find the main cause of rejection at different stages of manufacturing process of spring in Sitholi Spring factory Gwalior. And found the appropriate solution.

BRIEF LITERATURE SURVEY

G, Altshuller [1, 2], 1946-1950 started developing TRIZ and conducting his first TRIZ training sessions. At this time he realized a key role of resolving a technical contradiction in order to come up with an inventive solution. G, Altshuller, 1950-1954 wrote a letter to Soviet leader, I. Stalin, with a sharp critique of Soviet system of inventiveness. As a result he was imprisoned as a political prisoner.

In 1954, he was released and rehabilitated. G, Altshuller and R, Shapiro, 1956 published the article "About Technical Creativity" in the journal Questions of Psychology, #6, 37-491956 [1, 2]. It was the first official TRIZ publication, which introduced such concepts as technical contradiction, ideality, inventive system thinking (currently known as "System Operator" or "Multi-Screen Diagram of Thinking"), the law of Technical System Completeness, and Inventive Principles. G, Altshuller, [3, 4] the algorithm included 15 steps and 18 Inventive Principles (sub-principles); a step with "Ideal Final Result" was introduced.

G, Altshullerand Yu. Gorin 1971 [3, 4] ARIZ-71included 35 steps, 40 inventive principles (with 88 sub-principles), and the Matrix for Resolving Technical Contradictions with 39x39 parameters (it is the same matrix for resolving technical contradictions which is still in the wide use today). ARIZ-71was a major step in TRIZ development. It introduced Operator "Time-Size-Cost", the first version of the Method of Little Men, and included references to physical effects for solving inventive problems.

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G, Altshuller And N. Khomenko[5, 6]The first TRIZ software "Invention Machine™" was released by Invention Machine Labs (later evolved to "Tech Optimizer™" and "Gold fire Innovator™" by Invention Machine Corp.), which included Function Analysis, 40 Inventive Principles, Matrix of Resolving Technical Contradictions,76 inventive Standards, Databases of Physical, Chemical, and Geometric Effects, and Feature Transfer (Alternative Systems Merging). The software brought back the Matrix of Resolving Technical Contradictions as an independent tool due to its simplicity of use by TRIZ beginners (a modern version of software also includes Semantic Search Engine to index patent and document information according technical functions, and the Database of Effects now includes thousands of entries.) G, Altshuller [7], 1994-1998 had passed away and further coordination of TRIZ developments almost disappeared.

G, Altshuller, [8] different organizations with TRIZ expertise developed their own versions of TRIZ (I-TRIZ, TRIZ+, x TRIZ, Creax TRIZ, OTSM-TRIZ), thus a set of TRIZ tools developed under a guidance of Altshuller before 1998 is now titled "Classical TRIZ" to avoid confusion. G, Altshuller, [9, 10] A number of new tools emerge to help with complex problem analysis and management, which still remained a weak part of TRIZ: Root Conflict Analysis (RCA+) for decomposing inventive problems, Problem Flow Technology, Problem Networking for managing complex problems involving networks of contradictions.

Veleri Souchkov, [11] TRIZ and some its techniques with focus on technological applications of TRIZ. And Accelerate innovation of TRIZ. Vladimir Petrov, [12] continue to adapt tools and concepts of TRIZ for IT. Now I am trying to adapt the inventive principles and matrix.

V. Gerasimov and S. Litvin[13] a number of challenges that the freshly trained "TRIZnik" may face when returning from the training, as well as a number of recommendations for him or her, the direct manager, but also the company management, to safeguard the successful deployment of this powerful innovation tool.

Yu. Salamatov [14] briefly presents the history of development of the TRIZ namely the Theory of the Solution of Inventive Problems, introduces the current situation of the theoretical research and the application of the TRIZ, and propounds the emphasis and direction of the research and application of the TRIZ in China, which will contribute to the enhance the efficiency and benefits in Computer Aided Manufacturing.

METHODS AND TOOLS OF TRIZ

V. Tsourikov [15] research of over fifty years on Creativity and Inventive Problem Solving has led to many different classifications, methods and tools of invention. Inventive problem "as contradictions or conflicts" [16]: One of the first findings of altshuller was that "inventive problems are those that have contradictions/conflicts" TRIZ defines two kinds of contradiction, "physical and technical". Technical contradictions are the classical engineering "trade-off". The desire state can't be reached because something else in the system prevents it. In other words, when something gets better, something else gets worse. He defined 39 basic properties and 40 principles for solving problems containing contradiction in any two of 39 properties. This he gave in the form of a contradiction table of size 39*39 with each cell giving up to 4 principles. That may be used to eliminate the contradiction.

PHYSICAL CONTRADICTION ARE RESOLVED BY USING 6 SEPARATION PRINCIPLES

Yu. Murashkovsky [17] introduces TRIZwith 6 classical ways to resolve "physical contradiction" and these are known as "separation principles for "physical contradiction",

1. separation in space
2. separation in time
3. separation at micro level; transition to sub system
4. separation at macro level; transition to super system
5. separation in condition
6. convert to technical contradiction

TECHNICAL CONTRADICTIONS ARE RESOLVED BY USING CONTRADICTION MATRIX (39X39) AND 40 INVENTIVE PRINCIPLES:

Contradiction appears while trying to improve one desirable property another desirable property deteriorates! Conventional problem solving generally leads to a compromise solution. As mentioned before, the most inventive solution is obtained when a technical problem containing a contradiction is solved by completely eliminating the contradiction.

G. Altshuller, B. Zlotin, A. Zussman & V. Filatov [18], from his research on over 40,000 most inventive patents, found that there are only "39 Features" which either improve or degrade. So, every problem could be described as a conflict between a pair of parameters (2-out-of-39 parameters). Many patents had, in the past, resolved these individual conflicts in several different fields. The conflicts were solved over and over again, sometimes; these were spaced several years apart. He concluded that only "40 inventive principles" were used to resolve these contradictions fully, and not as a trade-off or compromise. He further argued that, if the latter researchers knew these earlier results, they would have solved their own problems with more ease.

S. Litvin & A. Lyubomirski [19] therefore, set about to extract and to organize the frequently occurring contradictions and the principles of the resolution of these contradictions. He put it in the form of a matrix of 39-improving parameters and 39-worsening parameters (39 X 39 matrix) with each cell entry giving the most often used (up to 4) inventive principles. This matrix is known as the "Contradiction Matrix" and remains to be the simplest and the most straightforward of TRIZ tools.

S Kaplan, S. Visnepolschi, B. Zlotin & A. Zusman [20]Contradiction matrix and examples (corresponding to each inventive principle) forms the first of the knowledge databases of the TRIZ. This is not given in these notes, as it is a part of the TRIZ software "TechOptimizer-3.0". In the principles module physical contradictions are situation where one object has contradictory, opposite requirement.

LIST OF THE 39 FEATURES

1. Weight of moving object.
2. Weight of stationary object
3. Length of moving object:
4. Length of stationary object
5. Area of moving object.
6. Area of stationary object:
7. Volume of moving object
8. Volume of stationary object
9. Speed:
10. Force
11. Stress or pressure
12. Shape.
13. Stability of the object's composition
14. Strength
15. Duration of action by a moving object
16. Duration of action by a stationary object
17. Temperature
18. Illumination intensity * (jargon)
19. Use of energy by moving object
20. Use of energy by stationary object
21. Power * (jargon)
22. Loss of Energy
23. Loss of substance
24. Loss of Information
25. Loss of Time
26. Quantity of substance/the matter
27. Reliability
28. Measurement accuracy
29. Manufacturing precision
30. External harm affects the object
31. Object-generated harmful factors
32. Ease of manufacture
33. Ease of operation /simplicity
34. Ease of repair
35. Adaptability or versatility
36. Device complexity
37. Difficulty of detecting and measuring:
38. Extent of automation:
39. Productivity

LIST OF THE 40 PRINCIPLES

Principle 1. Segmentation
Principle 2. Taking out
Principle 3. Local quality
Principle 4. Asymmetry
Principle 5. Merging
Principle 6. Universality

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Principle 7. "Nested doll"
Principle 8. Anti-weight
Principle 9. Preliminary anti-action
Principle 10. Preliminary action
Principle 11. Beforehand cushioning
Principle 12. Equipotentiality
Principle 13. 'The other way round
Principle 14. Spheroidality - Curvature
Principle 15. Dynamics
Principle 16. Partial or excessive actions
Principle 17. Another dimension
Principle 18. Mechanical vibration
Principle 19. Periodic action
Principle 20. Continuity of useful action
Principle 21. Skipping
Principle 22. "Blessing in disguise" or "Turn Lemons into Lemonade"
Principle 23. Feedback
Principle 24. 'Intermediary'
Principle 25. Self-service
Principle 26. Copying
Principle 27. Cheap short living objects
Principle 28. Mechanics substitution
Principle 29. Pneumatics and hydraulics
Principle 30. Flexible shells and thin films
Principle 31. Porous materials
Principle 32. Color changes
Principle 33. Homogeneity
Principle 34. Discarding and recovering
Principle 35. Parameter changes
Principle 36. Phase transitions
Principle 37. Thermal expansion
Principle 38. Strong oxidants
Principle 39. Inert atmosphere
Principle 40. Composite materials

IDENTIFICATION OF PROBLEM

We begin with “5W’s and an H” of Innovation. Ask these question of every system so that the system function and problem is identified.

W1. Who has the problem?
W2. What does the problem seem to be? What are the resources?
W3. When does the problem occur? Under what circumstances?
W4. Where does the problem occur?
W5. Why does the problem occur? What is root cause?
And
H1. How does the problem occur? How can the problem be solved?

DATA ANALYSIS

Table 1 Chart of process and cost, time, or rejection

S. No.	Process	Path	Cost per day (approx)	Time in process (minutes)	Rejection in bar
1.	Raw material (A)	-	0	0	0
2.	End tapering (B)	1-2	28000	0.83	2
3.	Bar heating (C)	2-3	38000	15	-
4.	Coiling (D)	3-4	9000	2	2
5.	Quenching (E)	4-5	15000	10	-
6.	Tempering (F)	5-6	35000	120	3
7.	End grinding & chamfering (G)	6-7	18000	25	-
8.	Shot peening (H)	7-8	16000	60	-
9.	Crack testing (I)	8-9	10000	10	2

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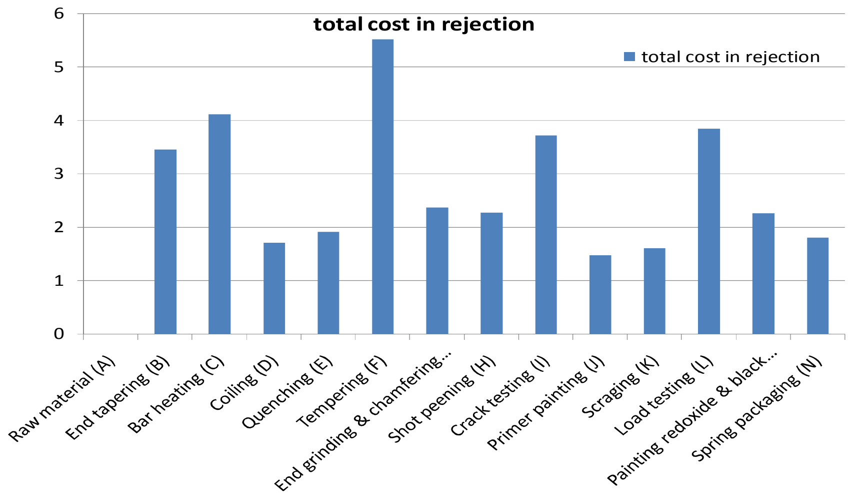
10.	Primer painting (J)	9-10	7000	0.30	-
11.	Scraging (K)	10-11	8000	2	-
12.	Load testing (L)	11-12	10000	2	2
13.	Painting redoxide & black paint (M)	12-13	14000	0.40	-
14.	Spring packaging (N)	13-14	8000	180	-

Table 2 Column chart of cost rejection

S. No.	Process	Path	Cost per day (approx.)	Cost in Time minutes(approx.)	Cost of Rejection bar(approx.)
1.	Raw material (A)	-	0	0	0
2.	End tapering (B)	1-2	28000	2200	4400
3.	Bar heating (C)	2-3	38000	3200	0
4.	Coiling (D)	3-4	9000	3700	4400
5.	Quenching (E)	4-5	15000	4200	0
6.	Tempering (F)	5-6	35000	5200	15000
7.	End grinding & chamfering (G)	6-7	18000	5700	0
8.	Shot peening (H)	7-8	16000	6700	0
9.	Crack testing (I)	8-9	10000	7200	20000
10.	Primer painting (J)	9-10	7000	7700	0
11.	Scraging (K)	10-11	8000	8000	0
12.	Load testing (L)	11-12	10000	8500	20000
13.	Painting redoxide & black paint (M)	12-13	14000	8600	0
14.	Spring packaging (N)	13-14	8000	10000	0



Graph 1 Graph Representing highest total cost in rejection

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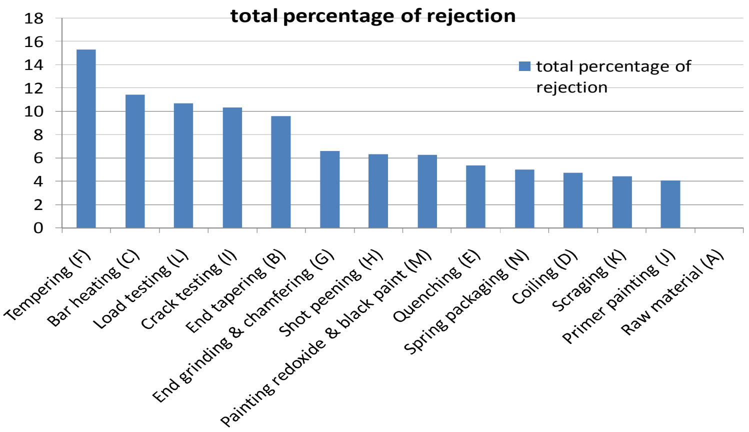
Table 3 Table in increasing order of percentage of rejection

S. No.	Process	Path	Cost per day (approx.)	Cost in Time minutes(approx .)	Cost of Rejection bar(approx.)	Total	Short by percentag e
1.	Tempering (F)	5-6	3.5	0.52	1.5	5.52	15.30
2.	Bar heating (C)	2-3	3.8	0.32	0	4.12	11.42
3.	Load testing (L)	11-12	1	0.85	2	3.85	10.67
4.	Crack testing (I)	8-9	1	0.72	2	3.72	10.31
5.	End tapering (B)	1-2	2.8	0.22	0.44	3.46	9.59
6.	End grinding & chamfering (G)	6-7	1.8	0.57	0	2.37	6.57
7.	Shot peening (H)	7-8	1.6	0.67	0	2.27	6.29
8.	Painting redoxide & black paint (M)	12-13	1.4	0.86	0	2.26	6.26
9.	Quenching (E)	4-5	1.5	0.42	0	1.92	5.32
10.	Spring packaging (N)	13-14	0.8	1	0	1.8	4.99
11.	Coiling (D)	3-4	0.9	0.37	0.44	1.71	4.74
12.	Scraging (K)	10-11	0.8	0.8	0	1.6	4.43
13.	Primer painting (J)	9-10	0.7	0.77	0	1.47	4.07
14.	Raw material (A)	-	0	0	0	0	0
					Total	36.07=100	99.96=100



Graph 2 Total percentage of rejection before implementation of TRIZ method

TRIZ METHOD AND CONTRADICTION MATRIX BASED SOLUTION OF TEMPERING

Que 1:-who has the problem?

Ans: - factory management

Que 2:-what does the prob. To be seem? What are the resources?

Ans:-after tempering process the hardness of spring not within limit. Due to change in structure of spring material.

Que 3:-when does the problem occur? Under what circumstances?

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Ans: - during tempering process. Under the variation in heating temperature or cooling process.
Que 4:- where does the problem occur?
Ans: - during tempering machine.
Que 5:- why does the problem occur? What is root causes?
Ans: -hardness depend on the temperature, time and duration of cooling in tempering. The root cause of improper heat treatment of tempering.
Que 6:-how does the problem occur? How can be solve?
Ans:-after tempering process change in structure of spring. We can solve this problem it will maintain the tempering temperature, cooling and heating time during heat treatment.

FINAL PROB.

Hardness of spring goes out of limit because of improper heat treatment during starting and end of process. It mean

1- Flow of material is not same for all.
2- Heat temperature for all spring is not same.
3- Cooling time and quality of oil is not same for all.

PHYSICAL CONTRADICTION

There is no physical contradiction in tempering process. Convert it to a technical contradiction b/w 2-or-39 feature

- Refer to the contradiction matrix.
-

USE CONTRADICTION MATRIX

Table 4 Contradiction Matrix

Worsening prob./improving prob.	Object generate harmful factor
Speed	2,24,35,21
Temp.	22,35,2,24
Quantity of substance	3,35,40,39

2. Taking out
24. Intermediary
35. Parameter change
21. Skipping
22. blessing in disguise or turn lemons in to lemonade
3. Local quality
39. Inert atmosphere
40 composite materials

ACCORDING TO TRIZ SOLUTION

35. Parameter change
    a. change an object’s physical state (e.g. to a gas ,liquid or solid)
    b. change the concentration or consistency
    c. change the degree of flexibility
    d. change the temperature
40. Composite material
    a. Change from uniform to composite (multiple) material.

MORE SUITABLE ANSWER IS

1- Change the concentration or consistency.
2- Change the temp.

CONCLUSION

Tempering is a heat treatment process. Proper heat treatment necessary from starting to end of process. Temperature in tempering m/c should maintain for all spring (480 degree centigrade). The hardness of spring should be in range 415-450 HBN for chrome moly spring steel. To make the hardness of spring within limit we have to keep constant flow of spring through the tempering m/c. with this cooling time and temp. Should remain constant. And maintain the consistency.

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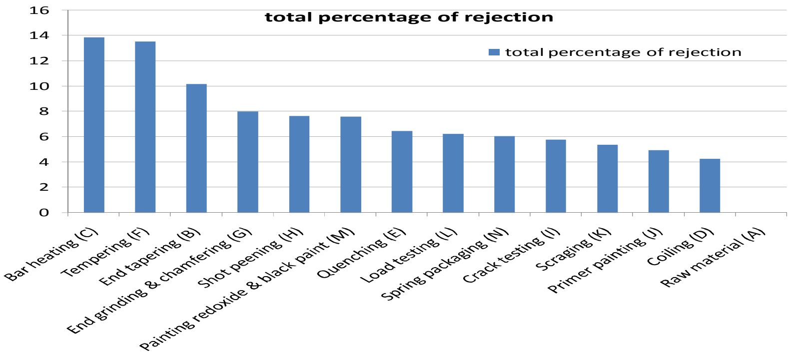
RESULT AND DISCUSSION

Table 5 Arranged in increasing order of percentage of rejection

S. No.	Process	Path	Cost per day (approx.)	Cost in Time minutes(approx.)	Cost of Rejection bar(approx.)	Total	Short by percentage
1.	Bar heating (C)	2-3	3.8	0.32	0	4.12	13.87
2.	Tempering (F)	5-6	3.5	0.52	0	4.02	13.53
3.	End tapering (B)	1-2	2.8	0.22	0	3.02	10.17
4.	End grinding & chamfering (G)	6-7	1.8	0.57	0	2.37	7.98
5.	Shot peening (H)	7-8	1.6	0.67	0	2.27	7.65
6.	Painting redoxide & black paint (M)	12-13	1.4	0.86	0	2.26	7.61
7.	Quenching (E)	4-5	1.5	0.42	0	1.92	6.46
8.	Load testing (L)	11-12	1	0.85	0	1.85	6.23
9.	Spring packaging (N)	13-14	0.8	1	0	1.8	6.06
10.	Crack testing (I)	8-9	1	0.72	0	1.72	5.79
11.	Scraping (K)	10-11	0.8	0.8	0	1.6	5.38
12.	Primer painting (J)	9-10	0.7	0.77	0	1.47	4.95
13.	Coiling (D)	3-4	0.9	0.37	0	1.27	4.27
14.	Raw material (A)	-	0	0	0	0	0
					Total	29.69=100	99.95=100



Graph 6 Process and total percentage of rejection after implementation of TRIZ METHOD

RESULTS

After the use of TRIZ method we reduce the 17.7 % of rejection in this process. And also make leanness in manufacturing of coil spring process. To reduce the delivery time and increase the production

CONCLUSION

In this thesis or research, an integrated TRIZ (theory of inventive problem solving) method was proposed to enhance leanness in manufacturing process of small scale industry. After the use of TRIZ method we reduce the 17.7% of rejection in this process. It reduces the rejection and Increase the production rate

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Table 5.2 Reduction in total rejection in cost after implementation of TRIZ method in all the processes

Process	Total rejection in cost before implementation of TRIZ	Identified prob. Through TRIZ	Suggestion	Total rejection in cost after implementation of TRIZ	Reduction
Tempering	5.52	hardness of spring goes out of limit	To make the hardness of spring within limit we have to keep constant flow of spring through the tempering m/c. with this cooling time and temp. Should remain constant. And maintain the consistency	4.02	1.5
Bar heating	4.12	temperature of bar heating machine not within limit	preventive maintenance should be done before starting m/c.	4.12	-
Load testing	3.85	improper heat treatment ductility of rod reduces	To make the toughness of spring within limit we have to keep constant flow of rod through the bar heating m/c. with this cooling time and temp. Should remain constant. And maintain the consistency.	1.85	2
Crack testing	3.72	cracks generate in spring due to ductile material and coiling the bar	To make the toughness of spring within limit we have to keep constant flow of rod through the bar heating m/c. with this cooling time and temp. Should remain constant. And maintain the consistency	1.72	2
End tapering	3.46	due to miss matching the flow of material and hydraulic machine time	Preventive maintenance of mechanism of chain conveyor and hydraulic m/c before starting the end tapering process.	3.02	0.44
End grinding & chamfering	2.37	Due to improper bar angle. both the end faces of the spring not grind with in limit	When bar are coil then maintain bar angle by using proper tools. Because the main purpose of this process is to make base of spring flat so that it can easily aligned with the flat base.	2.37	-
Shot peening	2.27	maximum cost rejection in this process	All thing are necessary for this process. So cost rejection not reduce in shot peening process	2.27	-
Painting redoxide & black paint	2.26	wastage of color due to old method use in coloring	New techniques used in coloring means spray the color in spring.	2.26	-
Quenching	1.92	improper oil temp and quality of oil	Maintaining the temp. Of oil container (60 degree centigrade). to relieve residual stress, improve ductility	1.92	-

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