



1



FMEA, FMECA, and RCM – What's the difference?

James Reyes-Picknell

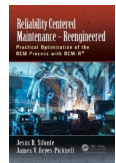
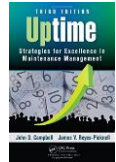
Founder, President & Principal Consultant

2

James Reyes-Picknell

BASc, P.Eng., CMC, CMRP, CAMA, MMP, CSAM, CBPro

- Mechanical Engineer, University of Toronto, 1977,
- Post grad with RNEC (UK) and TUNS (Dalhousie)
- 45+ year career in Maintenance and Asset Management.
 - Hands on roles in Canadian Navy, Esso Chemicals Canada, Saint John Shipbuilding / Naval Systems, IMP Aerospace.
 - Consulting since 1995: C&L, PwC (1998), IBM (2002), Conscious Asset (2004)
- Thought-leadership (reliability and maintenance management)
 - Magazines and Blog
 - "Uptime - Strategies for Excellence in Maintenance Management", 3rd edition, 2015
 - "Reliability Centered Maintenance – Re-Engineered: Practical Optimization of the RCM Process with RCM-R®" 2017
 - Other books (self-published)
 - "Reliability Centered Maintenance: A Key to Maintenance Excellence" 2000, Hong Kong Polytechnical University
 - "Uptime Made Easy" 2009
 - "No Surprises" 2016
 - "ISO 55000, What's Not to Like" 2016
 - "Paying Your Way" 2020
 - Frequent conference speaker and trainer
- 2016 – awarded PEMAC's prestigious Sergio Guy Award for significant contributions to the profession



3

What is FMEA?

- Systematic approach (method) used to identify potential failure modes, and determine their effects in equipment or system design
- This enables risk to be evaluated and determining if any **additional controls** are needed to address the risk – often by use of design changes
- Starts with component identification using a Bill of Material
- Usually performed by designers (engineers)
 - Often it is a solo-effort



5

FMEA Example: ASQC

Function	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential Cause(s) of Failure	O	Current Process Controls	D	R	P	N	C	R	Recommended Action(s)	Responsibility and Target Completion Date	Action Results	Action Taken	S	O	D	R	P	N	C	R
Dispense amount of cash requested by customer	Does not dispense cash	Customer very dissatisfied Incorrect entry to account Deposit system discrepancy in cash balancing	8	Out of cash Machine jams Power failure during transaction	5	Internal loan- cash alert Internal jam alert None	5	200	45															
Dispenses too much cash	Bank loses money Discrepancy in cash balancing		6	Bills stuck together Denominations in wrong tray	2	Loading procedure (offe- ards of bills) Two-person input verification	7	84	12															
Takes too long to dispense cash	Customer complains annoyed		3	Heavy computer network traffic Power interruption during transaction	7	None None	10	210	21															

FMEA often starts with BOM on the left, then describes the function of the item

- Function
- Potential failure mode
- Potential effects of failure
- Severity
- Potential cause (s) of failure
- Occurrence rating (probably of failure: 1 (extremely unlikely – 10 inevitable)
- Current process controls
- D = 1 to 10 (detection rating)
 - 1 is certain to be detected, 10 can't be detected
- RPN = S x O x D
- Crit = S x O
- Recommended actions
- Responsibility and complete target date
- Action results
 - Then new: S, O, D, RPM, Crit

6

What is FMECA?

- Similar to FMEA except with the addition of evaluation criticality – consequences to safety, environment, operations and mission
- Criticality assessment
 - Severity of effect + Probability (likelihood) used
 - Also looks at detectability – how easy is it to spot and diagnose the problem
- Enables designers to focus on critical failures and ignore others
- Like FMEA this is usually a solo designer effort

7

FMEA from Mil-Std 1629A (1977)

[illegible]

Figure 101.3 Example of FMEA worksheet format

- ID number
- Functional identification number
- Function
- Failure modes and causes
- Mission phase / operational mode
- Failure effects
 - Local, next higher, end effect
- Failure detection method
- Compensating provisions
- Severity class
- Remarks

Criticality Analysis: Mil-Std-1629A (1977)

[illegible]

Figure 102.1 Example of CA worksheet format

- First 5 columns same as before
- Severity class (same as before)
- Failure probability / failure rate data source
- Failure effect probability (β)
- Failure mode ratio (α)
- Failure rate (λ_p)
- Failure mode Crit #, $C_m = \beta \alpha \lambda_p^t$
- Item Crit #, $C_r = \sum (C_m)_i$
 - (for all items in same severity classification C)
- Remarks

Mil Std FMEA can require a lot of effort

- Ship propulsion diesel engine (16 cyl, 20 MW)
 - Approx 6 months to complete analysis
 - > 900 failure modes (began with parts list)
- Similar engine analyzed using RCM-R
 - 9 days (225 failure mode and causes analyzed)
- Functional approach (not Mil Std) dramatically reduces duplications



10

Example from DSI International

Item	Failure	Mission Phases	Root Failure Mode Causes	Failure Effects			Compensating Provisions	Severity Class
				Local	Next Higher	End Item		
Fuel Pump	Fuel pump fails to pump fuel.	Landing	Mechanical Failure	Engine shuts down during landing.	Loss of engine during landing.	Loss of engine during landing.	Compensated for by multiple engines and	MINOR
	Fuel pump fails to pump fuel.	Startup	Electrical Failure	Engine fails to start.	Vehicle fails to start.	Vehicle fails to start.		MINOR
	Fuel pump fails to pump fuel.	In Flight	Mechanical Failure Electrical Failure	Engine shuts down during flight.	Loss of engine during flight. Pilot/control adjustment to additional operating engine to keep vehicle running.	Loss of engine during flight. Pilot/control adjustment to additional operating engine to keep vehicle running.		CATASTROPHIC
Fuel Valve	Pressure restricted in valve	Landing	Valve Obstructed Mechanical Failure due to damaged or worn components	Engine shuts down during landing.	Loss of engine during landing.	Loss of engine during landing.	Compensated for by multiple engines and end-of-flight.	MINOR
	Pressure restricted in valve	In Flight	Mechanical Failure due to damaged or worn components Valve Obstructed	Erratic engine operation in flight	Engine operates erratically during flight. Pilot compensates with power adjustments between engine.	Engine operates erratically during flight. Pilot compensates with power adjustments between engine.		CRITICAL
	Pressure restricted in valve	Startup	Mechanical Failure due to damaged or worn components Valve Obstructed	Engine fails to start.	Vehicle fails to start.	Vehicle fails to start.		MINOR
	Valve stuck open or closed.	Landing	Mechanical Failure due to damaged or worn components Electrical Failure	Engine shuts down during landing.	Loss of engine during landing.	Loss of engine during landing.	Compensated for by multiple engines and end-of-flight.	MINOR
	Valve stuck open or closed.	In Flight	Mechanical Failure due to damaged or worn components Electrical Failure	Engine shuts down during flight.	Loss of engine during flight. Pilot/control adjustment to additional operating engine to keep vehicle running.	Loss of engine during flight. Pilot/control adjustment to additional operating engine to keep vehicle running.		CATASTROPHIC
	Valve stuck open or closed.	Startup	Mechanical Failure due to damaged or worn components Electrical Failure	Engine fails to start.	Vehicle fails to start.	Vehicle fails to start.		MINOR
	Valve stuck open or closed.	In Flight	Mechanical Failure due to damaged or worn components Electrical Failure	Engine shuts down during flight.	Loss of engine during flight. Pilot/control adjustment to additional operating engine to keep vehicle running.	Loss of engine during flight. Pilot/control adjustment to additional operating engine to keep vehicle running.		CATASTROPHIC
Landing Gear	Landing gear fails on ground.	Startup	Mechanical Failure	Landing gear failure on ground.	Landing gear fails on ground.	Landing gear fails on ground.		MINOR
	Landing gear fails on landing.	Landing	Mechanical Failure	Unable to extend landing gear.	Landing gear fails to extend during landing. Pilot attempts to manually extend gear.	Landing gear fails to extend during landing. Pilot attempts to manually extend gear.		CATASTROPHIC
	Landing gear fails to retract.	In Flight	Mechanical Failure Electrical Failure	Unable to automatically retract landing gear.	Landing gear fails to retract during flight. Drag on vehical performance during operation of vehical in flight.	Landing gear fails to retract during flight. Drag on vehical performance during operation of vehical in flight.		MARGINAL
VCU	Control failure prevents startup of system.	Startup	Power Supply Failure Discrete Output Buffer Failure Discrete Output Failure Controller Failed	Loss of control power during startup. Engine fails to start.	Vehicle fails to start.	Vehicle fails to start.		MINOR



11

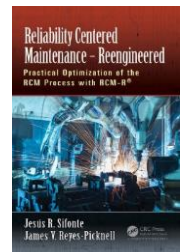
What is RCM?

- A method (approach) for determining failure management strategies
 - Maintenance and operator tasks, changes (various) including design
 - Allows run-to-failure (where consequences are tolerable)
- Emphasis is on dealing with the failure consequences, not necessarily the failures
- Begins with defining system / equipment functions
 - P&IDs and BOMs are useful in this process
 - Often one function involves multiple parts
 - Each part may be involved in more than one function
- RCM is a team effort involving maintainers and operators

12

Criticality and RCM

- The RCM standard, SAE JA-1011 does not require criticality to be used
- Criticality is usually assessed across an operational site to determine which equipment / systems warrant RCM's rigor
- Criticality can also be assessed at the level of failure modes and their causes:
 - Enables analysis team to ignore less critical failures,
 - Can also help to focus discussion on the most critical



13

RCM-R® FMEA worksheet



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	
1	Piramal	R1500 Reactor System and Filter Drier				Critical			ELE			AGE	How detected?	H	
2						Non-			EXT			DSG	Secondary damage & repair	S/E	
3						Hidden			INS			FAB	Safety impacts	O	
4									MAT			MGT	Production / operational impacts	M	
5									MEC			MIS	Damage & repair		
6													O&M	Environmental impacts	
7															
8	Function		Component	Functional Failure			Failure Modes			FM Causes			Effects	Type	
9	#	Description	A#	Description	Type	#	Description	Type	#	Description	Type	S	Description		
9	5	To enable charging of solid, liquid and gas ingredients	Inlet ports, nozzles, valves, and manway	A	Fails to enable charging	Critical	1	Valves stuck shut	MEC	A	Cotter pin is broken (glass valves) - vibration induced	AGE	Valve cannot be opened/closed. Maintenance called to correct and "fix" inserted to get operations through the batch. Valve replaced later. Safety impact: nil Environmental impact: nil Quality/production impact: minor delay	O	
76	5			A			1			B	Cotter pin is broken (glass valves) - overtightened in order to pass a pressure/vacuum test	O&M	Valve cannot be opened/closed. Maintenance called to correct and "fix" inserted to get operations through the batch. Valve replaced later. Safety impact: nil Environmental impact: nil Quality/production impact: minor delay	O	
77	5			A			2	Glass valve broken	MEC	A	Overtightening under vacuum/pressure	O&M	If valve is tightened under vacuum, it will be extra tight when under other pressures and can be broken. Maintenance may not be able to correct if batch is in process, until batch finished. Safety impact: if glass shatters under pressure there is risk to personnel from flying glass Environmental impact: nil Quality/production impact: minor delay, could introduce contamination into batch, deviation likely needed	S/E	
78	5			A			2			B	Improper securing of charging hoses	O&M	Charging hose vibrates and overstresses the glass leading to breakage. Liquid on floor / loss of containment. Repair time up to 2 hours. Safety impact: product exposure, vapor exposure, shattered	S/E	

14

RCM-R® Criticality



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1											0	No effect	No effect	< \$5k	No impact	> Annual	Audible alarm
2											1	First aid/minor ill	Minor Internal (cont)	\$5k to \$20K	1 h to 1 shift	Semi-annual to annu	Visual alarm
3											2	Lost time/reversible	Minor External (offsi	\$20k to \$50k	1 shift to 1 day	Quarterly to semi-an	Operator spots
4											3	Perm disability	Reportable	\$50k to \$100K	1 d to 2 d	Monthly to quarterly	Mtc/Eng'r
5											4	Death	Bus Stop/ Fine	> \$100k	> 2 d	Daily to monthly	SME/Contractor
8												Safety & Health	Environ	Mtc Cost	Operations	Like-h.	Detectability
	F	FF	FM	C													Crit Score
9										Type	4		3		1	3	x ²
							</										

15

```

graph TD
    Start(( )) --> Q1{1. ¿Existe una consecuencia S, E o P significativa?}
    Q1 -- S --> Q2{2. ¿Existe una tarea C, T o D que los operadores puedan realizar para llevar los riesgos/costos a un nivel tolerable?}
    Q1 -- Nc --> Q9{9. ¿Existe alguna tarea C, T o D que sea técnicamente factible y que valga la pena realizar?}
    Q2 -- S --> TC((Tarea C))
    Q2 -- Nc --> Q3{3. ¿Existe una tarea C que reduzca los riesgos o costos a un nivel tolerable y que valga a pena realizar?}
    Q3 -- S --> TC
    Q3 -- Nc --> Q4{4. ¿Existe una tarea T que reduzca los riesgos o costos a un nivel tolerable y que valga a pena realizar?}
    Q4 -- S --> TT((Tarea T))
    Q4 -- Nc --> Q5{5. ¿Existe una combinación C y T para que una consecuencia S reduzca los riesgos a un nivel tolerable?}
    Q5 -- S --> T2((Tarea 2 (C+T)))
    Q5 -- Nc --> Q6{6. ¿Es evidente el fracaso con consecuencias P o M, cuando correr hacia el fracaso es la opción más económica?}
    Q6 -- Si --> TF((Tarea F))
    Q6 -- Nc --> Q7{7. ¿La falla es H?}
    Q7 -- Si --> TF
    Q7 -- Nc --> Q8{8. ¿Existe alguna tarea D que valga la pena realizar?}
    Q8 -- S --> TD((Tarea D))
    Q8 -- Nc --> QR((Tarea R))
    QR --> Q9
    
```

El diagrama de flujo describe el proceso de selección de tareas basadas en la gravedad de la falla y la presencia de consecuencias significativas. El proceso comienza con la pregunta 1: "¿Existe una consecuencia S, E o P significativa?". Si la respuesta es "S" (Sí), se avanza a la pregunta 2: "¿Existe una tarea C, T o D que los operadores puedan realizar para llevar los riesgos/costos a un nivel tolerable?". Si la respuesta es "S", se selecciona la "Tarea C". Si la respuesta es "Nc" (No), se avanza a la pregunta 3: "¿Existe una tarea C que reduzca los riesgos o costos a un nivel tolerable y que valga a pena realizar?". Si la respuesta es "S", se selecciona la "Tarea C". Si la respuesta es "Nc", se avanza a la pregunta 4: "¿Existe una tarea T que reduzca los riesgos o costos a un nivel tolerable y que valga a pena realizar?". Si la respuesta es "S", se selecciona la "Tarea T". Si la respuesta es "Nc", se avanza a la pregunta 5: "¿Existe una combinación C y T para que una consecuencia S reduzca los riesgos a un nivel tolerable?". Si la respuesta es "S", se selecciona la "Tarea 2 (C+T)". Si la respuesta es "Nc", se avanza a la pregunta 6: "¿Es evidente el fracaso con consecuencias P o M, cuando correr hacia el fracaso es la opción más económica?". Si la respuesta es "Si", se selecciona la "Tarea F". Si la respuesta es "Nc", se avanza a la pregunta 7: "¿La falla es H?". Si la respuesta es "Si", se selecciona la "Tarea F". Si la respuesta es "Nc", se avanza a la pregunta 8: "¿Existe alguna tarea D que valga la pena realizar?". Si la respuesta es "S", se selecciona la "Tarea D". Si la respuesta es "Nc", se selecciona la "Tarea R", que luego se dirige a la pregunta 9: "¿Existe alguna tarea C, T o D que sea técnicamente factible y que valga la pena realizar?". La pregunta 9 tiene una salida "Nc" que se dirige a la pregunta 5.

H	Oculto
S	Seguridad
E	Ambiental
P	Producción
M	Mantenimiento

O	Operador (C o T)
C	Condición
T	Tiempo (uso)
"2"	C+T
R	Rediseño
D	Detectiva
F	Correr hacia el fracaso

RCM-R® Decisions

																											n/a										59	207																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080	1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1092	1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104	1105	1106	1107	1108	1109	1110	1111	1112	1113	1114	1115	1116	1117	1118	1119	1120	1121	1122	1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140	1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157	1158	1159	1160	1161	1162	1163	1164	1165	1166	1167	1168	1169	1170	1171	1172	1173	1174	1175	1176	1177	1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188	1189	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199	1200	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	1217	1218	1219	1220	1221	1222	1223	1224	1225	1226	1227	1228	1229	1230	1231	1232	1233	1234	1235	1236	1237	1238	1239	1240	1241	1242	1243	1244	1245	1246	1247	1248	1249	1250	1251	1252	1253	1254	1255	1256	1257	1258	1259	1260	1261	1262	1263	1264	1265	1266	1267	1268	1269	1270	1271	1272	1273	1274	1275	1276	1277	1278	1279	1280	1281	1282	1283	1284	1285	1286	1287	1288	1289	1290	1291	1292	1293	1294	1295	1296	1297	1298	1299	1300	1301	1302	1303	1304	1305	1306	1307	1308	1309	1310	1311	1312	1313	1314	1315	1316	1317	1318	1319	1320	1321	1322	1323	1324	1325	1326	1327	1328	1329	1330	1331	1332	1333	1334	1335	1336	1337	1338	1339	1340	1341	1342	1343	1344	1345	1346	1347	1348	1349	1350	1351	1352	1353	1354	1355	1356	1357	1358	1359	1360	1361	1362	1363	1364	1365	1366	1367	1368	1369	1370	1371	1372	1373	1374	1375	1376	1377	1378	1379	1380	1381	1382	1383	1384	1385	1386	1387	1388	1389	1390	1391	1392	1393	1394	1395	1396	1397	1398	1399	1400	1401	1402	1403	1404	1405	1406	1407	1408	1409	1410	1411	1412	1413	1414	1415	1416	1417	1418	1419	1420	1421	1422	1423	1424	1425	1426	1427	1428	1429	1430	1431	1432	1433	1434	1435	1436	1437	1438	1439	1440	1441	1442	1443	1444	1445	1446	1447	1448	1449	1450	1451	1452	1453	1454	1455	1456	1457	1458	1459	1460	1461	1462	1463	1464	1465	1466	1467	1468	1469	1470	1471	1472	1473	1474	1475	1476	1477	1478	1479	1480	1481	1482	1483	1484	1485	1486	1487	1488	1489	1490	1491	1492	1493	1494	1495	1496	1497	1498	1499

8

Comparison

- Similarities
 - All 3 methods focus on failure modes and their effects
 - When presented in tabular formats, they all look similar
 - All analyze equipment and / or systems

18

Comparison - differences

- FMEA and FMECA used at design stage – RCM at any stage of life cycle
- FMEA and FMECA usually performed by engineers – RCM performed by teams of operators and maintainers
- FMEA ignores criticality
- FMECA uses criticality
- RCM uses criticality in two way
- FMEA and FMECA have no decision logic – engineer has full discretion
- RCM includes a decision logic
- FMEA and FMECA usually begin with BOM may start with functions
- RCM begins with Functions (BOM may be used to help)
 - FMEA and FMECA – functionality is often duplicated
 - RCM functionality is not duplicated – analyses are shorter (by half or less)

19

Should you use a BoM or Functional approach?

- Consider your objective
 - If you want to beef-up design – use FMEA or FMECA and start with parts
 - If you want a failure management program – use RCM and a functional approach
- If you have an FMEA or FMECA created using BOM, using it as a start point for RCM is possible, but not recommended – start over for RCM
 - Component / part based approaches do not follow a logical functional sequence and can be confusing
 - Volume of work can be multiple times the effort when compared with functional approach

20

Summary

- FMEA – design tool, usually based on parts (BoM) and very detailed.
 - Engineering tool for design
- FMECA – similar to FMEA, includes criticality.
 - Engineering tool for design in complex systems
- RCM – a method to determine failure management policies.
 - RCM includes FMEA or FMECA.
 - Can be based on BoM, but most efficient if based on functions.
 - Operational focus is on failure consequence management.
 - Design changes are a “last resort”.
 - Team based

21

Questions and Discussion



22



Thank you!

James Reyes-Picknell
james@consciousasset.com

23