Title: Return Vehicle Parts Analysis

Background:

Litens automotive group develop products for the vehicle FEAD (Front End Accessories Drive), to reduce the noise, vibration and by this increase durability and reliability of all belt drive accessories. In the next figure please see example of the FEAD system:

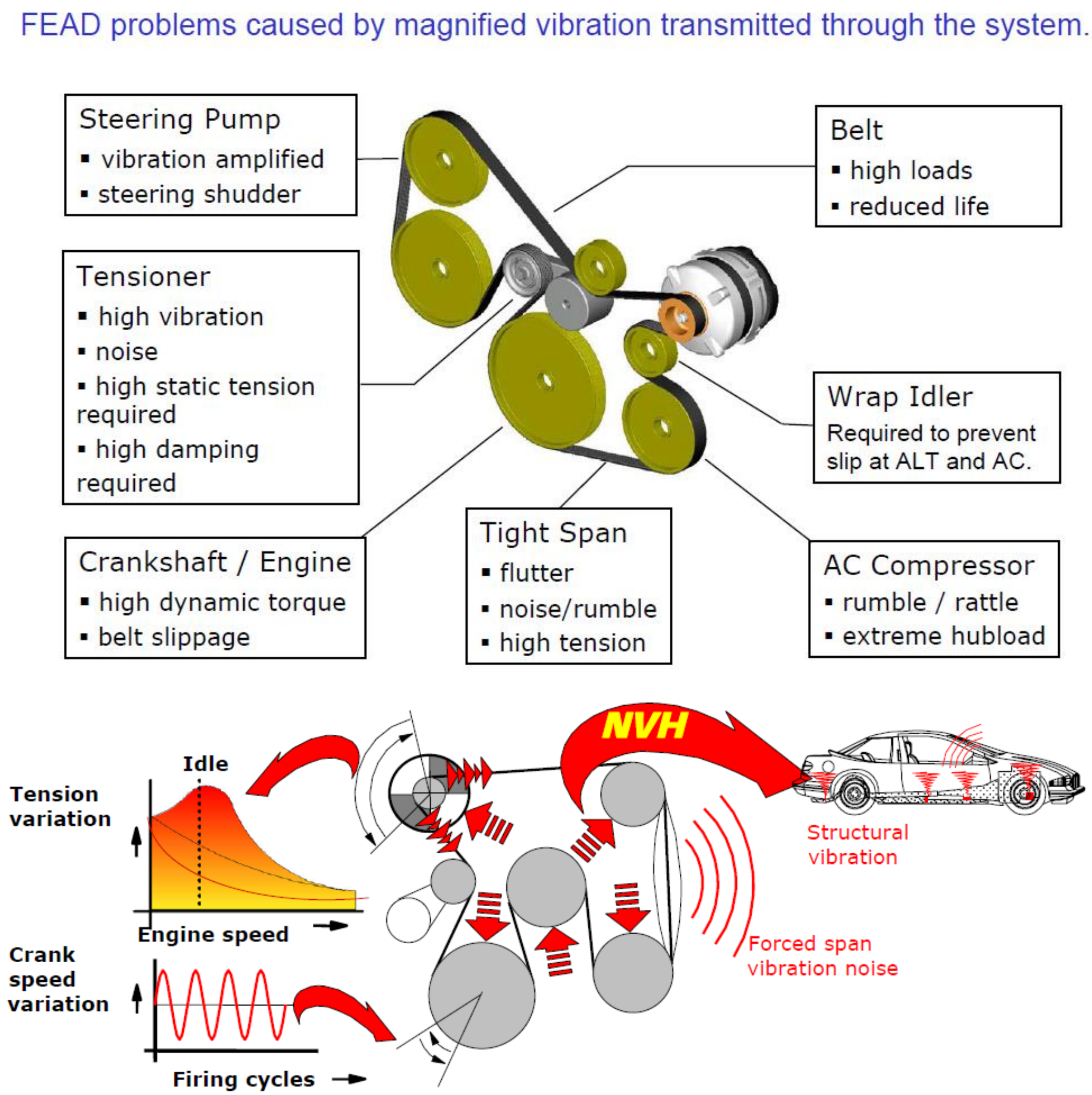


Figure 1.
FEAD example.

This research will be focused on three products, OAD (Overrun Alternator De-coupler), ADT (Accessories Drive Tensioner) and TBT (Time Belt Tensioner). The main function of OAD as for example is to reduce torsional vibration coming from the engine, and respond to fast shifts events by taking all the alternator inertia, please see effect of OAD in the next figure:

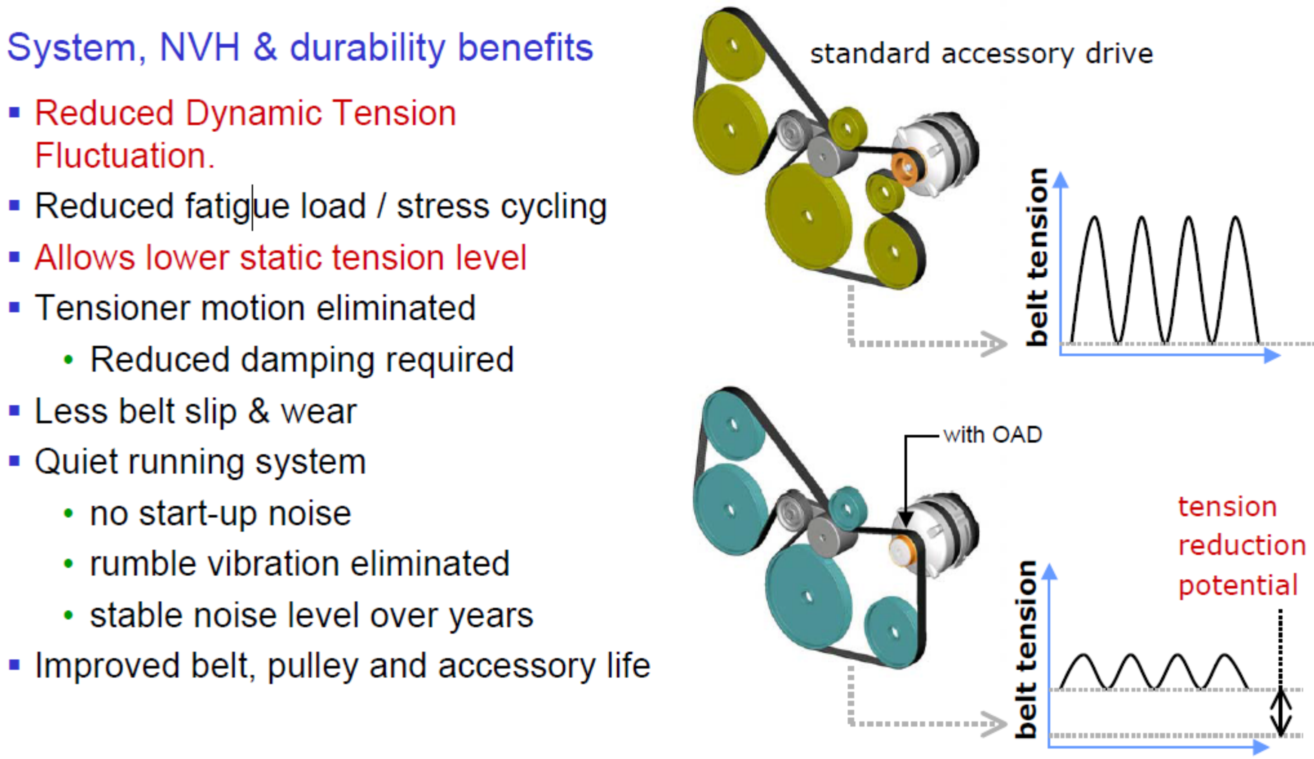
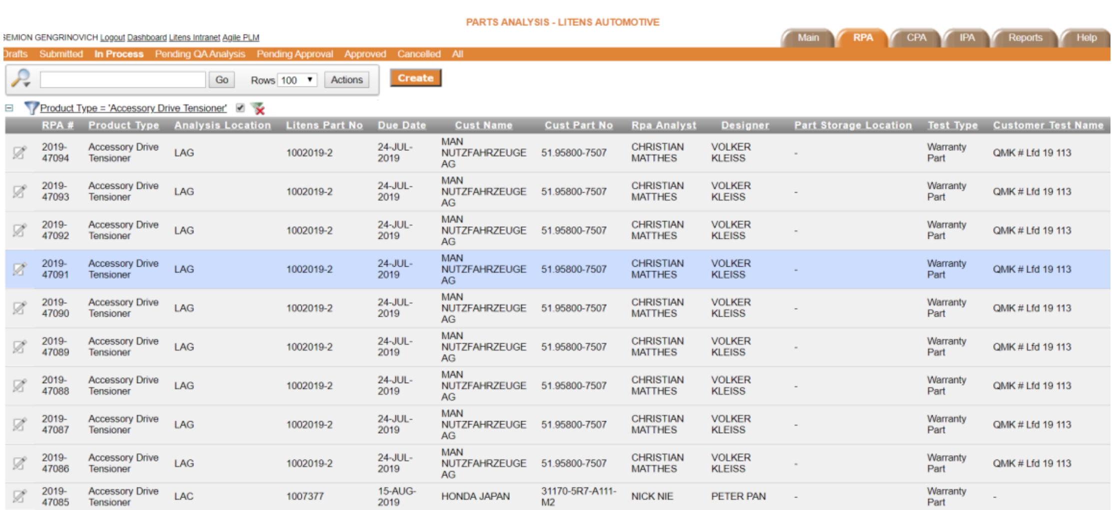


Figure 2.

OAD (Overrun Alternator De-coupler) effect on the belt system example.

The RPA (Return Part Analysis) system looks like the next sample:



PARTS ANALYSIS - LITENS AUTOMOTIVE

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Main RPA CPA IPA Reports Help

Drafts Submitted In Process Pending QA Analysis Pending Approval Approved Cancelled All

Go Rows 100 Actions Create

Product Type = 'Accessory Drive Tensioner'

RPA #	Product Type	Analysis Location	Litens Part No	Due Date	Cust Name	Cust Part No	Rpa Analyst	Designer	Part Storage Location	Test Type	Customer Test Name
2019-47094	Accessory Drive Tensioner	LAG	1002019-2	24-JUL-2019	MAN NUTZFAHRZEUGE AG	51.95800-7507	CHRISTIAN MATTHES	VOLKER KLEISS	-	Warranty Part	QMK # Lfd 19 113
2019-47093	Accessory Drive Tensioner	LAG	1002019-2	24-JUL-2019	MAN NUTZFAHRZEUGE AG	51.95800-7507	CHRISTIAN MATTHES	VOLKER KLEISS	-	Warranty Part	QMK # Lfd 19 113
2019-47092	Accessory Drive Tensioner	LAG	1002019-2	24-JUL-2019	MAN NUTZFAHRZEUGE AG	51.95800-7507	CHRISTIAN MATTHES	VOLKER KLEISS	-	Warranty Part	QMK # Lfd 19 113
2019-47091	Accessory Drive Tensioner	LAG	1002019-2	24-JUL-2019	MAN NUTZFAHRZEUGE AG	51.95800-7507	CHRISTIAN MATTHES	VOLKER KLEISS	-	Warranty Part	QMK # Lfd 19 113
2019-47090	Accessory Drive Tensioner	LAG	1002019-2	24-JUL-2019	MAN NUTZFAHRZEUGE AG	51.95800-7507	CHRISTIAN MATTHES	VOLKER KLEISS	-	Warranty Part	QMK # Lfd 19 113
2019-47089	Accessory Drive Tensioner	LAG	1002019-2	24-JUL-2019	MAN NUTZFAHRZEUGE AG	51.95800-7507	CHRISTIAN MATTHES	VOLKER KLEISS	-	Warranty Part	QMK # Lfd 19 113
2019-47088	Accessory Drive Tensioner	LAG	1002019-2	24-JUL-2019	MAN NUTZFAHRZEUGE AG	51.95800-7507	CHRISTIAN MATTHES	VOLKER KLEISS	-	Warranty Part	QMK # Lfd 19 113
2019-47087	Accessory Drive Tensioner	LAG	1002019-2	24-JUL-2019	MAN NUTZFAHRZEUGE AG	51.95800-7507	CHRISTIAN MATTHES	VOLKER KLEISS	-	Warranty Part	QMK # Lfd 19 113
2019-47086	Accessory Drive Tensioner	LAG	1002019-2	24-JUL-2019	MAN NUTZFAHRZEUGE AG	51.95800-7507	CHRISTIAN MATTHES	VOLKER KLEISS	-	Warranty Part	QMK # Lfd 19 113
2019-47085	Accessory Drive Tensioner	LAC	1007377	15-AUG-2019	HONDA JAPAN	31170-5R7-A111-M2	NICK NIE	PETER PAN	-	Warranty Part	-

Figure 3.

RPA (Return Parts Analysis) screenshot from the database sysytem.

The total available columns in the RPA database is 87, please see next table with the naming:

Rpa Number	Bearing Report
Product Type	Bearing Sent To Supplier Date
Analysis Location	Inspected By
Litens Part No	Creator
Cust Name	Part Mileage
Status	Time In Service
Part Storage Location	Submitted By
Customer Test Name	Submission Date
Date Code	Date Modified
Failure Check	Submitted For Qa Analysis Date
Requester	Qa Analysis Submitted By
Request Date	Qa Analysis Submitted Date
Due Date	Approved By
Rpa Type	Approval Date
Rpa Level	Received Date
Bearing Analysis From Supplier	Submitted For Qa Analysis By
Shipping Tracking No	Received By
Date Received From Cust	Fiscal Year
Cust Contact	Date Created
Cust Location	Test Type
Cust Part No	Cancelled By
Cust Claim No	Cancellation Date
Manufactured Date	Designer
Vin No	Rpa Analyst
Fault Found	Approver Name
Failed Comp	Qa Technician
Couse Of Failure	Rpa Editor Name
Observation	Revoked By
Conclusion	Revoke Date
Counter Measure	Counter Measure Date
Supplier	Vehicle Platform
Bearing Sent To Supplier	Alternator Manufacturer
Bearing Returned Date	Alternator Model
Functional Check	Alternator Part No
Qa Instructions	Analysis Type
Time In Service Unit	

Objective:

This analysis will include the data from 2011-2017 years or 7 years of return parts. Next questions we will try to answer in this study:

From all products that return to the company, what is percentage that failed and what is still in functional condition?

From the parts that defined as failed, what was the spread of failure modes:
Fatigue like steel cracks, material imperfection? (Related to infant mortality failures)

Wear out failure, like plastics wear, bushing degradation, grease degradation? (Related to the end of life of product)

Do the failures have spikes per specific period?

Relation Between the return parts and the time in service, need to investigate if the product has infant mortality failure and see if change in revision fixed it.

Does any specific OEM or World location have significant more failures than other?

Data Size period of time 7 years (2011-2017):

OAD matrix: 87(columns) x 8238 (rows)

ADT matrix: 87(columns) x 5572 (rows)

TBT matrix: 87(columns) x 3348 (rows)

SPRINT 1

Will focus on OAD data set.

Cleaning the data, next parameters I chose to investigate:

Rpa Number	Part Mileage In Km	Production Date	Conclusion	Observation	Failure Check

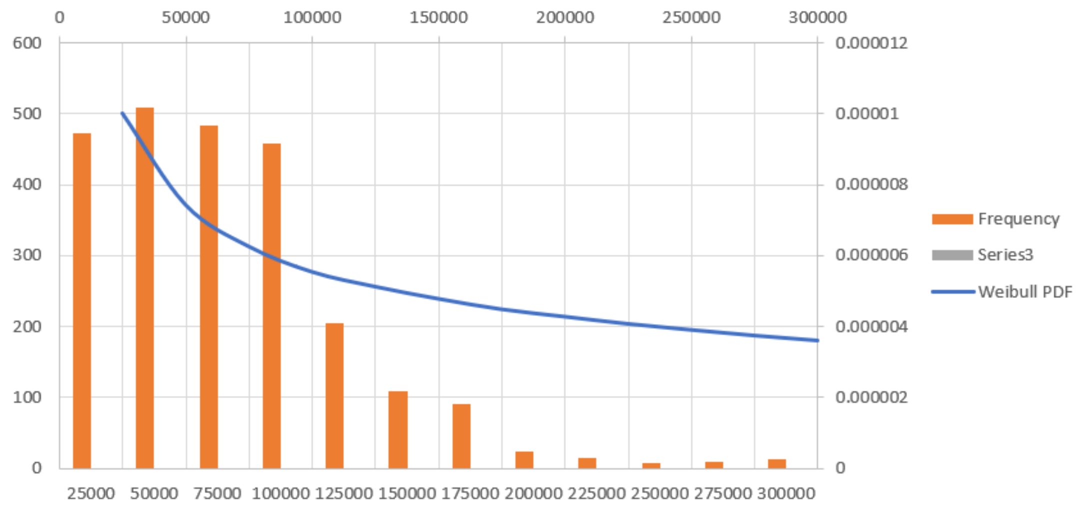
Part in mileage will define the usage life of the part. Failure check will identify if the part is consider as failed or still functional.

Conclusion and observation will identify the failure mode for those parts that failed.

This is the raw data for functional parts:

1	Rpa Number	Part Mileage I	Production Date	Conclusior	Observatic	Failure Check
2	2011-10587	5285	14-Oct-09	grease is	r was	Functional
3	2011-10608	97430	12-May-11	n:	Some e-	Functional
4	2011-10624	119662	-	-	r was	Functional
5	2011-10627	52893	06-Nov-04	cause:	r was	Functional
6	2011-10629	25629	30-Jun-05	cause:	r was	Functional
7	2011-10632	53809	26-Jan-06	cause:	r was	Functional
8	2011-10633	21388	17-Jan-07	cause:	r was	Functional
9	2011-10634	35222	19-Nov-05	cause:	r was	Functional
10	2011-10635	65653	23-Jan-06	cause of	r was	Functional
11	2011-10636	78217	30-Apr-09	Litens coul	r was	Functional
12	2011-10637	64521	21-Aug-07	cause of	r was	Functional
13	2011-10638	78489	07-Nov-04	cause of	r was	Functional
14	2011-10639	35853	23-Dec-05	cause:	r was	Functional
15	2011-10640	66486	11-Mar-08	cause of	r was	Functional
16	2011-10641	80949	12-Nov-08	Litens coul	r was	Functional
17	2011-10642	47342	07-Nov-05	cause:	r was	Functional
18	2011-10643	49894	29-Oct-07	cause of	r was	Functional
19	2011-10644	34486	17-Dec-04	cause:	r was	Functional
20	2011-10667	14380	17-Nov-08	found no	r was	Functional
21	2011-10669	84993	-	-	r was	Functional
22	2011-10673	129737	02-Apr-09	n:	on:	Functional
23	2011-10680	23965	15-Apr-08	cause of	r was	Functional
24	2011-10681	44512	29-Jan-08	cause of	r was	Functional
25	2011-10696	28742	26-Jul-07	CAUSE:	Confirmed	Functional
26	2011-10698	26022	04-Jan-06	cause of	r was	Functional

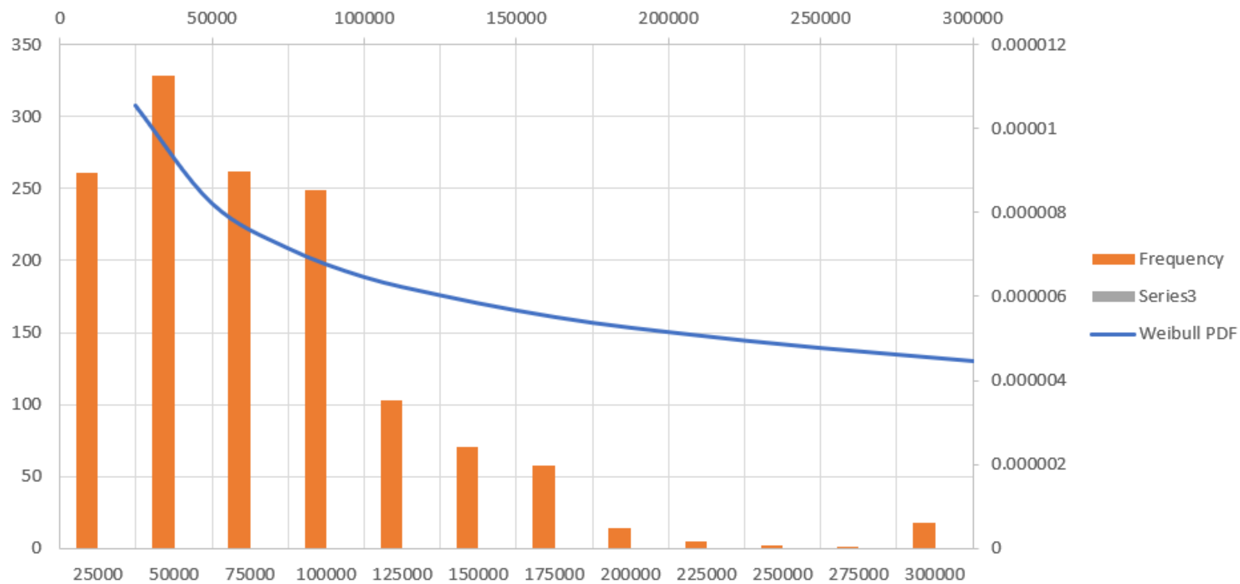
The frequency graph and fitted Weibull distribution for functional parts:



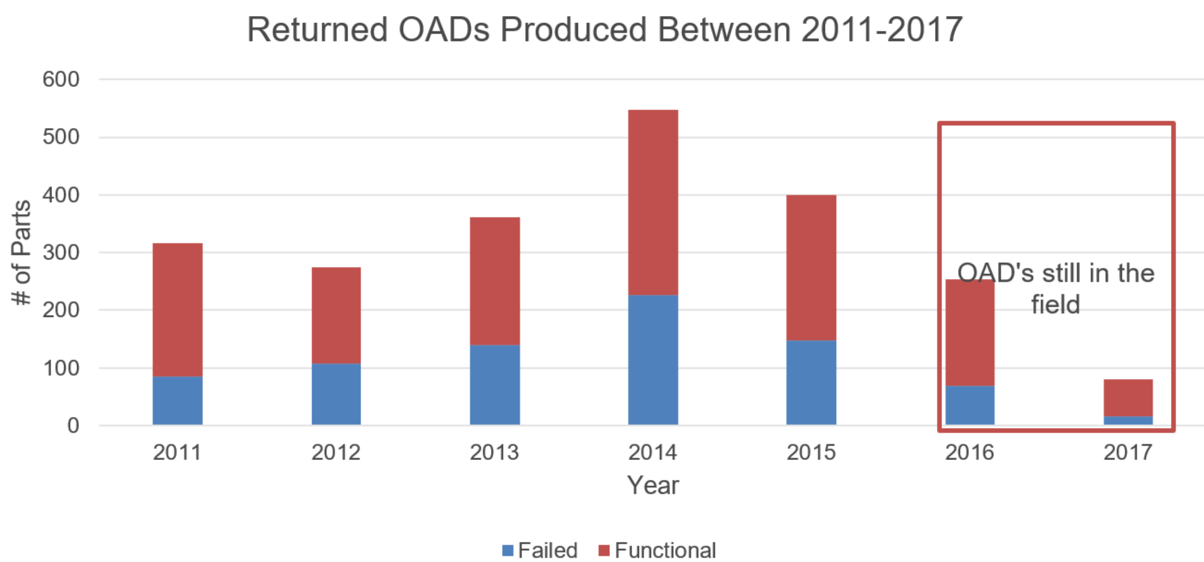
This is the raw data for the failed parts:

1	Rpa Number	Part Mileage In Km	Production Date	Conclusior	Observatic	Failure Checl
2	2011-10586	38954	27-May-08	damaged	Paint remc	Failed
3	2011-10593	45300	05-Oct-09	n: Clutch	ons:	Failed
4	2011-10594	116098	21-Apr-09	Conclusio	was	Failed
5	2011-10597	31966	10-Jul-08	Litens coul	r was	Failed
6	2011-10630	25321	25-Jan-06	cause:	r was	Failed
7	2011-10631	49750	10-May-06	cause:	r was	Failed
8	2011-10694	76144	25-Aug-08	n:	on:	Failed
9	2011-10695	42501	16-Jan-08	Litens four	r was	Failed
10	2011-10704	52334	18-Jan-06	cause of	r was	Failed
11	2011-10726	75000	22-Sep-09	n:	on:	Failed
12	2011-10727	75153	22-Sep-09	n:	on:	Failed
13	2011-10728	73285	22-Sep-09	n:	on:	Failed
14	2011-10754	45000	-	ment of	r was	Failed
15	2011-10758	54012	01-Oct-08	with OAD	r was	Failed
16	2011-10759	88106	07-Feb-07	CAUSE:	r has high	Failed
17	2011-10760	71130	-	is Gen4	d free	Failed
18	2011-10761	33594	28-Jul-06	CAUSE:	d OAD is	Failed
19	2011-10786	0	18-Jun-09	no fault	r was	Failed
20	2011-10893	62854	04-May-09	n:	ons:	Failed
21	2011-10896	823	18-Nov-10	E ROOT	d freespin	Failed
22	2011-10897	71572	15-Aug-06	CAUSE:	d OAD is	Failed
23	2011-10899	77150	23-Dec-05	CAUSE:	d OAD is	Failed
24	2011-10901	83225	18-Apr-06	CAUSE:	d OAD is	Failed
25	2011-10904	82790	01-Apr-06	CAUSE:	d OAD is	Failed
26	2011-10905	76658	31-Jan-08	CAUSE:	Confirmed	Failed
27	2011-10931	50000	28-May-08	of parts	d free	Failed

The frequency graph and fitted Weibull distribution for failed parts see in the next graph:



The over all relation between the failed part and still functional per production year was found:



For the sprint 2 Analysis of failed parts will be done to investigate what type of failure mode was found.

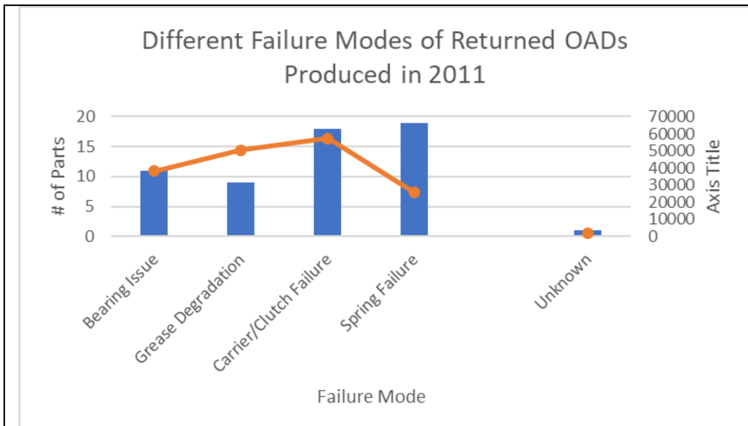
Sprint 2:

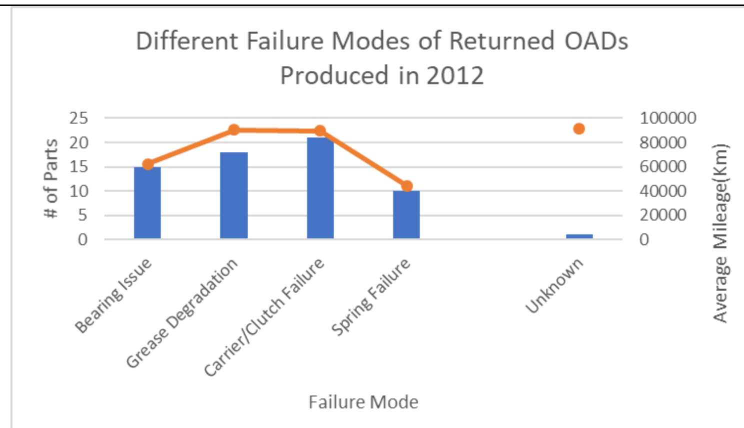
Please see in the next graphs, type of failure mode per given years from 2011-2017. The failure type was investigated in the columns of Conclusion and Observation. Every failure mode was searched by the key words. Those parts that was not identifying to any known failure mode was suspended as unknown failure mode.

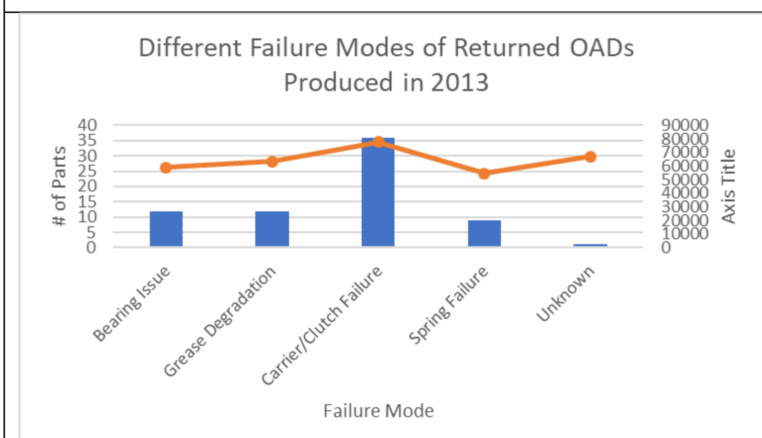
The failure modes naming is as follow:

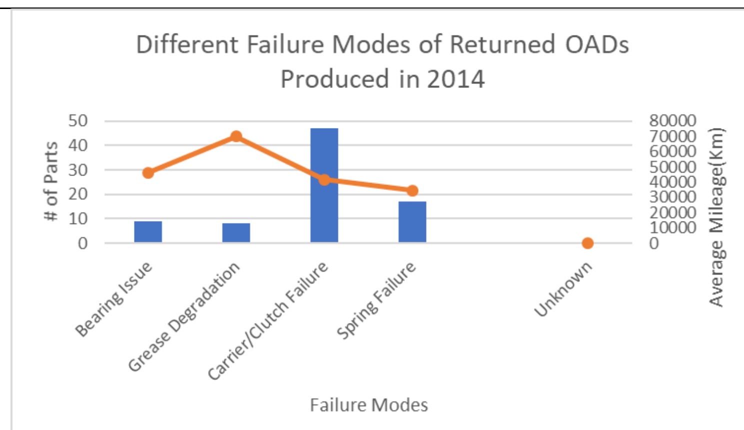
Bearing Issue
Grease Degradation
Carrier/Clutch Failure
Spring Failure
Unknown

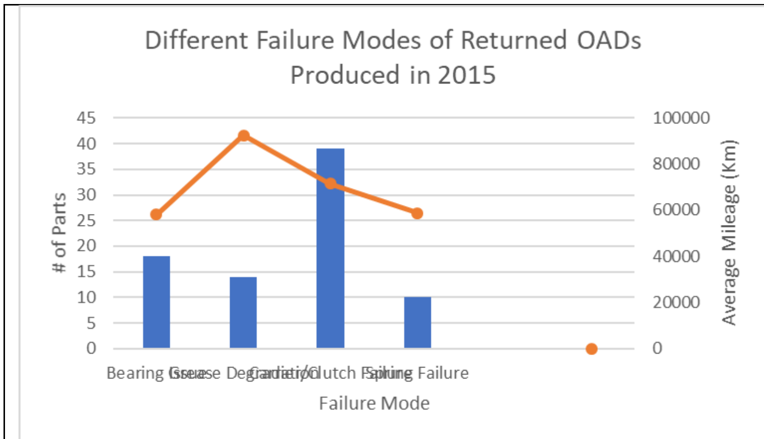
Please see in the next graphs type of failure mode per given years from 2011-2017:

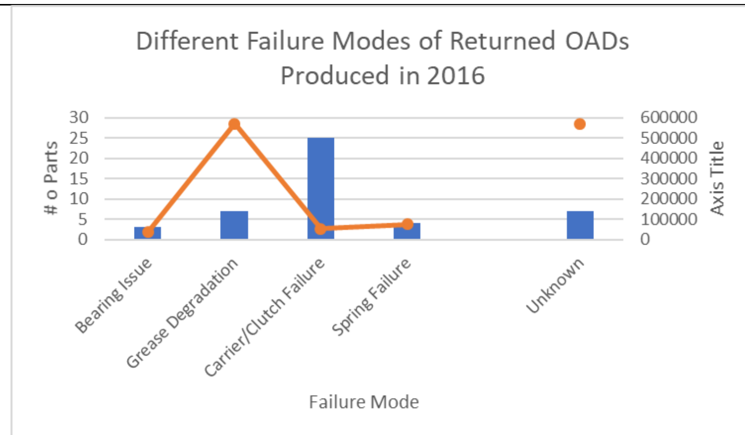


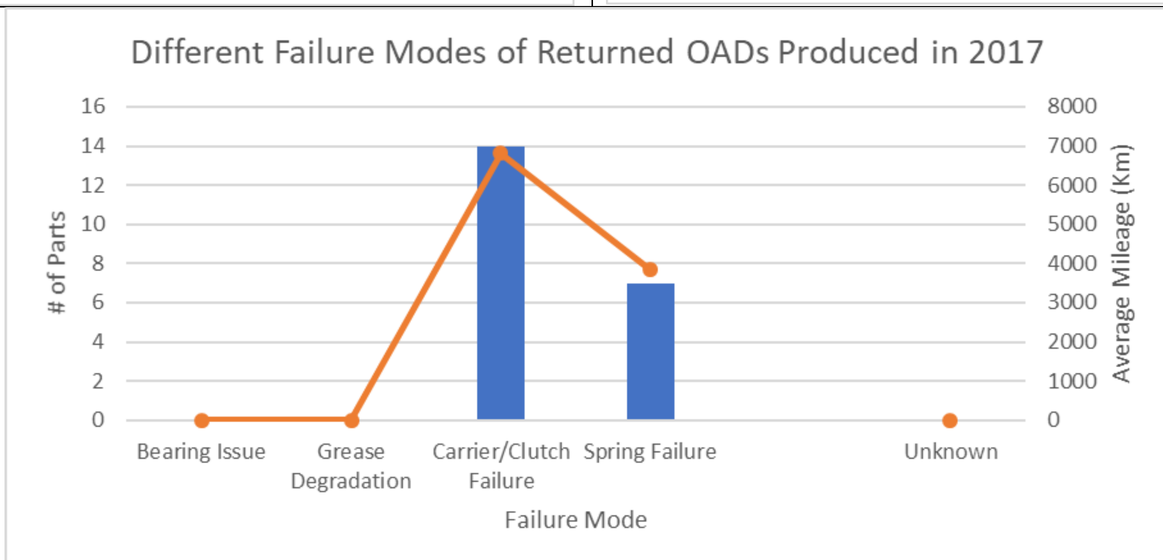












In table format, failure parts per year.

2011				
Bearing Issue	11	38235	28536.94	19%
Grease Degradation	9	50524.78	27233.39	16%
Carrier/Clutch Failure	18	57382.72	28258.89	32%
Spring Failure	19	25839.47	29734.88	33%
Unknown	1	1787	0	
2015				
Bearing Issue	18	58215.38	47011.72	22%
Grease Degradation	14	92426.08	42397.96	17%
Carrier/Clutch Failure	39	71533.95	42673.05	48%
Spring Failure	10	58866.6	39354.54	12%
Unknown	0	0	0	

2012				
Bearing Issue	15	62147.2	31751.48	23%
Grease Degradation	18	90389.17	44765.68	28%
Carrier/Clutch Failure	21	89594.19	59001.83	33%
Spring Failure	10	44353.8	47641.65	16%
Unknown	1	91415	0	
2016				
Bearing Issue	3	35525.67	28705.24	8%
Grease Degradation	7	570474.1	108228.3	18%
Carrier/Clutch Failure	25	52358.12	33307.64	64%
Spring Failure	4	74233.5	60681.28	10%
Unknown	7	570474.1	108228.3	

2013				
Bearing Issue	12	58935.58	23386.92	17%
Grease Degradation	12	63567	26571.6	17%
Carrier/Clutch Failure	36	77701.75	90508.07	52%
Spring Failure	9	54560.44	49157.1	13%
Unknown	1	66907	0	
2017				
Bearing Issue	0	0	0	0%
Grease Degradation	0	0	0	0%
Carrier/Clutch Failure	14	6807.5	12913.16	67%
Spring Failure	7	3840.429	2891.811	33%
Unknown	0	0	0	

2014				
Bearing Issue	9	46178.33	29783.14	11%
Grease Degradation	8	69941.88	20162.25	10%
Carrier/Clutch Failure	47	41659.55	25825.34	58%
Spring Failure	17	34609.24	24450.07	21%
Unknown	0	0	0	