



When Run to Failure is Not an Option: Developing a Proactive Preventive Maintenance Strategy

An abundance of data does not generate value for an organization. It's the process of analyzing data that generates the necessary insights that drive a strategy for change and improvement.

According to the McKinsey Global Institute, manufacturing companies could achieve up to **50 percent** lower costs in product development and up to **25 percent** lower operating costs – *if* they can deploy the potential of their data.

To that point, organizations that take the steps to replace or repair their equipment only after it has failed will spend more time, money and other resources than those that have a proactive preventive maintenance strategy in place. Preventive maintenance helps companies save the life of their assets and reduce unplanned downtime.

In the snapshots below, we illustrate manufacturing challenges across industries that motivated teams to dig into their data to craft preventive solutions using Minitab 18.

Editor's note: All results and scenarios in this white paper are based on actual experiences. Data units, variable names, etc. have been changed for confidentiality reasons.

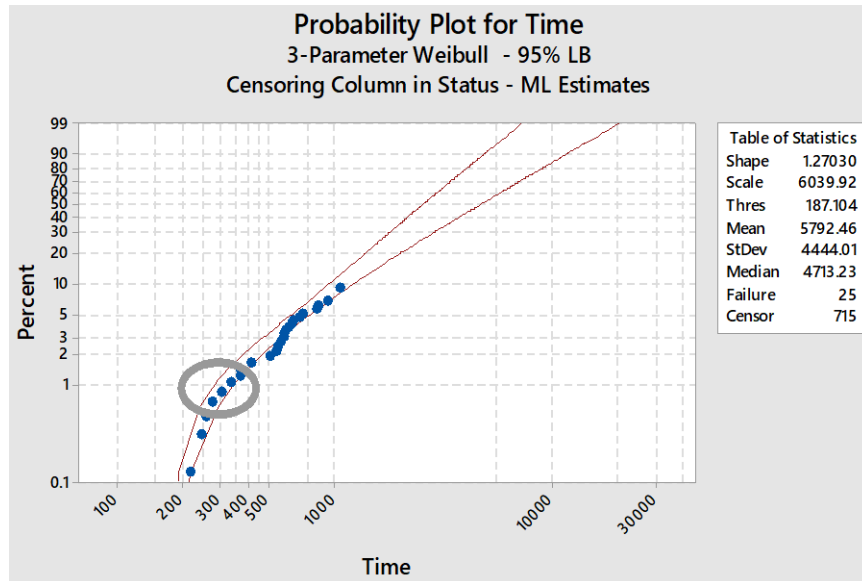
Commercial aircraft manufacturer reduces downtime by scheduling part replacement within 282 days



The Challenge

Consider an aircraft manufacturer aiming to predict the reliability of a specific jet engine flex hose.

Analysis



Parametric distribution analysis estimates the time at which 1 percent flex hoses are expected to fail and 99 percent are expected to survive; flex hose replacement is scheduled ahead of that time.

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Table of Percentiles

Percent	Percentile	Standard Error	95.0% Normal Lower Bound
1	348.659	44.6660	282.414

After running the analysis, we can be 95 percent confident that 99 percent of flex hoses will last at least 282.414 days. Scheduled replacement before that reduces unscheduled maintenance and downtime, resulting in large cost savings.

Power Company Finds Wind Turbines Require Maintenance or Retirement Before Runtime Exceeds 16,000 Hours

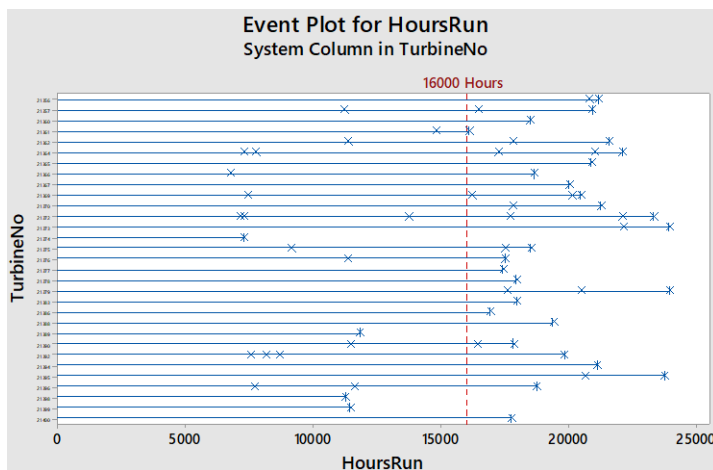
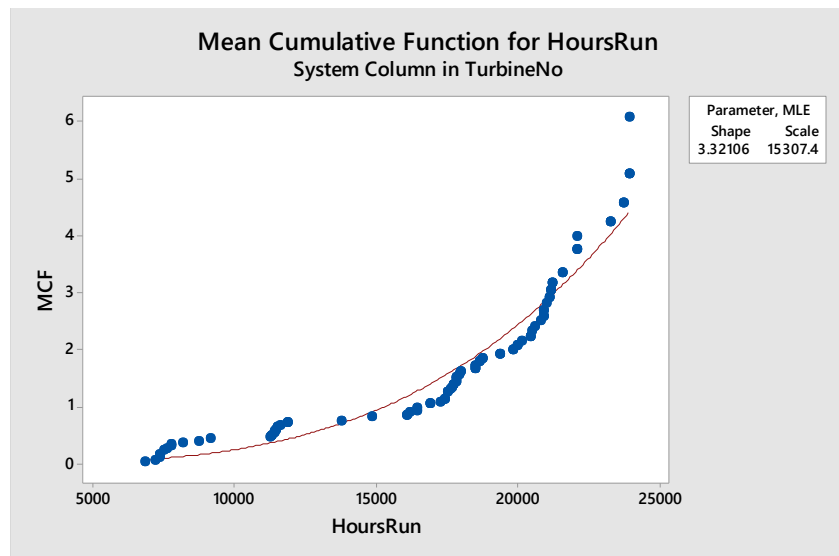


The Challenge

Wind turbine failures are tracked over time by a wind farm. The power company needs a predictive model to schedule maintenance and retirement for each turbine.

Analysis

Minitab's Parametric Growth Curve predicts the mean cumulative number of failures for the wind farm based on the number of hours a turbine is run. Turbine retirement and replacement is scheduled based on predicted number of failures and associated costs.



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An event plot shows the average number of necessary repairs increases rapidly once the runtime exceeds roughly 16,000 hours. The cost of increasing repair needs must be balanced against the cost of equipment replacement. Scheduling maintenance and repairs before these 16,000 hours have passed will reduce unplanned costs of downtime.

Which Fighter Jet Equipment Presents the Greatest Risk of Failure?



The Challenge

A specific type of failure has caused multiple engine failures on a fleet of F-15 and F-16 engines. Engineers must predict the risk to the fleet to determine which specific engines have the highest risk to prioritize maintenance on these engines.

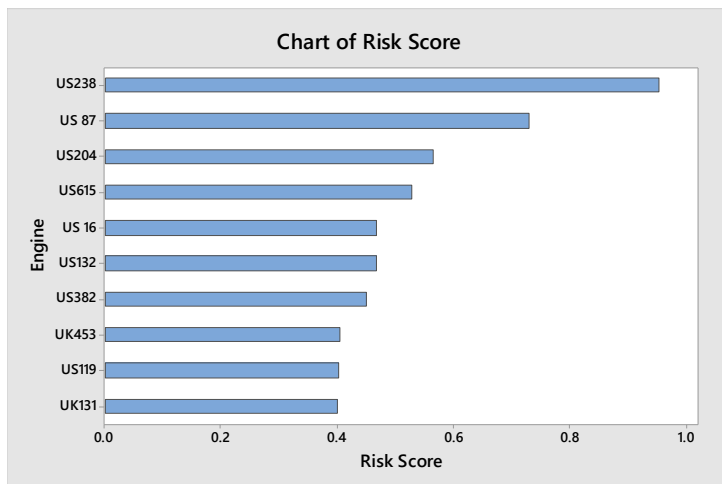
Analysis

Regression Table

Predictor	Coef	Standard Error	Z	P	95.0% Normal CI	
					Lower	Upper
Intercept	8.53990	0.478819	17.84	0.000	7.60143	9.47837
Aircraft						
F16	0.945006	0.669851	1.41	0.158	-0.367878	2.25789
Base						
US	0.520364	0.269982	1.93	0.054	-0.0087911	1.04952
HotTime	0.0051898	0.0097601	0.53	0.595	-0.0139395	0.0243192
Aircraft*HotTime						
F16	-0.0303797	0.0144874	-2.10	0.036	-0.0587744	-0.0019849
Shape	4.99104	1.22724			3.08241	8.08151

Minitab's Regression with Life Data models the relationship between time to failure and predictors such as aircraft type and location. The resulting predictive model identifies the specific aircraft with the highest failure risk.

The Minitab Solution



↓	C1-T	C2-T	C3-T	C4	C9	✓
	Engine	Aircraft	Base	HotTime	Risk Score	
1	US238	F16	US	68.0	0.953646	
2	US 87	F16	US	61.2	0.729190	
3	US204	F16	US	57.6	0.564296	
4	US615	F16	US	56.8	0.528245	
5	US 16	F16	US	55.4	0.467430	
6	US132	F16	US	55.4	0.467430	
7	US382	F16	US	55.0	0.450717	
8	UK453	F15	UK	21.0	0.404440	
9	US119	F16	US	53.8	0.402641	
10	UK131	F15	UK	21.6	0.399662	

For each engine in the fleet, the predictive model calculates the associated risk of component failure within a given number of cycles. Aircraft with the highest risk are prioritized for immediate repair.

It Begins and Ends with Data

Leveraging the potential of preventive maintenance begins and ends with your data. It's an opportunity to lower product development and production costs, improve gross margins and add to your competitive advantage.

And, with data you have already acquired through your processes, you can start today. It does not require robust investments such as exchanging or improving your machinery.

Are you ready? To start today, download your free Minitab 30-day trial at <http://www.minitab.com/products/minitab/free-trial>.

ABOUT MINITAB

Minitab helps companies and institutions to spot trends, solve problems and discover valuable insights in data by delivering a comprehensive and best-in-class suite of data analysis and process improvement tools. Combined with unparalleled ease-of-use, Minitab makes it simpler than ever to get deep insights from data. Plus, a team of highly trained data analytic experts ensure that users get the most out of their analysis, enabling them to make better, faster and more accurate decisions.

For over 40 years, Minitab has helped organizations drive cost containment, enhance quality, boost customer satisfaction and increase effectiveness. Thousands of businesses and institutions worldwide use Minitab Statistical Software, Companion, and Quality Trainer to uncover flaws in their processes and improve them. In 2017, Minitab acquired Salford Systems, a leading provider of advanced analytics which delivers a suite of powerful data mining, predictive analytics and modeling capabilities.

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