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A TRIZ-based Tool for Remanufacturing Using Additive Manufacturing: RE-AM-TRIZ

Introduction

Remanufacturing is a process of returning a used product to at least the original equipment manufacturer (OEM) performance specification from the customers' perspective and giving the resultant product a warranty that is at least equal to that of a newly manufactured equivalent. Even though there are many benefits of remanufacturing, there are barriers when it comes to its implementation. There can arise contradictions when dealing with different products, or in different steps during the remanufacturing process. A method to solve contradictions like those is TRIZ, which is a problem-solving method that can resolve technical contradictions.

Objectives

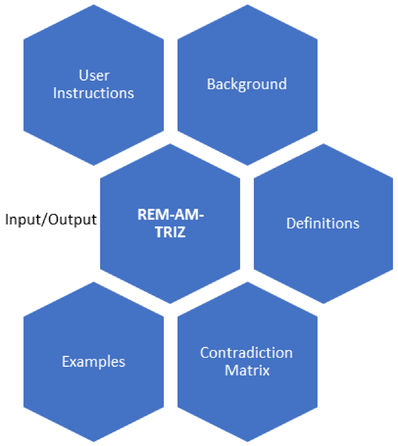
- Identify improving and worsening conditions for remanufacturing
- Apply principles that would resolve contradictions
- Create TRIZ Matrix to consolidate possible solutions
- Gather examples and further readings for every principle within the TRIZ Matrix
- Develop tool to allow for intuitive problem resolution
- Design and implement a user friendly, intuitive interface for easy parameter selection

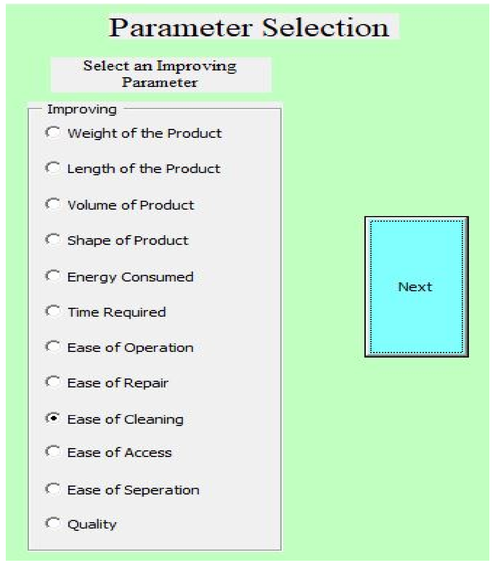
Methodology

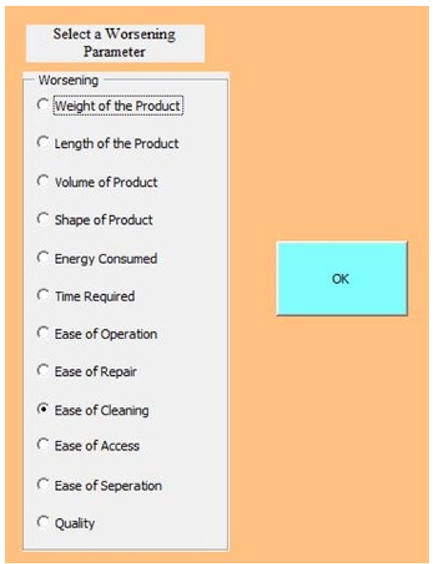
The tool was developed based on the foundations developed from our earlier work, and modified a standard TRIZ Matrix. Following steps are taken to retrieve solution principles:

- Starting with selecting the Improving Parameter, the user determines what choice would best suit their given situation.
- The horizontal row is selected that matches this choice.
- The Worsening Parameter is chosen to specify which column within the row will be used in the answer.
- The answer is provided, giving up to six possible principles for every set of Improving and Worsening Parameters

(An example of this matrix selection will be shown to the right).





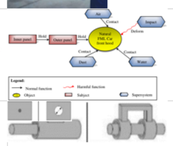


Worsening

Improving

Improving	#	Remanufacturing Contradiction Matrix																							
		Weight of the Product			Length of the Product			Volume of the Product			Shape of the Product			Energy Consumed			Time Required			Ease of Operation					
		1			2			3			4			5			6			7					
Weight of the Product	1				1			7			46	53	64	19	15		15	2	61	6	13	1	2		
Length of the Product	2										15	7		6			30	7		2					
Volume of the Product	3										7	2	53	1	15		61			46			1		
Shape of the Product	4				14	7		7	2		66			14	41	63	14	17	63	32	15	26	2		
Energy Consumed	5	19	6	3	6	7		7			53	66					32	7		1	54	55	62		
Time Required	6	42 20	26	5	30	24	14				17	41	53							63 28	54	55	1		
Ease of Operation	7	5 6	13	1				46			66 15	53	64	2	13	13	28	62	65	67			12		
Ease of Repair	8	2						1			1	2		1	13		1			1	12	26			

An example of a final solution provided by the selection tool:

		Improving	Worsening
Begin		Ease of Cleaning	Energy Consumed
Principle #	Recommended Principle(s)	Example	Picture(s)
50	Smooth surface	Polish or grind down coarse surfaces; fill in porous surfaces so that they are no longer porous	
49	Wear resistance	Covering often worn-down pieces with protective coatings; Use material more resilient than that originally used	
60	Minimum diameter	Make holes within pieces large enough so they do not collect unwanted material within them	

Conclusion

Overall, the presented tool makes it easier for designers to solve contradictions in the field of design for remanufacturing using additive manufacturing. The tool has a simple user interface, and it also has added information to allow users of all backgrounds to research remanufacturing, additive manufacturing and TRIZ, and to make improvements that suits their needs.

Further Development

The program developed for this tool could easily be reformatted for similar Triz matrixes in other fields of engineering. If desired, the program can easily be updated by anyone who knows basic VBA. This can be done by changing the code found on any of the user forms labeled with a single letter, each covering all the possible options for Improving Parameters. (This means A covers all Weight of the Product Improving Parameters, and B covers all Length, etc.)

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