Component Reliability & Impact on the Operation

Maze Hobeyn, Director, Component Services

Jazz Aviation LP

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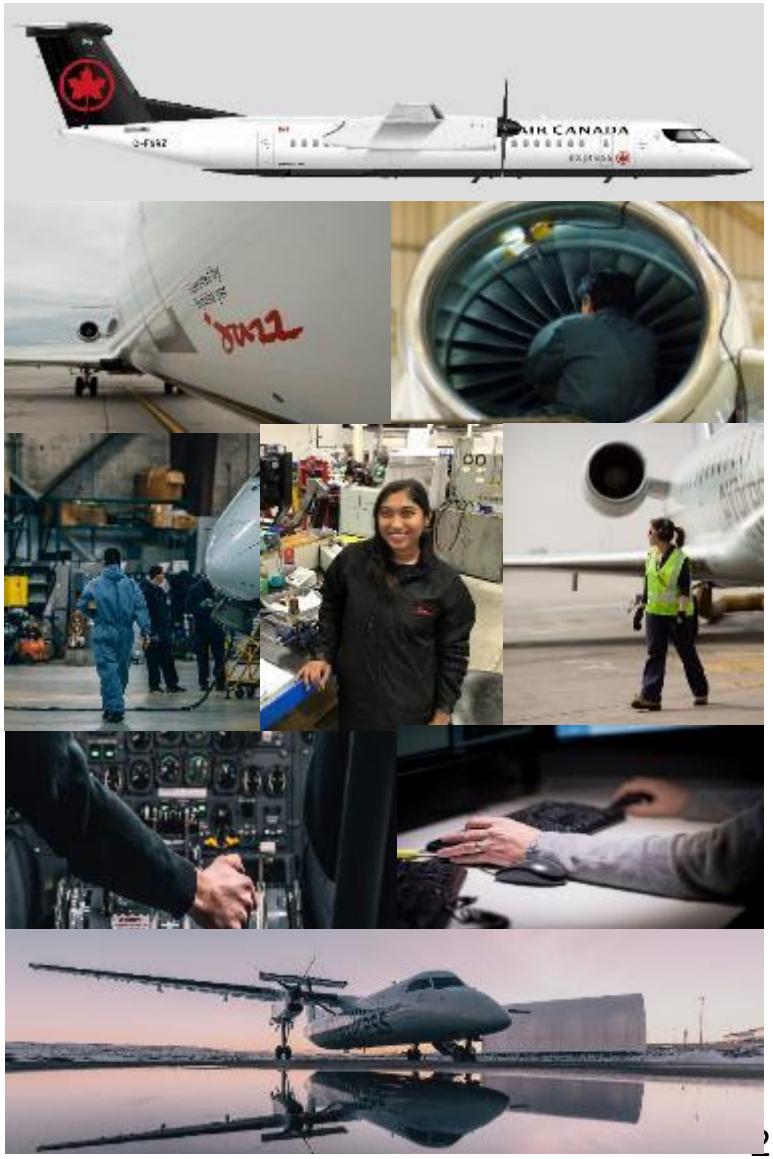
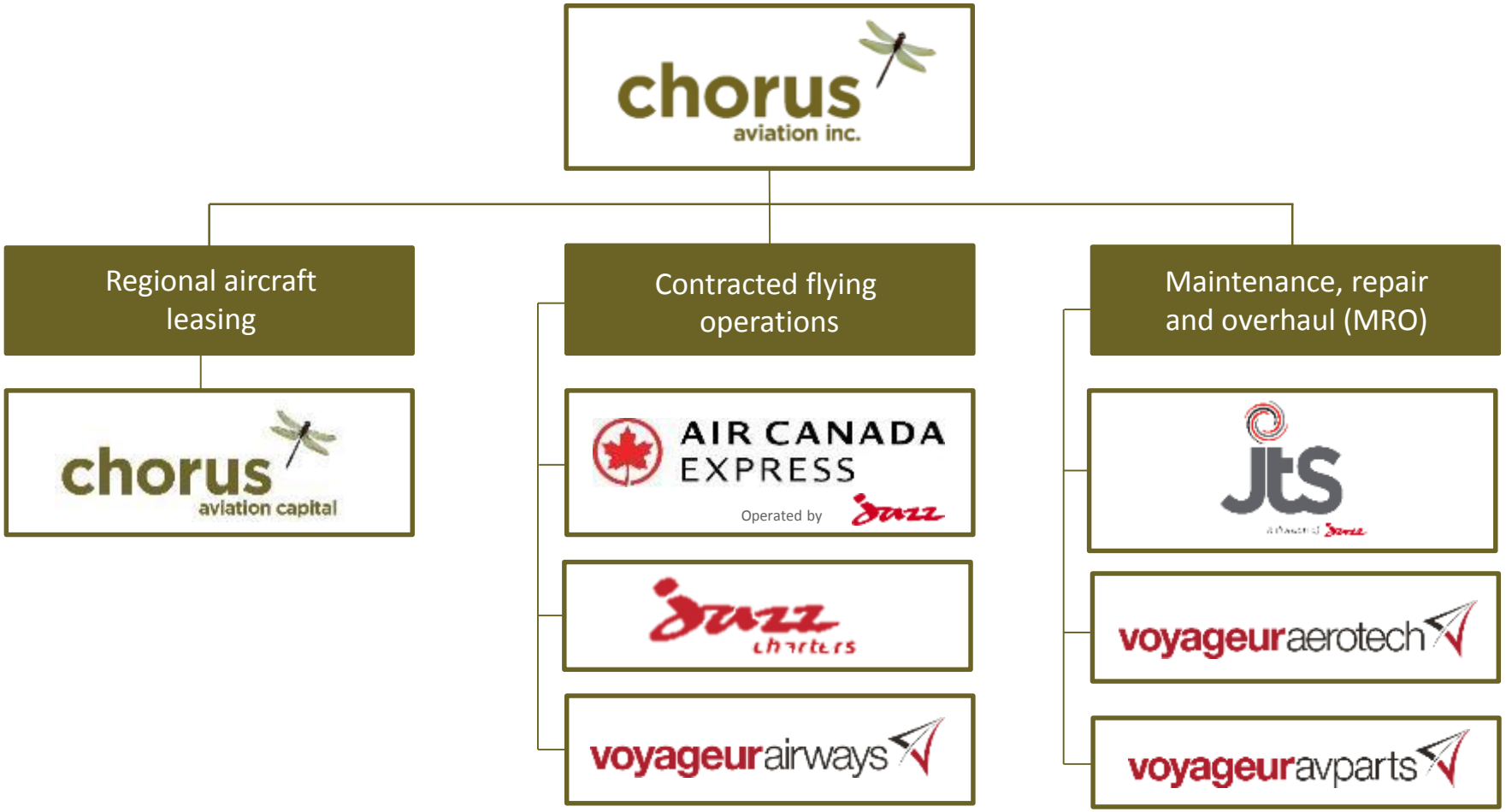
Agenda

- Chorus & Jazz Background
- The Challenge
- Sources of Data
- Component Reliability
- Component Removal Trends
- Reliability & Removals - Correlation
- Data Drill Down
- Understanding the Repair Cycle
- Lessons learned and results
- Keys to success



Chorus lines of business

Focused on providing a full suite of regional airline services to customers around the world



OUR VISION

We offer regional aviation to the world.

OUR VALUES

Listen, collaborate, improve.

Awards and Recognition

Jazz Background

Stats

Destinations Served	78 destinations across Canada and the U.S.
No. of Employees	Approx. 4,600 total employees
Daily Flights Operated	675 (approx., based on weekday operation)
Daily Passengers Carried	30,000 (based on weekday operation)
Annual Passengers Carried	10.6 million (based on 2017 figures)

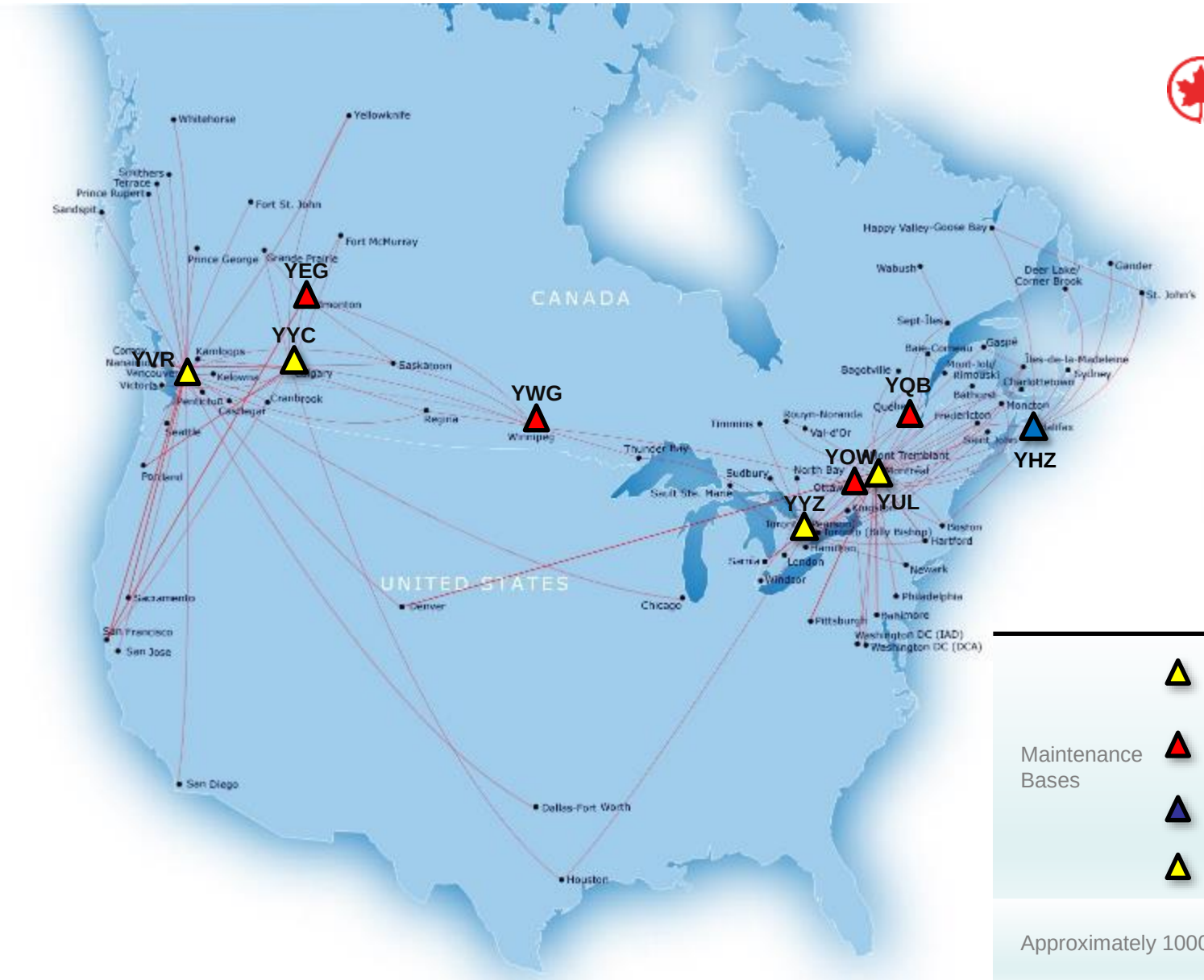
Operating Fleet – As of Mar 2018

Aircraft (number of seats)	Air Canada Express	Charter Fleet	Total
Q400 NextGen (74 seats)	44	-	44
CRJ 900 (75 seats)	21	-	21
CRJ – 200 (50 seats)	10	-	10
Dash 8 – 300 (50 seats)	26	-	28
Dash 8 – 100 (37 seats)	15	-	15
Total	**116**	**-**	**116**

Air Canada Express Network

78 destinations across Canada and the U.S.
Approximately 675 Daily Flights

Maintenance Network



AIR CANADA EXPRESS

Maintenance Bases

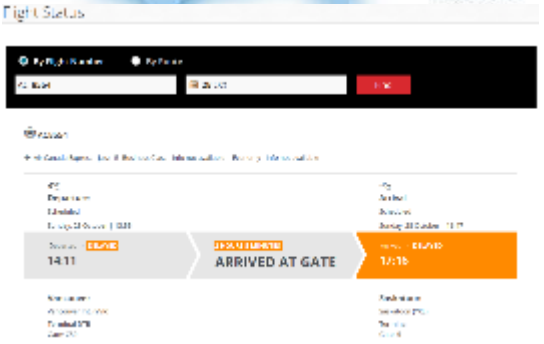
- 4 Line Mtc bases
  YVR, YYC, YYZ, YUL
- 4 AOG Line Stations,
  YEG, YWG, YOW, YQB
- 1 Heavy MTC - YHZ
  Jazz Technical Services
- 2 Component Shops
  YVR, YYC

Approximately 1000 Maintenance Employees

Question?

Who in the room has ever experienced a flight delay or cancellation due to MTC?

Possibly a flat tire?



Every operator at some time will experience a flat tire

- Q400 Main Wheel - 2018 Flat Tires
- approx. 1 every 37,000 Fleet Cycles

The Challenge

When a disruption occurs:

- How can we get our passengers back on their way?
- Is stock available locally?
- If not available locally, what is the closest point to source?
- Can we purchase, lease, borrow, exchange, a replacement part?

Post event:

- How do we prevent this from happening again?
- How do we avoid future delays?
- How do we ensure we have stock available?
- Do we have adequate stock or do we need to adjust inventory levels?
- Is the repair TAT adequate?
- Has the component reliability changed?

The Challenge

Today's market continues to challenge all Operators to "Do more with less!"

- Provide a safe service to the Customer
- Improve reliability
- Improve parts availability
- Reduce freight and shipping costs
- Reduce maintenance costs, inventory levels and Capital ($) outlay

- How do we this yet…improve On-Time Performance?
- How do we improve part(s) availability to the Operation?
- How do we manage or reduce inventory costs?
- Cheaper, better, faster…What's the best value for our money?

The Challenge

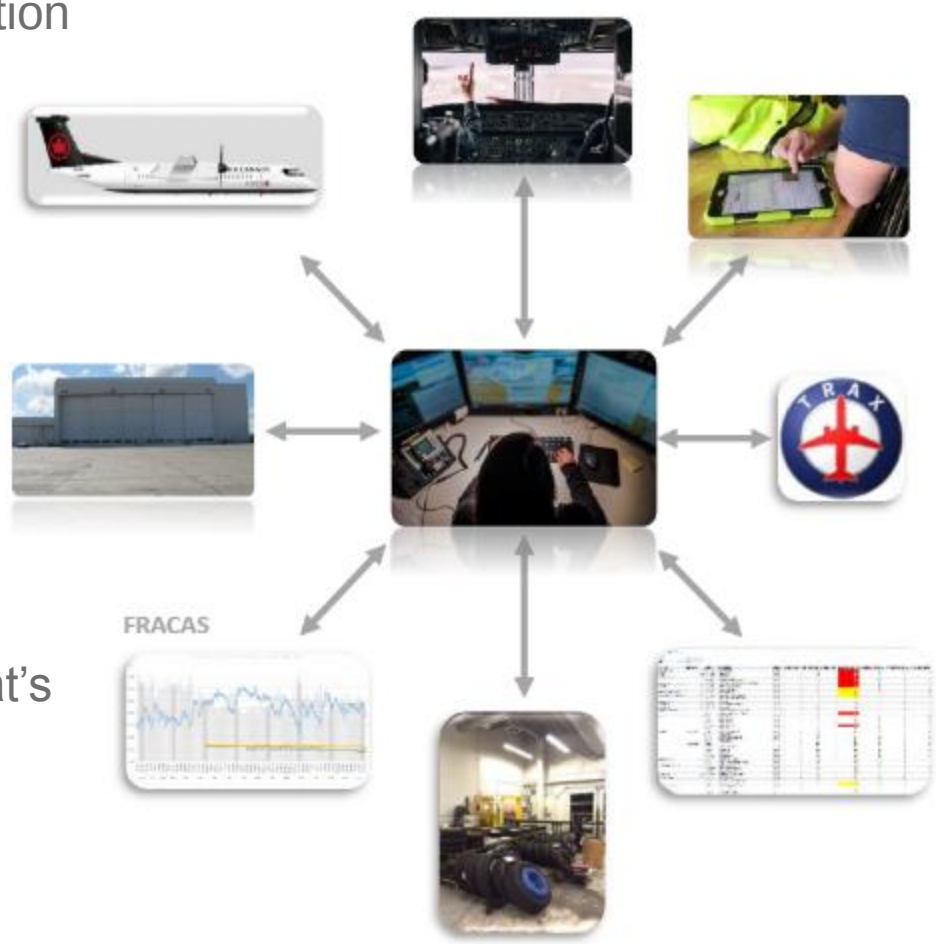
Several areas that we pay attention to:

- Component reliability and it's effect to your operation and the Supply Chain
  - On-wing performance and it's direct impact to the operation
  - Quality of repairs – Cheaper is not always better
  - Maintenance cost per operating hour
- Understanding the repair cycle
  - Prioritizing the parts that are in repair
  - Critical vs routine
  - Component removal trends & On-wing performance
  - Repair turn around times and work stops
- Impact to inventory levels - Can we operate with less?

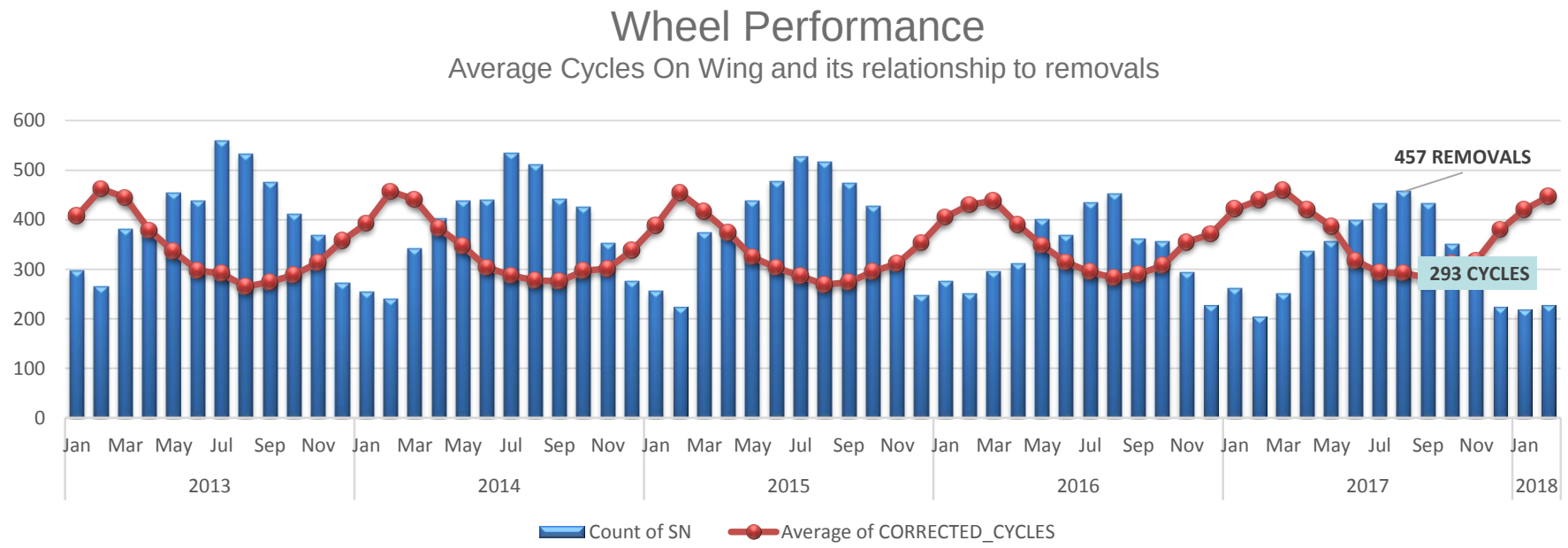
It all starts with data so you can make an informed decision…

Sources of Data

- Access to data has never been better
- Data is coming in from across the operation
  - Aircraft
    …***but on Regional size A/C data may be limited***
  - Flight & MTC Crews
  - MRO & Shop Technicians
  - Internal MTC groups
  - MIS Software
  - Fracas, OEM's, Suppliers
  - Other Operators
- Analyzing data daily
  - Drilling down will shed light into what's happening
  - Monitor performance and reliability trends
  - Communicating your findings

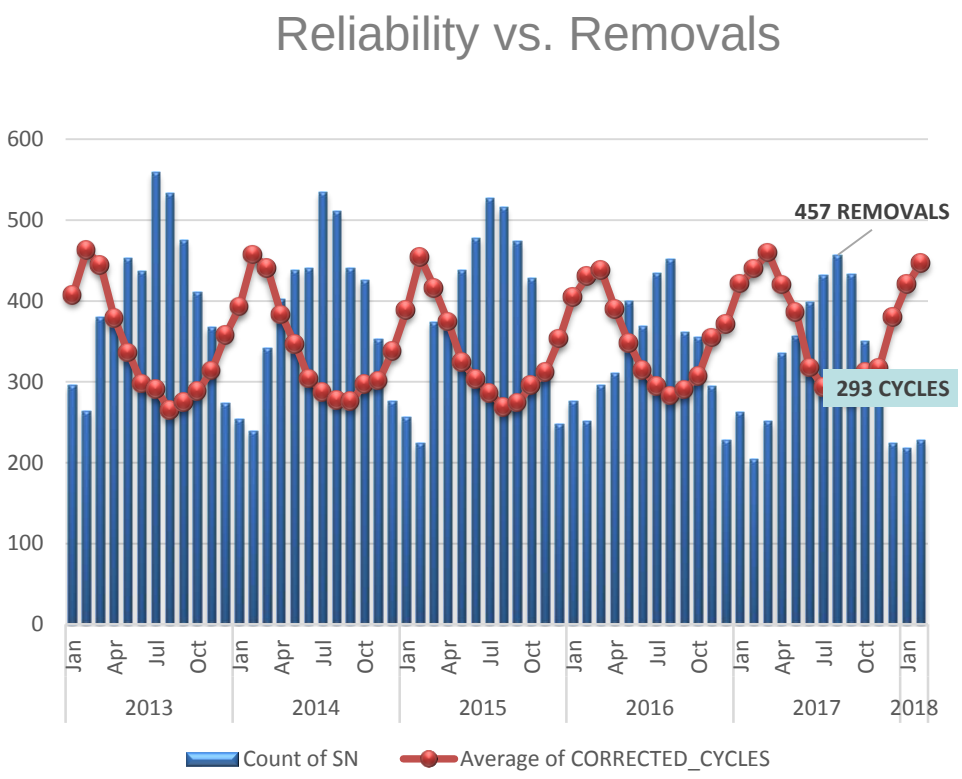


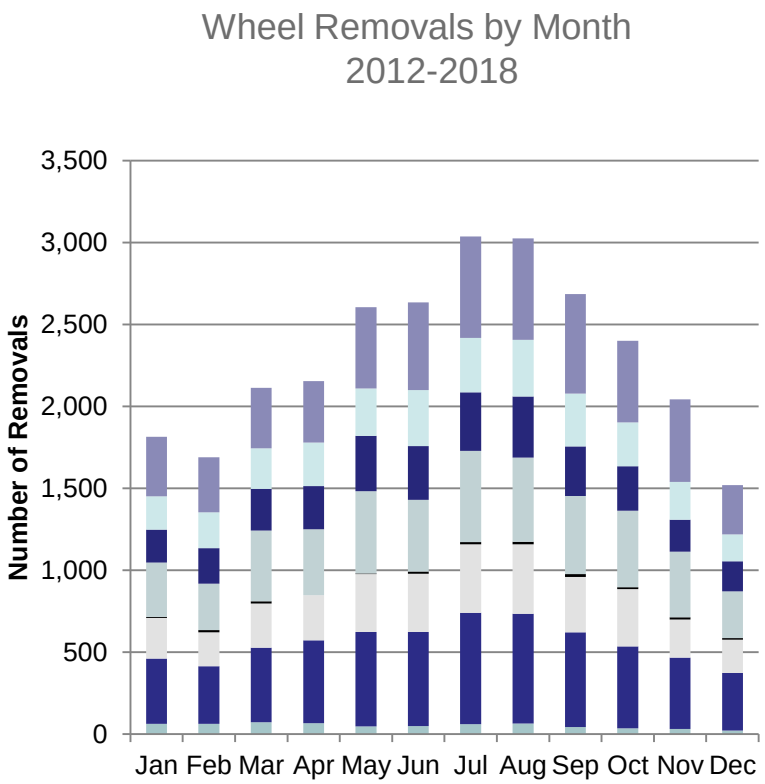
Component Reliability



- Component reliability and removal trends are more predictable than most may imagine
- Understanding what's driving reliability is key
  - Factors may include:
    - Part design or redesign, Suppliers, OEM's, Repair Vendors, Maintenance Program Revisions
    - Component life cycle
    - Environment, Weather, Seasonality, Schedule changes
    - Aircraft faults, troubleshooting
    - SOP's, Processes (Flight Ops, Maintenance, Airports, etc)

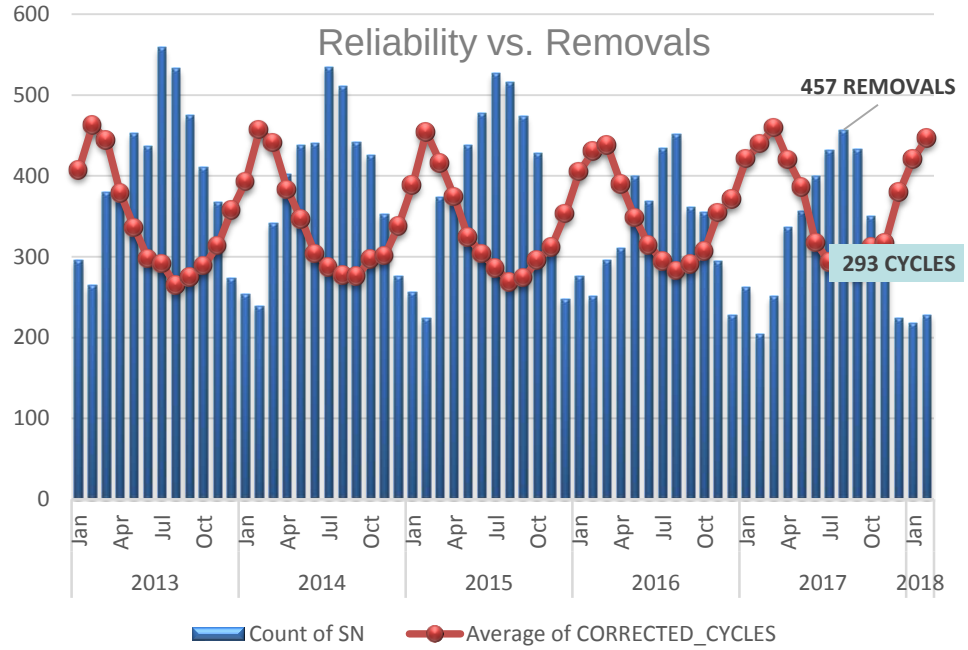
Component Removal Trends

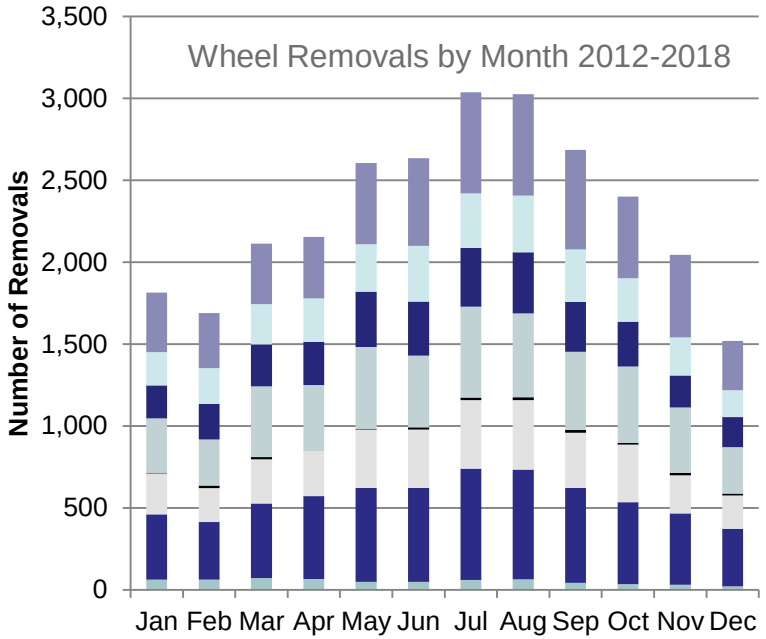




- What can these charts tell us?
- How can we use this information to prepare for future events?

Component Removal Trends





- Wheel (Tire) performance increases during the winter months & decreases during the summer months
- Wheel removals peak in July each year
- Data collection is the first step in helping us understand what is going on
  - We need to understand:
    - Where we are in the seasonal cycle
    - If staffing and shift schedules are aligned with peak times
    - Removal and Reliability trends – ***DON'T only look backwards,*** also ***look forward to known changes***
    - If Supply Management will have materials available and in stock for the peaks – arrange for disposal
    - What repairs to prioritize, resolve aging WO's. Eliminate workflow bottlenecks.
    - Current component Turn Around times – not only shop TAT but also shipping time to/from bases
    - ***Watch the weather channel !!!***

Data Drill Down

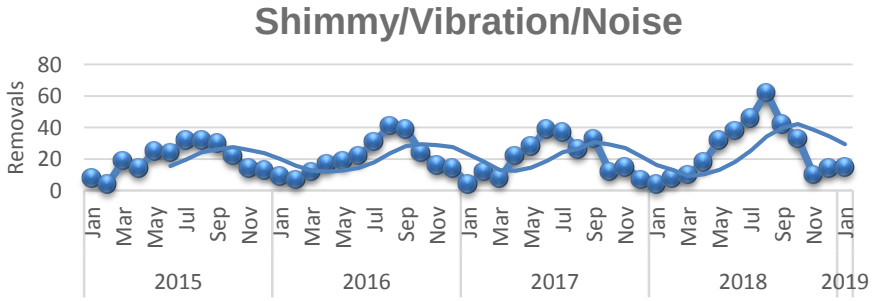
- Access the data
  - Removal data
  - Reliability data - Mean Time Between Failures
    - (Flight Hours, Cycles, Days)
  - Schedule data extracts and create Excel or Databases to work through data
- Drilling down into the data
  - will begin to shed light into what's happening at the part number level
- ***LET THE DATA SPEAK!***
  - Look at ***ALL*** potential factors that may impact performance
    - Corporate Schedule changes
    - Maintenance Program changes
    - Part changes…etc
  - Challenge assumptions
    - Ask questions
    - See if data validates assumptions
  - Be open minded
    - You may be surprised that the answer is different than your assumption
  - Collaborate with subject matter experts
    - Frontline production staff, OEM's, other operators,
    - Participate in OEM Forums

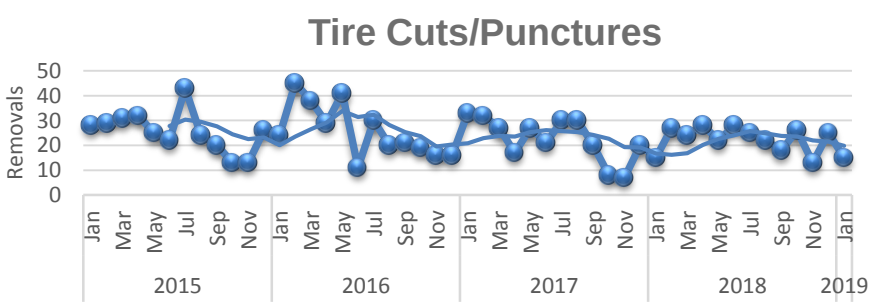
Removal Category

Count of SN Row Labels	2013	2014	2015	2016	2017	2018	Grand Total
Worn to limits	82.1%	78.4%	81.3%	79.6%	78.4%	77.4%	79.6%
Tire cut/puncture	6.2%	7.5%	6.6%	7.6%	6.7%	6.4%	6.8%
Shimmy/Vibration/Noise	6.1%	7.0%	5.1%	6.2%	5.9%	7.5%	6.3%
CRJ	4.6%	4.6%	3.6%	3.7%	2.9%	2.7%	3.7%
DHC	1.5%	2.4%	1.5%	2.5%	3.1%	4.8%	2.6%
Mate to opposite tire	1.3%	1.3%	1.1%	1.5%	1.8%	2.1%	1.5%
Underinflation/leak	1.5%	1.8%	1.1%	1.0%	1.2%	1.4%	1.3%
Groove cracking	0.1%	0.3%	2.1%	0.8%	2.1%	2.0%	1.2%
Flat tire	0.8%	0.6%	0.5%	0.5%	0.7%	1.0%	0.7%
FOD	0.6%	0.5%	0.4%	0.7%	0.5%	0.4%	0.5%
Scheduled removal	0.0%	1.0%	0.0%	0.4%	0.9%	0.0%	0.4%
Tech Records	0.2%	0.2%	0.5%	0.5%	0.3%	0.4%	0.4%

Removal by Region

			Average Cycles		% of Total				
Count of SN Region	Main Wheel	Nose Wheel	Main Wheel	Nose Wheel	Main Wheel	Nose Wheel	Total Removals	Total Average Cycles	Total % of Total
West	6,194	4,260	368	280	43.7%	42.8%	10,454	332	43.3%
East	3,945	3,001	381	253	27.8%	30.2%	6,946	326	28.8%
Central	4,050	2,688	387	271	28.5%	27.0%	6,738	341	27.9%
Grand Total	14,189	9,949	377	270	100.0%	100.0%	24,138	333	100.0%





Understanding the Repair Cycle

- Jazz utilizes ***136*** Q400 Main Wheels to support its fleet of 44 Q400's
- Total spares we carry must be enough:
  - Fill the needs of each base
  - Cover the quantity of wheels that are in the repair cycle

- Do we know how many wheels are in repair?
- Do we have clear visibility of the u/s parts?
- What's the current component reliability?
- What parts are at the greatest risk?
- What can we do to mitigate the risk?
- What benefits can we see if we reduce TAT?

The longer a part is in the repair cycle the longer it's not available when needed

Understanding The Repair Cycle

- If parts are stuck in the repair cycle, additional inventory ***WILL*** be needed to maintain service levels
    - At this point the Operator has only a few options to return the a/c to service:
        1) Purchase additional inventory ($$$)
        2) Rent or lease a part may while the original part undergoes its repair
        3) Exchange the part
        4) Move the part through repair faster - TAT must improve
- If inventory is not added, the Operation ***must accept*** the risk of ***not having*** the part available when needed
    - Direct impact to the passenger & operation
- Repair cycle turn around time (TAT) must operate within set parameters to fulfill the needs of the operation and manage the existing spares

Understanding The Repair Cycle

Thursday Oct 25, 2018 – Q400 Main Wheels

MASTER PN	PN_DESCRIPTION	FLEET	SERVICEABLE PARTS COUNT	TOTAL PARTS ON SHOP WO's	TOTAL PARTS IN WIP	U/S IN TRANSIT COUNT	PENDING STATUS / QTY US	TOTAL ASSETS	SVC PARTS %	PARTS IN REPAIR %
3-1435-2	WHEEL, MLG	DH1	18	12	7	5	2	32	56%	44%
3-1448	WHEEL ASSY, NLG	DHC	43	28	19	9	3	74	58%	42%
3-1480-1	WHEEL, MLG	DH3	40	24	17	7	2	66	61%	39%
3-1573-1	WHEEL, MLG 34"	DH4	62	71	54	15	5	136	**46%**	**54%**
3-1574	WHEEL, NLG 22 X 6.50-10	DH4	51	30	21	9	4	85	60%	40%
5010571-1	WHEEL ASSY, MLG	RJ2	39	31	22	5	13	79	49%	51%
5010598	WHEEL ASSY, NLG	RJ2	38	19	17	2	11	68	56%	44%
5013640	WHEEL, NLG INCLUDING TIRE	RJ9	38	24	18	6	0	62	61%	39%
90001200-1	WHEEL & TIRE, MAIN	RJ9	41	33	27	5	2	75	55%	45%
Grand Total			**370**	**272**	**202**	**63**	**42**	**677**	**55%**	**45%**

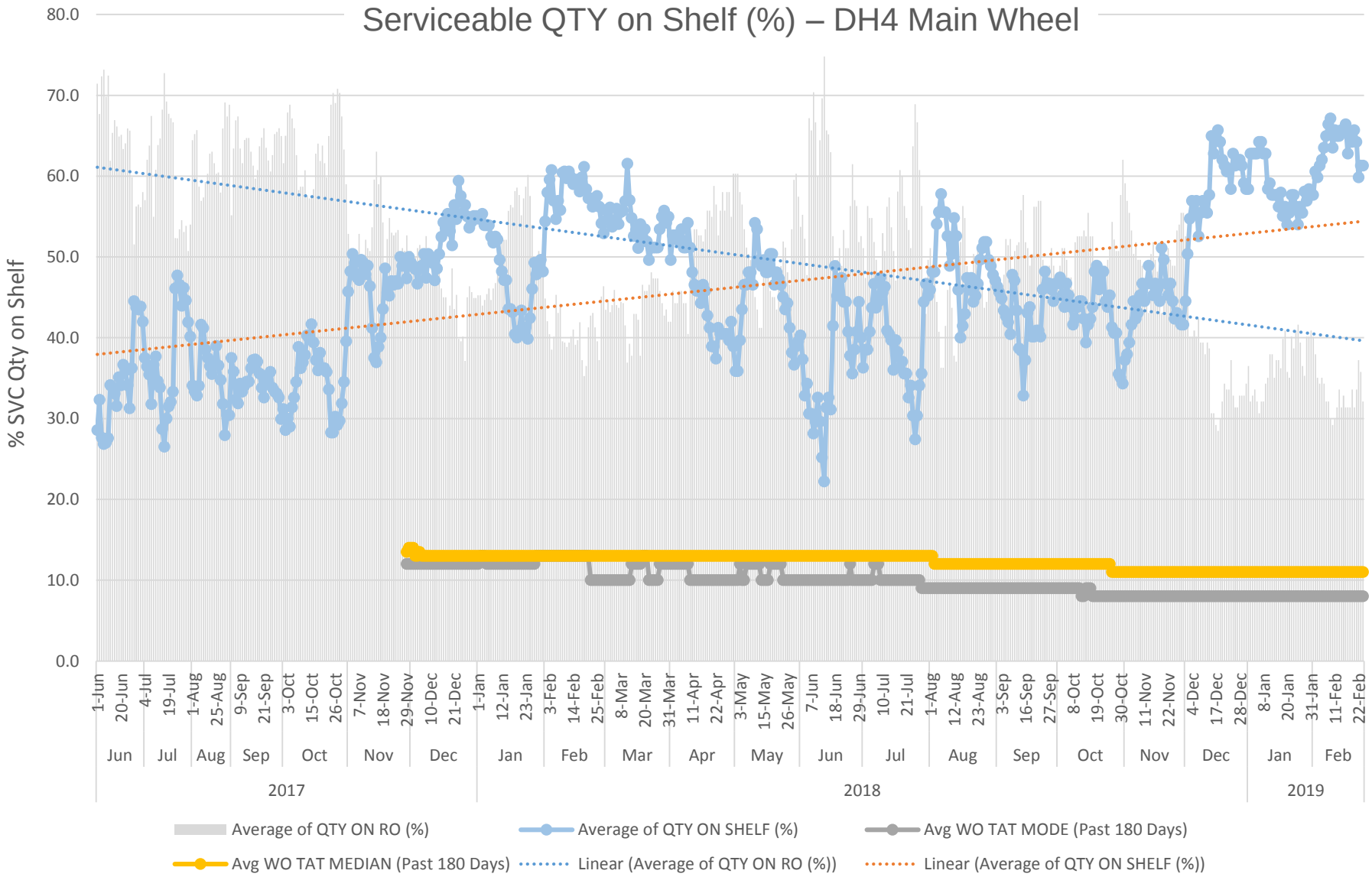
Of the 136 Q400 MW spares:

- Approximately 46% (62 Wheels) Serviceable
- ***54%*** of the spares (74 wheels) are unserviceable and in the repair cycle

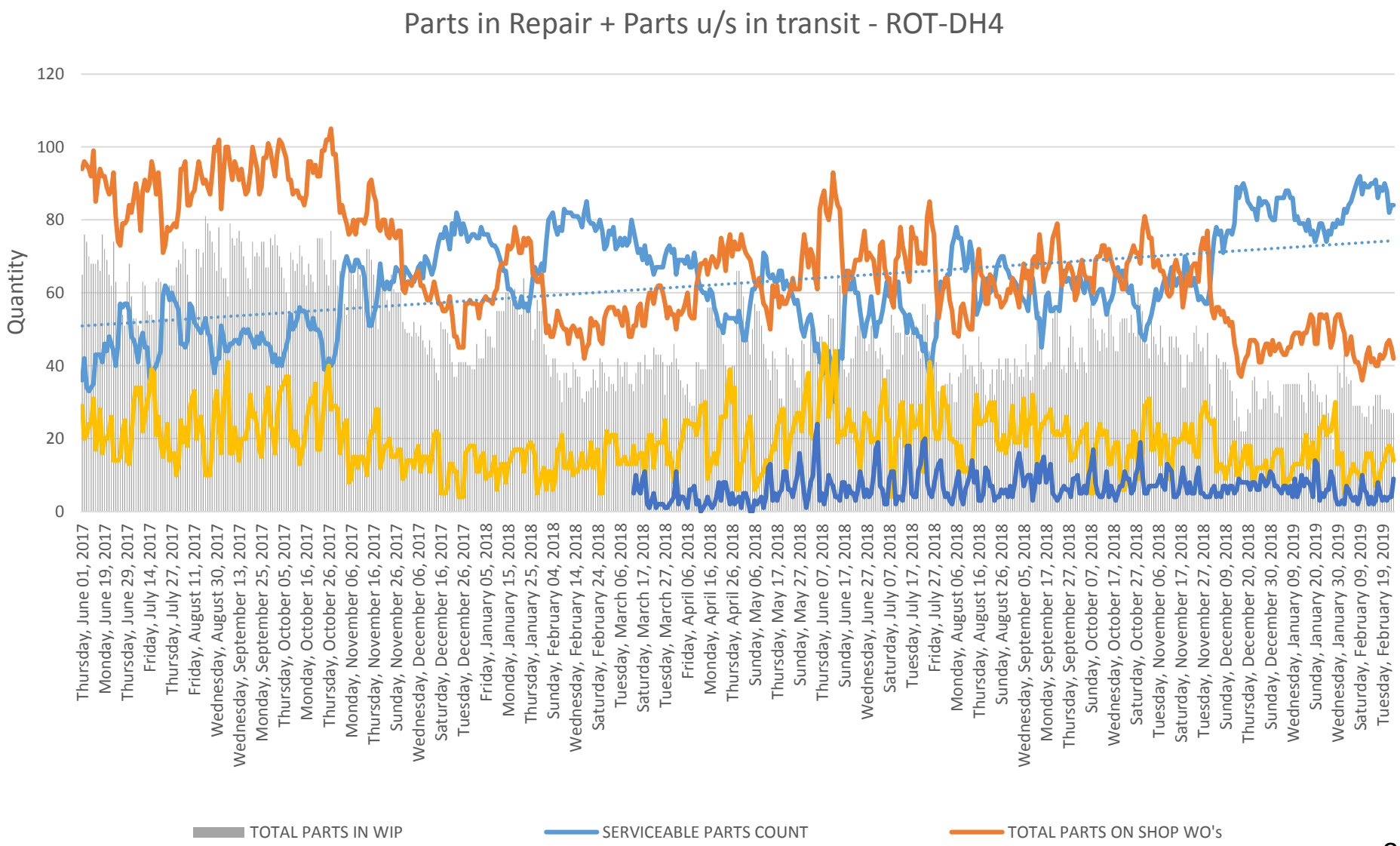
- What parts do we repair first?
  - ...total of 272 wheels in repair cycle on this day
- Why work on RJ Wheels when Q400 MW's are at greater risk?

Prioritizing what to repair first is critical to those managing the repair cycle….

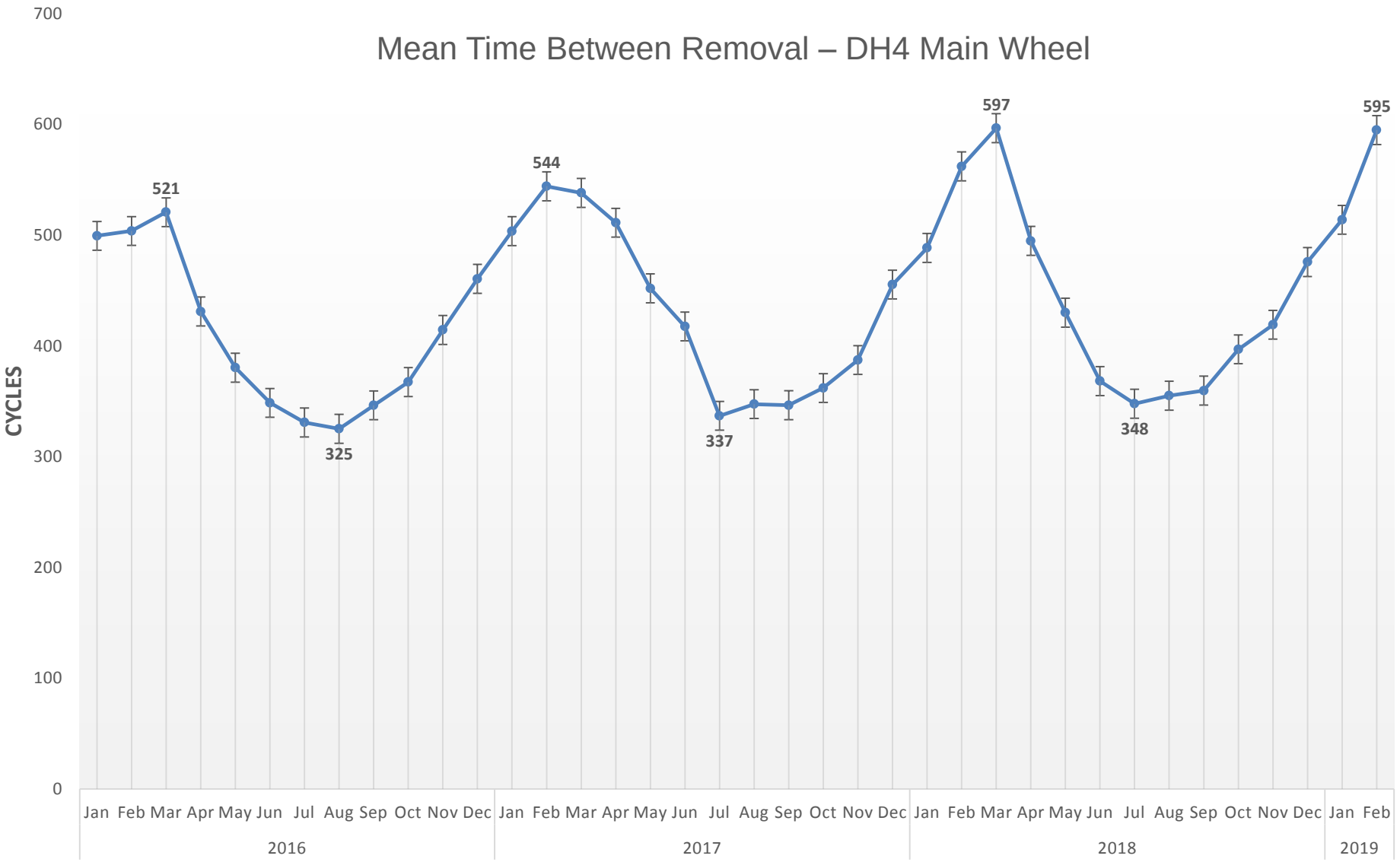
Understanding The Repair Cycle



Understanding The Repair Cycle

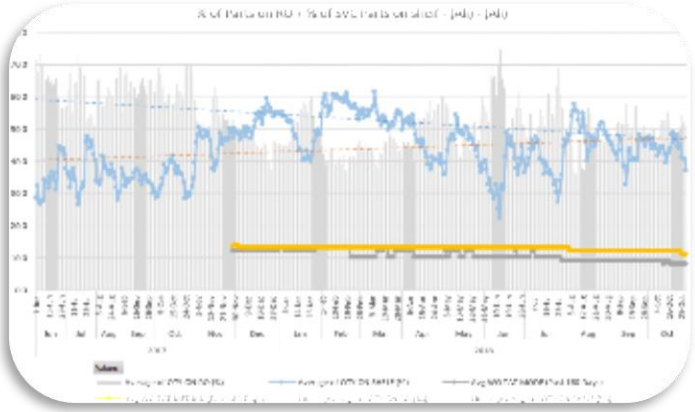


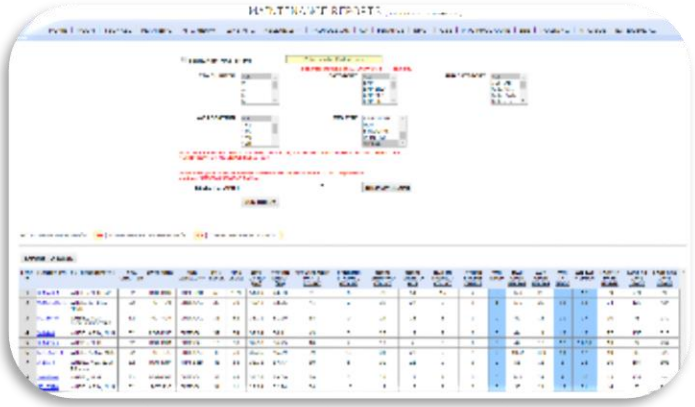
Understanding The Repair Cycle



Lessons learned and keys to success

- Make the repair cycle visible to those that manage it
  - Front line technicians, Stores, Repair Managers, Suppliers and Vendors
- Identify critical components and parts at risk & ***prioritize*** the repairs
- Identify & action bottlenecks – Work Stops or delays
- Communicate priorities, establish goals and deadlines, and engage the teams and Suppliers
- Maintain production control
  - Reallocate available resources
    - Manpower, Support staff, Suppliers
- Monitor performance trends
  - Removals, reliability, TAT, etc. - Directly impacts the Supply Chain
  - Apply data analytics to help predict future events





Year end results - TAT

Shop WO Production

- Shop WO increased slightly from 2017
  - 2017 – Total WO's 15,474, 2018 – Total WO's 15,684
  - Overall TAT improved by ***44%***
    - 2017 Avg TAT = 59 days
    - 2018 Avg TAT = reduced to 32.9 days

				Count of item										Average of TAT DAYS										Total Count of item	Total Average of TAT DAYS
wo_categ	category	pn_master	pn_description	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018		
SHOP	ROT-DHC			4,425	5,084	5,227	4,943	5,730	5,687	5,721	4,678	4,307	4,458	57.1	35.3	44.0	43.5	77.6	71.7	46.7	57.1	67.7	37.1	50,260	54.3
	EXP-REP			1,348	1,645	2,153	2,367	2,700	3,029	2,763	2,361	2,746	2,617	146.7	105.0	105.1	103.4	157.5	115.6	57.3	59.9	72.6	35.5	23,729	93.9
	ROT-RJC			3,443	3,636	3,322	2,661	2,118	1,839	1,855	1,281	1,013	1,011	14.4	17.1	14.6	14.3	30.2	52.1	36.4	33.2	46.4	30.3	22,179	24.6
	ROT-DH4					120	558	1,524	2,287	2,153	2,913	3,634	3,852			56.7	12.5	38.8	37.8	26.9	29.1	44.1	25.1	17,041	32.9
	ROT-DH3			1,160	1,342	1,496	1,404	1,343	1,382	1,362	1,154	1,060	1,100	77.7	31.1	26.4	32.4	40.2	65.0	33.9	28.1	50.2	29.1	12,803	41.1
	ROT-DH1			1,098	1,617	1,690	1,578	1,650	1,488	1,383	888	706	646	175.6	21.6	47.4	30.1	59.7	56.8	46.2	51.6	59.4	34.9	12,744	56.1
	ROT-RJ9			712	739	800	682	726	713	742	770	801	845	10.9	14.3	17.7	18.8	22.2	45.7	32.5	18.5	39.4	22.9	7,530	24.4
	TOOL-SN			166	277	274	271	422	649	691	664	558	674	15.7	34.3	35.4	44.0	93.8	79.9	28.6	73.3	55.8	56.6	4,646	56.6
	ROT-COM			269	401	442	322	326	332	515	348	401	248	45.1	19.7	17.8	13.7	76.7	45.3	50.4	62.6	94.2	39.1	3,604	46.4
	EXP			65	115	116	123	120	125	101	81	81	86	89.9	164.8	93.4	147.1	204.9	136.9	53.8	32.4	109.8	42.4	1,013	116.3
	SUP-TECH				4	6	4	6	11	3	19	22	1		206.5	532.7	481.0	118.3	100.4	21.7	15.9	65.4	28.0	76	126.2
	SUP-GEN				1	2		2	2		4	1			58.0	0.5		5.0	26.0		17.0	7.0		12	16.3
	TOOL-757				10	1									14.2	12.0								11	14.0
	ROT-RJ2			2	3	1	2		2			1		10.5	248.0	48.0	9.0		29.5			#DIV/0!		11	89.0
	SUP-757				1	2	1								29.0	896.5	1,336.0							4	789.5
	EXP-757						2										6.5							2	6.5
	UPLOAD												1										243.0	1	243.0
SHOP Total				12,688	14,875	15,652	14,918	16,667	17,546	17,289	15,161	15,331	15,539	64.0	36.3	43.3	43.4	75.1	70.2	42.6	46.2	58.9	32.7	155,666	51.6
FABRICAT	EXP-REP			75	62	73	70	79	71	95	70	97	65	72.1	120.9	106.4	53.9	61.4	91.8	41.8	51.3	75.8	47.1	757	71.3
	EXP			26	50	48	29	14	29	34	21	31	59	101.3	105.0	373.1	285.4	128.7	104.4	95.1	57.9	86.1	59.5	341	147.4
	TOOL-SN			57	8	4	18	12	16	3	1	5	17	427.1	212.0	255.0	206.7	316.5	253.3	292.0	15.0	26.0	65.4	141	289.7
	SUP-TECH			9	5	5	9	4	4	6	3	8	2	45.9	82.6	53.6	47.1	91.5	23.8	49.0	87.7	81.8	39.0	55	59.4
	SUP-GEN			2	3	3	2	1	1	1	2	2	2	71.5	30.7	161.7	17.5	158.0	460.0	43.0	23.5	130.5	33.5	19	94.3
	ROT-DHC					10										50.4								10	50.4
	EXP-757				2										5.0									2	5.0
	ROT-DH1			1										35.0										1	35.0
	SUP-757					1										8.0								1	8.0
	TOOL-757								1										494.0					1	494.0
FABRICAT Total				170	130	144	128	110	122	139	97	143	145	194.0	115.1	194.2	126.1	99.8	120.1	60.3	52.9	77.4	53.9	1,328	113.7
Grand Total				12,858	15,005	15,796	15,046	16,777	17,668	17,428	15,258	15,474	15,684	65.7	36.9	44.7	44.1	75.3	70.6	42.7	46.2	59.0	32.9	156,994	52.1

Year end results - TAT

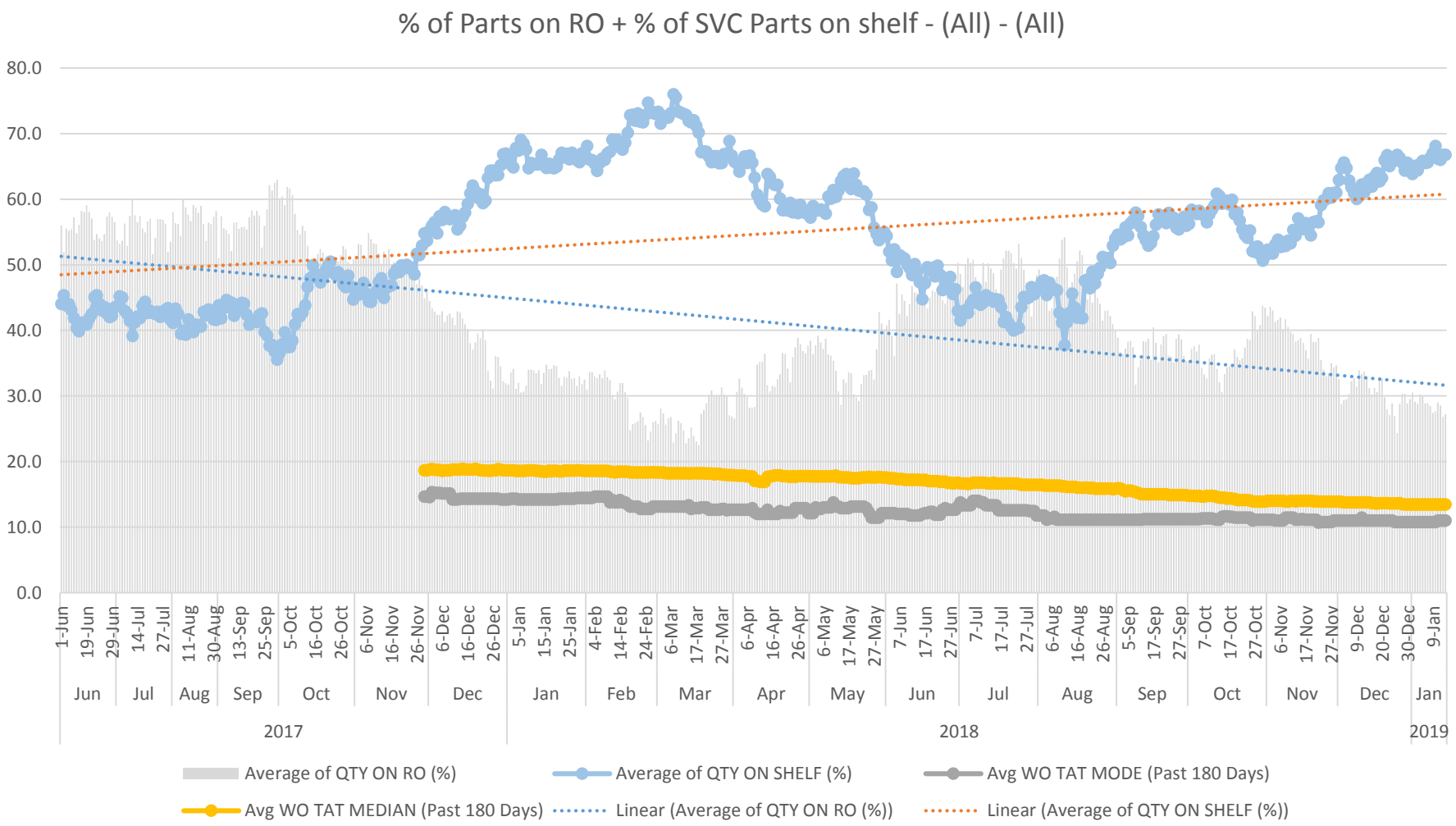
Shop WO TAT improvement – cont'd

- Overall improvement on critical parts and service levels
  - Critical parts improvement – by 40%
    - Leading edges - 64%
    - E light batteries - 63%
    - Wheels – 33%

		Count of item		Average of TAT DAYS		% of Total Qty		Total Count of item	Total Average of TAT DAYS	Total % of Total Qty	
		2017	2018	2017	2018	2017	2018				
sub_category	Ops CAT										Variance
JAZZ-REP		6,298	6,556	79.7	40.8	40.64%	41.74%	12,854	61.0	41.19%	49%
CRITICAL	WHEELS	2,621	2,602	29.1	19.4	16.91%	16.57%	5,223	24.4	16.74%	33%
CRITICAL	BATTERY - E LIGHT	691	656	72.6	26.9	4.46%	4.18%	1,347	50.9	4.32%	63%
CRITICAL	BRAKES	557	531	51.1	42.0	3.59%	3.38%	1,088	47.0	3.49%	18%
CRITICAL	BATTERY - MAIN	345	317	25.6	19.6	2.23%	2.02%	662	22.8	2.12%	23%
CRITICAL	LEADING EDGE	16	22	94.4	33.6	0.10%	0.14%	38	61.4	0.12%	64%
CRITICAL Total		**4,230**	**4,128**	**39.1**	**23.4**	**27.30%**	**26.28%**	**8,358**	**31.5**	**26.79%**	**40%**
TNM-BBD		2,628	2,745	32.6	23.4	16.96%	17.48%	5,373	28.0	17.22%	28%
(blank)		1,177	1,078	73.2	39.2	7.60%	6.86%	2,255	58.0	7.23%	46%
TNM-AAR		359	401	49.7	35.0	2.32%	2.55%	760	42.3	2.44%	30%
FABRICAT		348	287	87.5	49.1	2.25%	1.83%	635	71.0	2.03%	44%
TC-TOOL		206	225	33.2	66.0	1.33%	1.43%	431	49.4	1.38%	-99%
PBH-BBD		125	153	65.0	20.1	0.81%	0.97%	278	42.0	0.89%	69%
PBH-AAR		77	44	89.7	15.5	0.50%	0.28%	121	63.5	0.39%	83%
CPL-UTC		1	45	386.0	23.4	0.01%	0.29%	46	31.2	0.15%	94%
VMI-IFL		24	3	59.1	9.3	0.15%	0.02%	27	53.6	0.09%	84%
VMI-AVL		3	19	103.3	77.9	0.02%	0.12%	22	81.6	0.07%	25%
OBS		12	8	274.8	110.4	0.08%	0.05%	20	214.3	0.06%	60%
IN-HOUSE		5	7	128.6	20.9	0.03%	0.04%	12	65.8	0.04%	84%
EXCL-AAR		2	5	241.0	10.3	0.01%	0.03%	7	102.6	0.02%	96%
SB KIT			2		#DIV/0!	0.00%	0.01%	2	#DIV/0!	0.01%	#DIV/0!
705-IFE		2		177.0		0.01%	0.00%	2	177.0	0.01%	100%
PBH-GED			1		6.0	0.00%	0.01%	1	6.0	0.00%	#DIV/0!
Grand Total		**15,497**	**15,707**	**59.0**	**32.9**	**100.00%**	**100.00%**	**31,204**	**46.4**	**100.00%**	**44%**

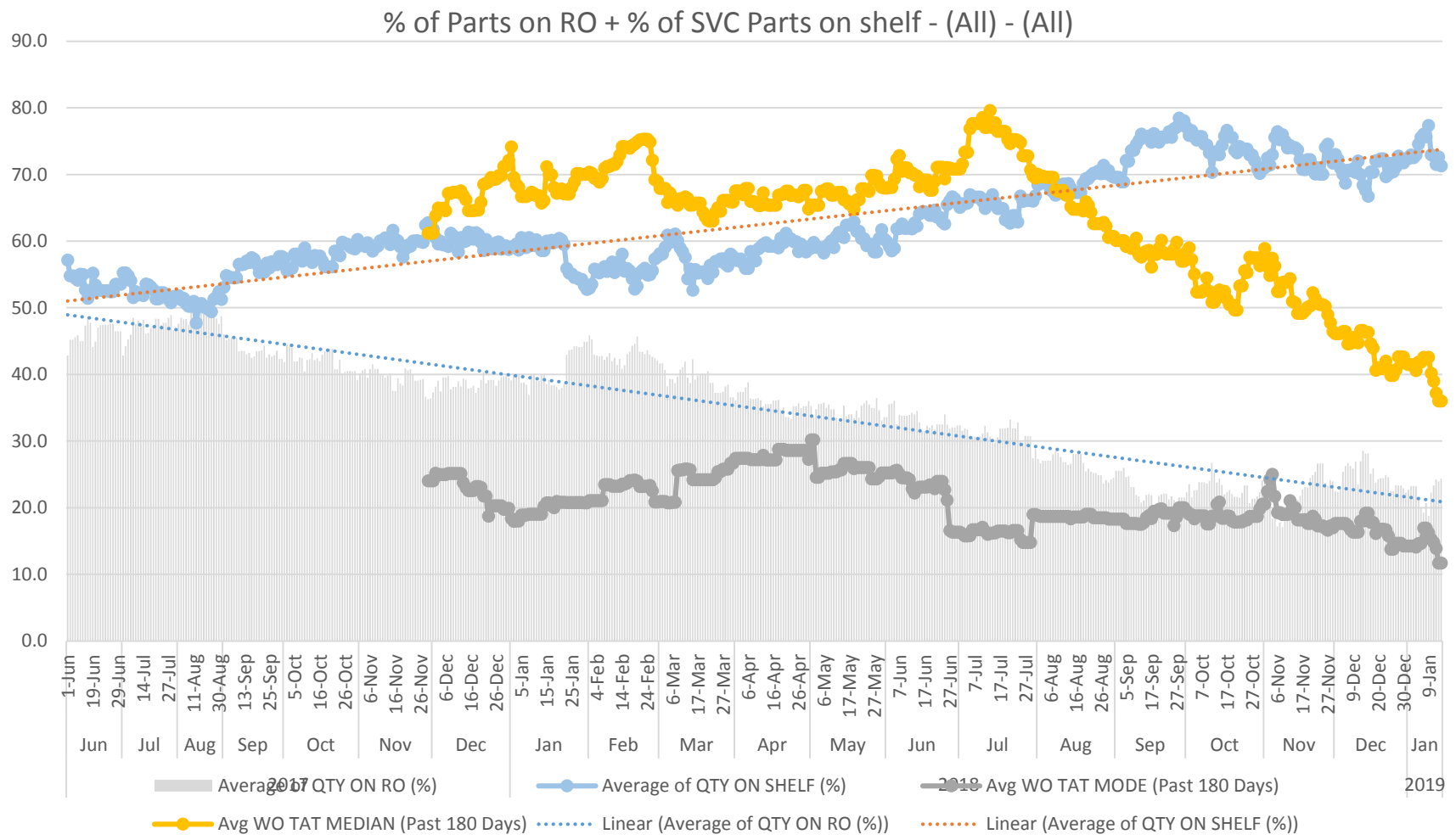
Year end results – Cont'd

Wheels serviceable levels improve (Jan 1, 2018 = 52%, Jan 3, 2019 to 61%)

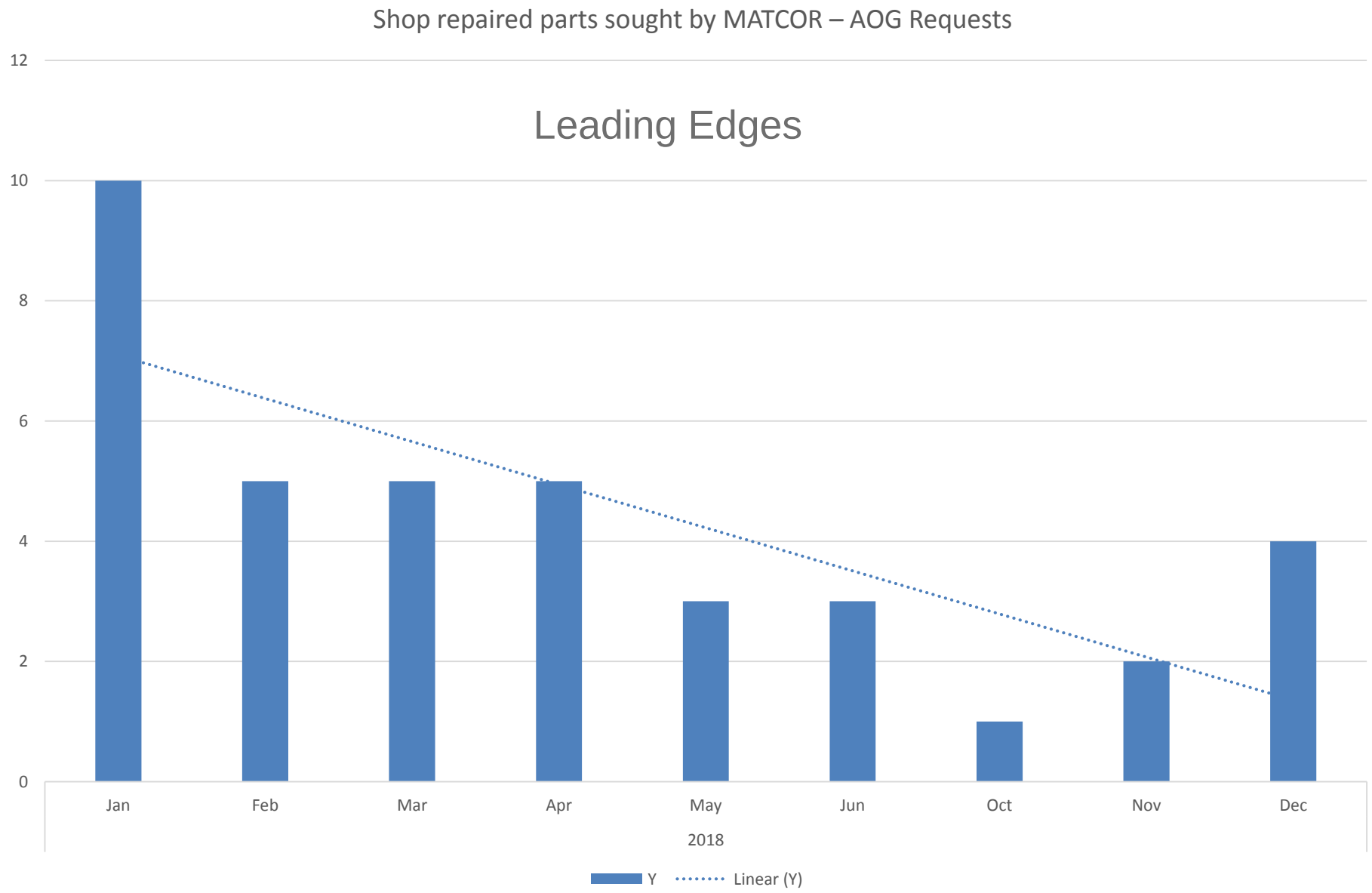


Year end results – Cont'd

Leading edge serviceable levels improve (Jan 1, 2018 = **59.6%**, Jan 3, 2019 to **72.5%**)

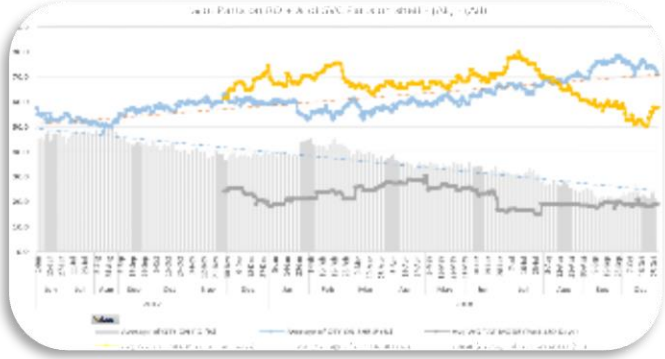


AOG Log results - 2018



Lessons learned and keys to success

- In Closing…
  - Seek out and use ALL available data or information
    - Engage SME's to validate and challenge
    - Use reliability data and analytics to help predict the future
  - Improve component reliability & on-wing performance
  - Manage the repair cycle
    - if we ***prioritize the repairs***
    - *and* ***continue to manage or reduce the repair cycle turn times***
- We will:
  - Improve On-Time Performance
  - Improve part(s) availability to the Operation
  - Manage or reduce inventory costs



Thank You

Maze Hobeyn,
Director, Component Services
Jazz Aviation LP

1 (403) 974-2337
Maze.Hobeyn@flyjazz.ca