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TOOL LIFE MANAGEMENT FOR CNC MACHINE

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Abstract - *The output from a computer numerical control machine tool can be increased to a large extent by using a tool life management system if and when the tool life management system is applied or implemented properly. When considering whether the system is right for the given applications, we consider that the ultimate goal of any tool life management system is to keep all tool maintenance offline. Tool maintenance includes any task done to keep tools cutting on size (measuring work pieces and sizing tools) as well as any task performed when tools get dull (tool/insert replacement, re-measuring program zero, trial machining, and more). By doing tool maintenance offline, the task must be done in conjunction with the production run, while the machine is in cycle. The design of machine should be done in such a way that a tool can easily and safely removed and replaced while performing the maintenance of the machine and the machine is running so as to neglect the unproductive time.*

Key Words: **Data Analysis for Tool Life, Tool usage per day, No. of Tool pre-setting, No. of Tool changes etc.**

1. INTRODUCTION

With a proper, effective and efficient application, tool life management systems can increase the output from CNC machine tool to a great extent. While considering the fact that whether the system is suitable for various applications of tool life management systems, it is quite essential as well as necessary to keep all tool maintenances offline. Tool maintenances include the tasks of keeping the cutting size of tool within its range/limit, as well as it includes tasks which are required when tools get dull. By performing tool maintenance offline, the tasks are thus done in conjunction with the production run, while the machine is in cycle.

Also we need to consider a fact that tool life management in many applications could add a lot of production run time. For the matter of fact to avoid such circumstances many CNC machines, especially their turning centers are kept down while the dull cutting tools are being replaced. Thus if the tool maintenance are kept away from affecting the production run time, the jobs would get completed much faster and also the cycle time would be reduced visibly. Also tool life management do play a vital role in metal working processes, so that the information regarding the tool can be uniformly managed or organized. Tool life management in general deals with two major parts which include documentation and transaction data; where the documentation handles the information required for trouble and impactful production processes. Tool life management provides flexibility in its working system by its ability of modifying the feeds and cutting speeds based on cutting tool material required for metal working processes. Thus due to this several functions such as processing, modifying, documenting ,managing etc. together as a whole can be handled through tool life management.

1.1 METHODOLOGY

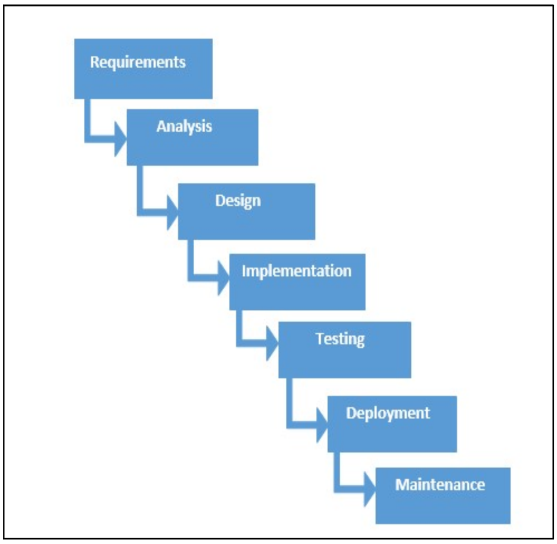

Fig-1: Flow Chart for Tool –Life Management

1.2 Tool-Life Definition

1. The tool life is the duration of actual cutting time after which the tool is no longer usable.
2. There are many ways of defining the tool life and the common way of quantifying the end of a tool life is by a limit on the maximum acceptable flank wear.
3. With a good application and when properly applied, a tool life management system can dramatically increase for a CNC machine tool.
4. Tool life management includes any task done to keep

tools cutting on size as well as any task performed when tools get dull.

5. Ultimate goal of Tool life management is to keep all tools offline. Thus by keeping tools offline all tasks should be done in conjunction in production run, while machine is in cycle.

2. TOOL DESCRIPTION FOR VARIOUS MODELS

Table -1:

MODEL NUMBER	TOOL DESCRIPTION
JZ/Sprint/JV/BM100	Dia 9.5 x 25 mm Drill cum face spot (Spark Plug Hole)
B104D	Dia 2mm Drill
K1K2	M10x1 Tap
K11	Dia 7x45 Step Drill
Super 100	Dia 9 x 100 x 160 mm Drill
Ku Head	Dia 8mm drill
Lombordini Block	Dia 8.5 X 10 X 117 mm Drill (clamping hole)
M4WL	Dia 8.5mm WIDIA TC drills
Piaggio	Dia 8 mm End Drill
Manifold	Dia 9.15 End mill
Flange	Dia 4 mm Gun Drill
MMAC1, AC2	Dia 11.95 x 15.17 mm hole mill

2.1 Data Analysis for Tool Life

CPC Tracking: For the Month of Aug 2016

Line	Model	1			2			3			4			5			6		
		Prodn	Tool Cost	CPC	Prodn	Tool Cost	CPC	Prodn	Tool Cost	CPC	Prodn	Tool Cost	CPC	Prodn	Tool Cost	CPC	Prodn	Tool Cost	CPC
	JZ/Sprint/JV/BM100						#DIV/0!	450	3853.5	8.56	501		0.00	796		0.00	764	642.44	0.84
	B104D Head	365		0.00			#DIV/0!	390	3653.4	9.37	488		0.00	540	3063.44	5.67	500	46	0.09
	K1, K2	576		0.00			#DIV/0!	745	33886.41	45.49	902	49861.59	55.28	901	3828.5	4.25	996	15772.19	15.84
	K11	90		0.00				290		0.00	385	816.8	2.12	361	1414.87	3.92	162	2231.67	13.78
	Super 100	78		0.00			#DIV/0!	632	15772.18	24.96	876	3298.75	3.77	814		0.00	490	19634.55	40.07
Aluminium	Total	1109	0	0.00			#DIV/0!	2507	57165.49	22.80	3152	53977.14	17.12	3412	8306.81	2.43	2912	38326.85	13.16
Export	KU Head	85		0.00			#DIV/0!	213	3319.44	15.58	345	17895.36	51.87	365	25279.1	69.26	420	8844.03	21.06
	Lombordini Block	122	410.4	3.36			#DIV/0!	240	50	0.21	110		0.00	370	1300	3.51	387	1300	3.36
	M4WL	163	685.5	4.21			#DIV/0!	104			45	956.2	21.25	110	2196.8	19.97	104	650	6.25
	Piaggio							0				280.69						3610.5	
	Manifold						#DIV/0!	47	3356.4	71.41	71	1579.8	22.25		2137.5				
	Flange	74		0.00				39			87	1579.8	18.16	13		0.00	20		0.00
	MMAC1, AC2																		
Export	Total	444	1095.9	2.47	0	0		643	6725.84	10.46	658	22291.85	33.88	858	30913.4	36.03	931	14404.53	15.47
Total		4911	62663.87	12.8	0	0	#DIV/0!	6352	105577.65	16.6	7565	114485.08	15.1	8566	84380.21	9.9	8002	81798.42	10.2

Fig-2: Data analysis for August month (day 1 to 6)

CPC Tracking: For the Month of Aug 2

Line	Model	7			8			9			10			11			12		
		Prodn	Tool Cost	CPC	Prodn	Tool Cost	CPC	Prodn	Tool Cost	CPC	Prodn	Tool Cost	CPC	Prodn	Tool Cost	CPC	Prodn	Tool Cost	CPC
	JZ/Sprint/JV/BM100	551	10613.38	19.26	483		0.00			#DIV/0!	543		0.00	547	270	0.49	316		0.00
	B104D Head	494	3952.4	8.00	578		0.00	140		0.00	520	46	0.09	514		0.00	562		0.00
	K1, K2	1015	22204.7	21.88	1120	9186.14	8.20	335	1353.5	4.04	992	8778.5	8.85	925	1785.84	1.93	1030		0.00
	K11	75	2421	32.28	126		0.00			#DIV/0!	222	5745.65	25.88				246		0.00
	Super 100	888		0.00	846		0.00			#DIV/0!				586	470	0.80	592	207	0.35
Aluminium	Total	3023	39191.48	12.96	3153	9186.14	2.91	475	1353.50	2.85	2277	14570.15	6.40	2572	2525.84	0.98	2746	207	0.08
Export	KU Head	393	12290.66	31.27	406	11790.81	29.04		11560	#DIV/0!	391	10031.12	25.66	357	9880.5	27.68	328	9207.6	28.07
	Lombordini Block	223	410.9	1.84		650				#DIV/0!	192	280.69	1.46	116		0.00	301	96	0.32
	M4WL	135	789.9	5.85	118	22068.05	187.02			#DIV/0!	144		0.00	133	19003.68	142.88	82		0.00
	Piaggio									#DIV/0!				200.00		0.00	132	410	3.11
	Manifold	46	2369.7	51.52							34	1579.8	46.46	44	323.33	7.35	43	1579.8	36.74
	Flange										54			72		0.00	45		
	MMAC1, AC2																		
Export	Total	797	15861.16	19.90	524	34508.86	65.86	0	11560	#DIV/0!	815	11891.61	14.59	922	29207.51	31.68	931	11293.4	12.13
Total		8390	82335.88	9.8	8272	73788.78	8.9	875	24167.38	27.6	7802	52620.18	6.7	8511	42877.97	5.0	8196	48921.8	6.0

Fig-3: Data analysis for August month (day 7 to 12)

CPC Tracking: For the Month of Aug 2

Line	Model	13			14			15			16			17			18		
		Prodn	Tool Cost	CPC	Prodn	Tool Cost	CPC	Prodn	Tool Cost	CPC	Prodn	Tool Cost	CPC	Prodn	Tool Cost	CPC	Prodn	Tool Cost	CPC
	JZ/Sprint/JV/BM100	579		0.00	504	642.44	1.27			#DIV/0!			#DIV/0!	405	0	0.00	221		0.00
	B104D Head	574		0.00	510	642.46	1.26						#DIV/0!	540	0	0.00	554	3952.4	7.13
	K1, K2	953	22133.69	23.23	1131	5219.3	4.61			#DIV/0!			#DIV/0!	1091	570	0.52	1090	3170.52	2.91
	K11	60	560	9.33	100	6416.19	64.16			#DIV/0!			#DIV/0!	201	628	3.12			
	Super 100	836		0.00	856	22164.88	25.89						#DIV/0!	490	0	0.00		270	
Aluminium	Total	3002	22693.69	7.56	3101	35085.27	11.31			#DIV/0!			#DIV/0!	2727	1198.00	0.44	1865	7392.92	3.96
Export	KU Head	360	13895.41	38.60	215	18707.1	87.01			#DIV/0!			#DIV/0!	250	6668.9	26.68	363	11657.5	32.11
	Lombordini Block	175		0.00	245	635.6	2.59			#DIV/0!			#DIV/0!	228	0	0.00	180		0.00
	M4WL	163	531.8	3.26	74	2285.6	30.89			#DIV/0!				72	280.6	3.90	107	842.07	
	Piaggio	135.00	244.65	1.81	81.00	941.8	11.63			######			######	171	0	0.00	166	3620.4	21.81
	Manifold	35	3055.2	87.29	23	0	0.00			#DIV/0!			#DIV/0!	21	196.8	9.37	48		0.00
	Flange	41		0.00		0	#DIV/0!								0				
	MMAC1, AC2					0	#DIV/0!								0				
Export	Total	909	17727.06	130.9646	638	22570.1	35.38	0	0	#DIV/0!	0	0	#DIV/0!	742	7146.30	9.63	864	16119.97	18.7
Total		7861	64772.66	8.24	7339	74562.77	10.16	0	0	######	0	0	######	6861	27240.67	3.97	6175	58254.90	9.4

Fig-4: Data analysis for August month (day 13 to 18)

CPC Tracking: For the Month of Aug 2

Line	Model	19			20			21			22			24			25		
		Prodn	Tool Cost	CPC	Prodn	Tool Cost	CPC	Prodn	Tool Cost	CPC	Prodn	Tool Cost	CPC	Prodn	Tool Cost	CPC	Prodn	Tool Cost	CPC
	JZ/Sprint/JV/BM100	541	239.00	0.44	357	4594.8	12.87	305	642.44	2.11	475	478	1.01	746	8270	11.09	696	2421	3.48
	B104D Head	520	7904.80	15.20	344	239	0.69	126		0.00	384		0.00	548	0	0.00	445	4492.4	10.10
	K1, K2	1085	1923.50	1.77	1070	52119.94	48.71	1055	1441.44	1.37	1724	478	0.28	1065	7023.49	6.59	1252	2695.08	2.15
	K11	60	254.00	4.23	255		0.00	109		0.00			#DIV/0!	264	4618.24	17.49	112	881.44	7.87
	Super 100	476	12089.78	25.40	590		0.00				580	239	0.41	920	11400	12.39	748	0	0.00
Aluminium	Total	2682	22411.08	8.36	2696	58307.24	21.63	1595	2083.88	1.31	3163	1195.00	0.38	3770	31311.73	8.31	3253	10489.92	3.22
Export	KU Head	366	6589.80	18.00	375	25171.35	67.12	369	13635.12	36.95	316	8848.7	28.00	200	2876.38	14.38	325	10750.19	33.08
	Lombordini Block						#DIV/0!	55	1673.2	30.42	178	3906.8	21.95	156	655.05	4.20	57		0.00
	M4WL	92	196.80		129	7986.25	61.91	92	196.8	2.14	27	1650	61.11	115	804.5	7.00	123	758.18	6.16
	Piaggio	202	393.60	1.95	188.00		0.00	191		0.00	239	2083.6	8.72	185	0	0.00	214	609.2	2.85
	Manifold	46		0.00	27	502	18.59				42	435.8	10.38	45	789.9	17.55	50	3508.8	70.18
	Flange																		
	MMAC1, AC2																	28825	
Export	Total	706	7180.2	10.17	719	33659.60	46.81	707	15505.12	21.93	802	16924.9	21.10	701	5125.83	7.31	769	44451.37	57.80
Total		7833	73141	9.3	7589	116435	15.3	6445	29170	4.5	9055	38472.37	4.2	8850	68958	7.8	7605	75369.43	9.9

Fig-5: Data analysis for August month (day 19 to 25)

CPC Tracking: For the Month of Aug 2

Line	Model	26			27			MTD (Tdt.)		
		Prodn	Tool Cost	CPC	Prodn	Tool Cost	CPC	Prodn	Tool Cost	CPC
	JZ/Sprint/JV/BM100	685			488	780	1.60	10953	33447.00	3.05
	B104D Head	502	4495.94		552		0.00	10690	32488.24	3.04
	K1, K2	917	2638.38	2.88	1194	30511.41	25.55	23164	276582.12	11.94
	K11	135	1353.5	10.03	0	0		3253	27341.36	8.40
	Super 100	248			643		0.00	12189	85546.14	7.02
Aluminium	Total	2557	8487.82	3.32	3182	31291.41	9.83	60931	456758.36	7.50
Export	KU Head	360	9842.96	27.34	388	10513.29	27.10	7190	259255.32	36.06
	Lombordini Block	80	280.69	3.51	172	477.49	2.78	3587	12126.82	3.38
	M4WL	95	986.7	10.39	79	196.8	2.49	2306	63066.23	27.35
	Piaggio	185.00	0	0.00	214	609.20	2.85	2503	12803.64	5.12
	Manifold	33	1579.8	47.87	46		0.00	701	22994.63	32.80
	Flange				21		0.00	466	1579.80	3.39
	MMAC1, AC2						0.00	0	28825.00	0.00
Export	Total	753	12690.15	16.85	920	11796.78	12.82	16753	400651.44	23.92
Total		7205	35355.46	4.9	8379	61901	7.39	168639	1497249.99	8.88

Fig-6: Data analysis for August month (day 26 to 27)

The above mentioned excel sheet consist of the following parameters for analysis: -

1. Production

It basically refers to the number of products that were produced in a day. It is based on the working capacity of the tool life and its functionality.

2. Tool Cost

It is basically based on production and it is the estimation cost of the tool required for producing products in a single day.

3. CPC

Cost per Capital is a ratio of Total Tool Cost to Production and it varies if either of the parameters changes.

2.2 TOOL COST SPENT

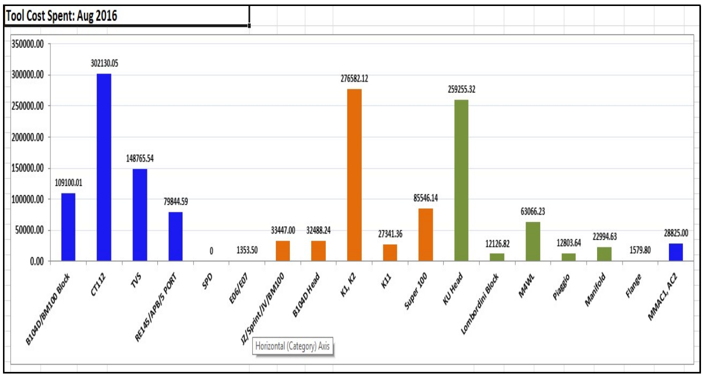

Fig-6: Data analysis for tool cost spent for month of August

The above graph shows the amount of money spent on tool for performing various operations. The X axis represents the name of the component whereas Y-axis represents the cost spent on tool.

CT112 , K11, Super 100 etc. are the name of the motorcycle and the cost spent on tool is the cost of tool used to produce the parts of those motorcycles. The Manhattan of the CT112 , KL K2 and KU head is highest as seen in the graph.

2.3 TOOLING REVIEW AND PREVENTIVE MEASURE COST SPENT

Table -2:

MODEL NUMBER	TOOL DESCRIPTION	CONCERN DECRIPTION / ROOT CAUSE ANALYSIS	ACTION PLAN TAKEN
JZ / Sprint / JV / BM100	Dia 9.5 x 25 mm Drill cum face spot (Spark Plug Hole)	Quality issue (Regrinding issue) in cutting edges which creates burr sticking in the drill gashing, spot face	Informed to supplier to do the corrective measure regarding finishing and grinding.
B104D	Dia 2mm Drill	Tool broken. Observation: Vc - 13m/min; tool life in mtrs. - 8 mtrs.	As a corrective action, every shift beginning - the tools are getting changed. Tool breakage frequency is reduced.
K11	Dia 7x45 Step Drill	Fully Aluminum got welded in cutting edges 	Uncoated tools with polished flute to be used Straight flute drills will have better chip evacuation Coolant pressure to be increased 2 tools were modified geometry for better Burr evacuation; performed well.
Super 100	Dia 9 x 100 x 160 mm Drill	Tool broken and created abnormal noise. Burning marks observed (dry cut). When checked the machine, the coolant pipes not focused.	As like CT112 - 8.5 drill, double margin drill will be developed. (based on the performance of Dia. 8.5 drill, it will be done)
Lombordini Block	Dia 8.5 X 10 X 117 mm Drill (clamping hole)	Frequent tool breakage issue	Set tool life is on higher side.
M4WL	Dia 8.5mm WIDIA TC drills	Trough coolant drills	Trough coolant drills after 2nd Re-sharpening loaded on machine Drill1 = 600 Cycles, Drill 2 = 369 Cycles O/s issue, Drill 3 = 280 Cycles wear out, Drill 4 = 500Cycles
Piaggio	Dia 8.3 mm Drill	At exit of the hole, it is opening out in Cross Hole on the same feed	At Exit, feed rate to be reduced to 1/3 of the feed rate. Feed should be 200mm/min for 2~3mm at exit
Manifold	Dia 9.15 End mill	Continuous breakage - Checked clamping	With same tool 2 more drill cycles added to avoid

		pressure Found 50 Bar, For another machine its 40 bar, Milling cutter path need to change as its failing with clamping nut	excess load. End mill 2.Milling path changed.
Flange	Dia 4 mm Gun Drill	New tool is loaded, when truing the drill - hit in the fixture got bend. Observation: When tightening the gun drill in the spindle, it deflects and rubbing inside bush	The gun drill was inserted in guide bush, and after that gun drill is tightened in the spindle.
MMAC1, AC2	Dia 11.95 x 15.17 mm hole mill	Observation: Regrinding tools are creating problem	Check the diameter and corner chamfer.

2.4. NUMBER OF TOOL CHANGES

Month	1-Aug	2-Aug	3-Aug	4-Aug	5-Aug	6-Aug	7-Aug	8-Aug	9-Aug
Schedule	35	34	36	37	32	38	43	36	
Un-Schedule	7		7	8	12	10	11	16	
Total	42	34	43	45	44	48	54	52	0
% of Un-Schedule	17%	0%	16%	18%	27%	21%	20%	31%	#DIV/0!

Fig-7: Number of Tool Changes (day 1 to 9)

Month	10-Aug	11-Aug	12-Aug	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug
Schedule	35	55	41	49	37			35	36
Un-Schedule	10	12	18	14	13			8	14
Total	45	67	59	63	50	0	0	43	50
% of Un-Schedule	22%	18%	31%	22%	26%	#DIV/0!	#DIV/0!	19%	28%

Fig-8: Number of Tool Changes (day 10 to 18)

Month	19-Aug	20-Aug	21-Aug	22-Aug	23-Aug	24-Aug	25-Aug	26-Aug	27-Aug
Schedule	41	44	35	46		44	41	34	48
Un-Schedule	18	11	8	11		9	14	10	13
Total	59	55	43	57	0	53	55	44	61
% of Un-Schedule	31%	20%	19%	19%	#DIV/0!	17%	25%	23%	21%

Fig-9: Number of Tool Changes (day 19 to 27)

Month	28-Aug	29-Aug	30-Aug	31-Aug	MTD
Schedule					912
Un-Schedule					254
Total	0	0	0	0	1166
% of Un-Schedule	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	22%

Fig-10: Number of Tool Changes (day 28 to 31)

The above sheet shows the no. of tools changes that were made on that particular day. The above sheet is further divided into two more categories i.e. scheduled an un-scheduled

Scheduled – It is the actual no. of changes that were meant to happen as decided by the company. Those changes were compulsory and had to be done.

Un-scheduled – It is the no. of tool changes that weren't decided but made due to some adverse conditions that were faced on that particular day. Or else the job to be done was completed before the expected time. Due to which the tool had to be changed. Thus Un-scheduled tool may be a good sign or bad depending upon the situation.

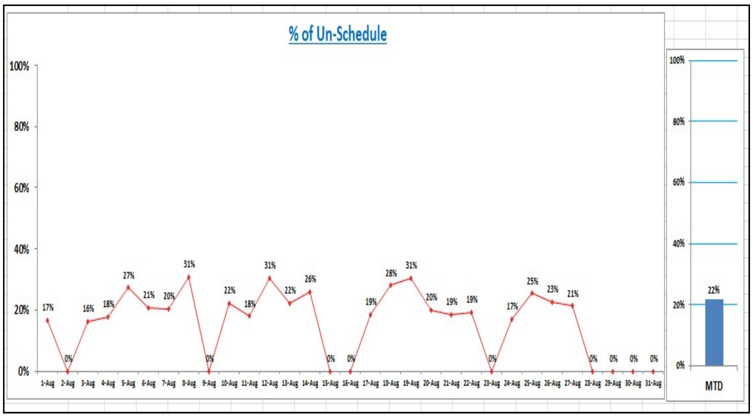

Fig-11: Graph of Data Analysis for No. of Change of Tool for un-scheduled Tooling

3. TOOL USAGE PER DAY

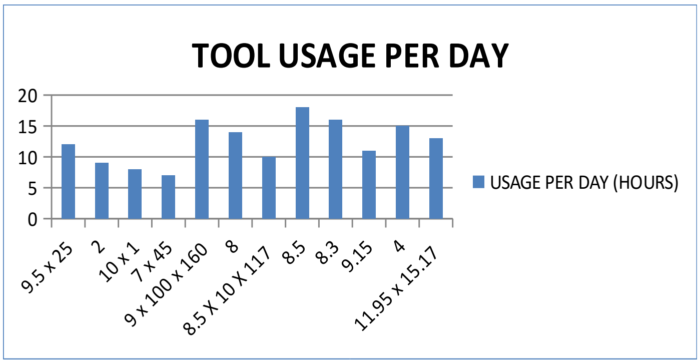

Fig-12: Graph of Tool usage per day

The above graph shows a brief description of the drill tool usage per day. The X-axis represents the various diameters of drills used in performing operations on the component; whereas the Y-axis represents the number of hours for which the tool is used per day.

4. CONCLUSIONS

This project provides detail knowledge and study about tool life analysis of the tools used in an industry for the month of august. It also describes the names of various tools and jobs that have been used for this project. Analysis of data of tool life is done and recorded in an excel sheet. The collected data is summarized in the form of various graphs and different results are concluded. A table of type/name of tool, reason of failure and along with the action plan taken is for the above analysis is shown in this paper.

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BIOGRAPHIES

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