













#### Meet the Presenter:

# **Ming Dong**

Senior Analytics Consultant

- 14+ years providing training, support and consulting to Minitab customers in the APAC region and globally
- Degree in Industrial Engineering Management, Masters of Computer Science and Masters of Applied Statistics
- Broad business development experience in mining, banking and medical device companies



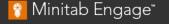


















### Minitab for Data Driven Decisions

- Easier, Better and Faster.
- Customers "Powerful statistical software everyone can use"
  - Citizen data analysts
  - Data scientists
  - Quality professionals
  - Project management
  - **Business Decision**
- The Minitab Assistant / Graph Builder
- Visualizations to Illustrate Findings
- **Global** Support/Services
  - **Technical Support**
  - **Technical Training**
  - **Training Online**
  - Consulting
  - Built-in Help System
- Intuitive GUI No coding















2020-21 Oct 2021 - Release 21 2018-19 2019-2020

### Minitab<sup>®</sup> 18

#### **User Interface**

- Session Window
- Sorting worksheets
- **Command Line**

#### Statistical tools improved

- DOE
- More distributions
- **REML**
- MSA
- **GLM Response Optimiser**

#### **Reporting Improvement**

Export to Word & Excel using table formats



#### Minitab<sup>®</sup> 19

#### User Interface

- **Tabbed Worksheets**
- **Output Pane**
- Navigator
- Split View

#### Statistical tools added

- Model Selection Criteria
- DOE Binary response
- **CI for Capability Analysis**
- The Predictive Analytics Menu (CART)
- **Cross-Validation for Regression**
- Multi-Vari Charts

#### **Visualisation**

- Correlation Matrix Plot
- Pareto Effects for Regression

#### Performance

- **64-bit Architecture**
- **Open-source integration Python**
- **Graph Editing and Brushing Improvements**
- Menus/Toolbars/New View Menu
- Command Line/History View
- New file format
- **Algorithm improvements**
- Minitab for the MacOS

#### **Reporting Improvement**

Send analysis to Minitab Engage & Workspace

### Minitab® 20 & 21

#### **Platform Extension**

Available on Cloud via Web-App

#### **User Interface Improvements**

Multi-Select in Navigator

#### **Statistical Methods**

- Model selection for CART
- Model Validation of Binary Logistic Regression and Poisson Regression

#### **Improved Visualisation**

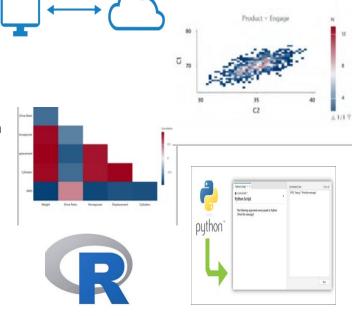
- Updated: Variability Chart
- New: Parallel Coordinates Plot
- New: Binned Scatter Plots
- New: Heatmaps and Correlograms
- **Integration with Open Source**
- Integration with R and Python

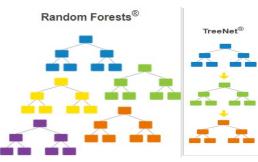
#### Reporting

New Reports

#### **Predictive Analytics Module Add-On**

- Tree based ML Algorithms Random Forests and TreeNet
- **Automatic Graph Builder**
- **Auto Machine Learning**



















# **Graphical Analysis**

- Tyre life at a hot desert mine site
- Improving crusher throughput
- Rock sample ingredients







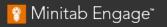
# Minitab















### Case Study

#### **ORGANIZATION**

- One of Australia's largest gold producers
- Over 4,500 employees
- CHALLENGE
- Slower trucks take longer to deliver their payloads to the crusher.

#### PRODUCTS USED

Minitab<sup>®</sup> Statistical Software – Hypothesis Testing

#### **RESULTS**

- Quantified factors with greatest impact on haul truck speed
- Adjusting ramp grade improved haul speeds
- Project will save more than \$835,000 in just its first year

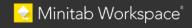














# Case Study

#### **OVERVIEW**

- World's largest primary silver producer
- Mexico's second-largest gold producer
- Holds the largest precious-metals land reserve in Mexico
- Operates six mines in Mexico
- Flagship mine has been in operation for almost 500 years

#### CHALLENGE

 Maximize silver recovery without diminishing the grade of finished silver concentrate.

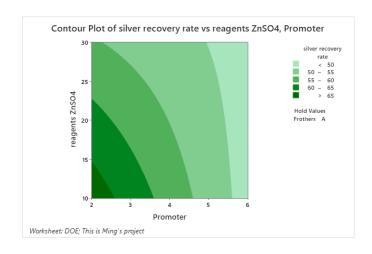
#### PRODUCTS USED

Minitab<sup>®</sup> Statistical Software -- DOE

#### RESULTS

Increased monthly revenue by over \$2 million

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#### Multiple Response Prediction

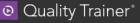
Variable	Setting			
Promoter	2			
reagents ZnSO4	10			
Frothers	Α			
Response	Fit	SE Fit	95% CI	95% PI
-1			15 1 50 71 01	1 460 06 70 74

silver recovery rate 68.00 1.44 (64.69, 71.31) (62.26, 73.74)







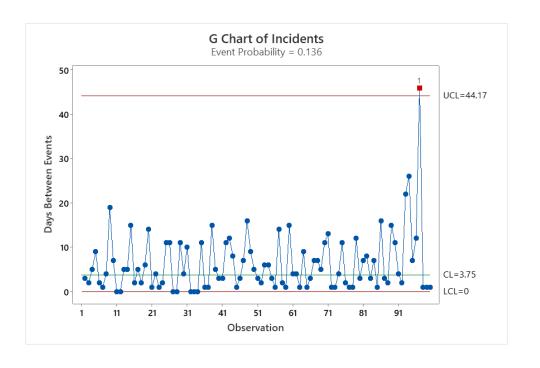






### Operational Excellence Tools

- Control Charts
  - ■There have been several incidents involving explosives processing equipment, piping and ventilation systems.
  - •A quality engineer wants to monitor the time between incidents. Is the process stable?
  - Root cause analysis

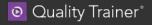


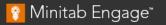
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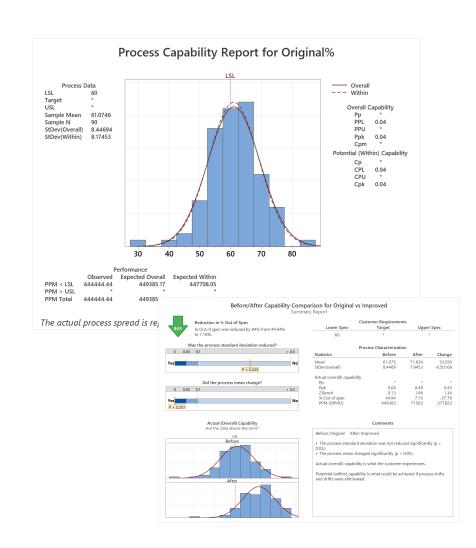






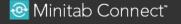
# Operational Excellence Tools

- Capability Analysis
  - Blasting at the quarry was producing oversized rock that needed to undergo secondary breaking with a breaker, which resulted in increased production costs..
  - A project aiming at improving fragmentation and crusher throughput was launched.
  - The specification required for the throughput rate is at least 60%.
  - •Is the process capable?
  - Original vs Improved?



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# Asset Management System

- What is the current state of my assets?
  - Condition & failure modes
  - Residual life
  - Replacement & costs
- Asset Management System
  - Prioritize necessary repair & replacement
  - Predicting the life cycle of an asset
  - Predicting the maintenance cost of an asset















# Life Cycle: Understanding Shelf Life

### **Example:**

- Chemicals form a crucial part of a manufacturing/mining process.
- We want to understand the life cycle of a particular chemical.
- We collected 30 bottles of this type of chemical and checked the number of days until the chemical expires.

#### Chemical life

113

90

107

128

133

136

125

115

126

134



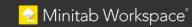






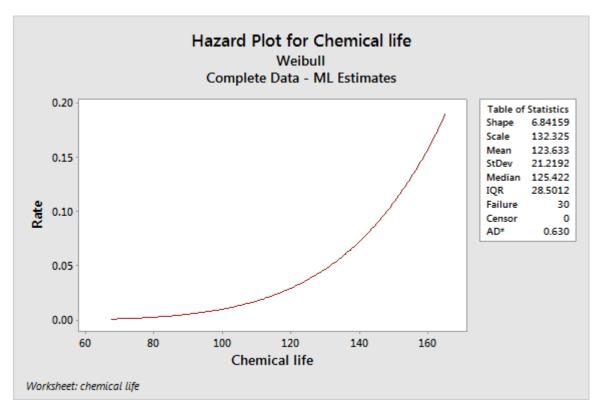


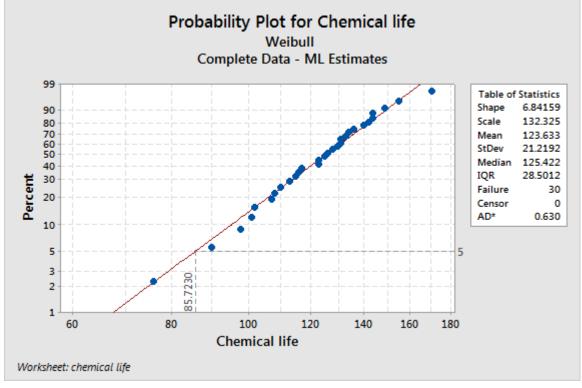






### **Understanding Shelf Life**

















### What are the Limitations of Assets?

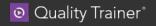
- Engineers test the individual wires in a dragline for their breaking strength.
- Risk from cable damage:
  - Electric shock
  - Ignition of gas or dust
  - Fires

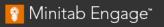
















### What are the Limitations of Assets?

Engineers wanted to determine

the probability that a wire can
withstand 50 tons of force.

- at what load 0.1% of those wires start to break?
- Engineers recorded the breaking load for 60 wires.
- Why the lower end of the distribution?

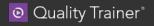
```
Load (ton)
63.04
58.46
63.83
59.88
62.74
67.17
65.12
64.46
```

#Minitab

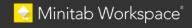






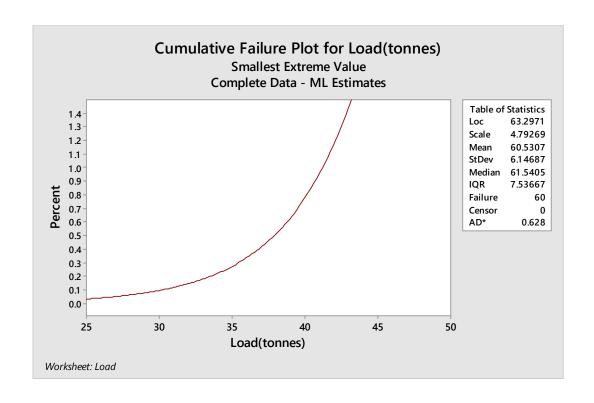








### What are the Limitations of Assets?



#### Table of Percentiles

Standard 95.0% Normal CI Percent Percentile Lower Upper 19.1550 10.4777 27.8324 0.01 23.5346 36.8510 0.1 30.1928 41.2500 36.5916 45.9085

Table of Survival Probabilities

95.0% Normal CI Load Probability Lower Upper 0.939522 0.887225 0.967999

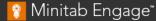












### Example:

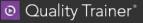
- Engineers record unscheduled maintenance actions for a machine engine.
- They want to determine whether this repairable system is deteriorating, improving or remaining constant over time.
- They also want to determine whether repair costs are increasing over time.





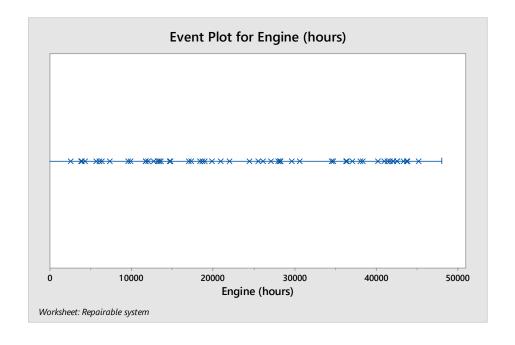


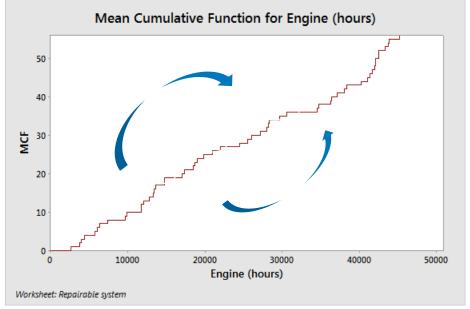










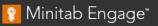
















Is the failure rate constant?

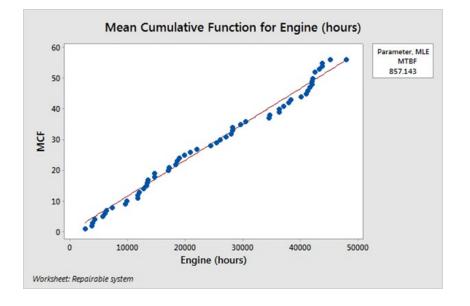
**Trend Tests** 

Anderson-Darling

**Test Statistic** 0.66

P-Value  $0.597 > 0.05 \rightarrow$  Failure rate is constant

**MTBF** 857.143 hours



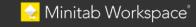






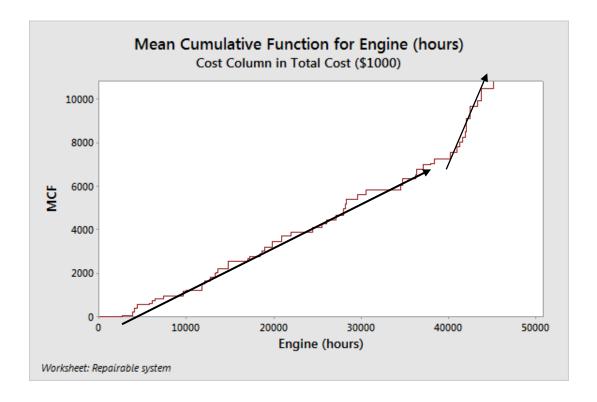








Maintenance cost?



Hours Cost

\$7.2m 0-40,000 40,000-48,000 \$3.2m











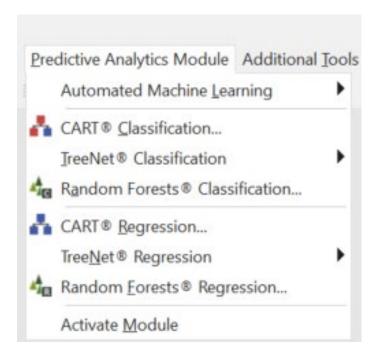




# Predictive Analytics

Boost your predictive analytics further with Minitab's tree-based machine learning algorithms:

- CART
- TreeNet® (Gradient Boosting)
- Random Forests®
- Automated Machine Learning
- Provide deeper insights
- Visualize complex interactions for easily explainable insights
- Handle larger data sets















# Crushing Process Sensor Study



- The ore is crushed down to rock sizes of 9 mm through three stages of crushing commencing with a jaw crusher, followed by secondary and tertiary crushing using cone crushers.
- Engineers installed 56 sensors on a process line. More than 4000 observations were recorded over a typical interval. Engineers were interested in how to apply essential sensor readings to identify potential failure batches quickly.

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# Questions?

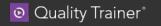
**Try Minitab Statistical Software:** 

minitab.com/products/minitab/free-trial/













### Our Approach: More Than Business Analytics... Solutions Analytics

Solutions analytics is our integrated approach to providing software and services that enable organizations to make better decisions that drive business excellence.

### Software

— Data Analysis — Data Transformation — Predictive Modeling — Online Training — Visual Business Tools — Project Oversight —

Minitab® Minitab Connect® SPM® Quality Trainer® Minitab Workspace® Minitab Engage®

Powerful statistical software everyone can use. Data access, automation, and governance for comprehensive insights. Machine learning and predictive analytics software. Master statistics and Minitab anywhere with online training. Visual tools to process and product excellence. Start, track, manage and execute improvement projects in real-time.

### **Services**



Learn first-hand by attending public or customized trainings in your facilities according to your requirements.



Statistical Consulting

Personalized help with statistical challenges from collecting the right data to interpreting analysis more.

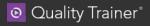


Support

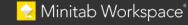
Assistance with installation, implementation, version updates and license management.













# Thank You!

From all of us at











