



Material services - ICEAA Conference 2015

Cheryl R. Wilson/A CER Development Process for Spares Estimating

June 9, 2015

The statements contained herein are based on good faith assumptions and are to be used for general information purposes only. These statements do not constitute an offer, promise, warranty or guarantee of performance.

Copyright © 2015 Boeing. All rights reserved.



Cheryl Wilson

Background

Northrop Corp Electronics/Aircraft Divisions,
Boeing Commercial Airplanes – 22 years

Estimating and Pricing Specialist – Commercial
Aviation Services (CAS), Renton, WA

CEBoK Classes


Statistics/Parametric Estimating - Boeing

ICEAA NW Board

Commercial Aviation Services (CAS) Material Services

Right Part, Right Place, Right Time

CAS's Material Services makes sure our customers have the spare parts and maintenance services they need to keep their airplanes flying

[Read More](#) 

Parts

- Genuine Boeing parts
- Aviall – A Boeing Company – online parts service

Parts Support

- 24/7/365 parts support
- Boeing PART page
- Service Ready support

Parts Solutions

Component services
Integrated Materials Management
Landing gear

BOEING **EDGE**
Material Services

Abstract

A CER Development Process for Spares Estimating

This presentation shows the CER development process journey of a Spares Cost Estimating group and the advancement of our statistical skills through education, research, analysis and teamwork.

Cheryl Wilson

A CER Development Process for Spares Estimating

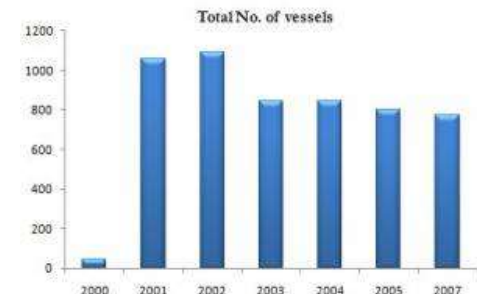


"A judicious man looks on statistics not to get knowledge, but to save himself from having ignorance foisted on him."
Thomas Carlyle

Our Group Background

A CER Development Process for Spares Estimating

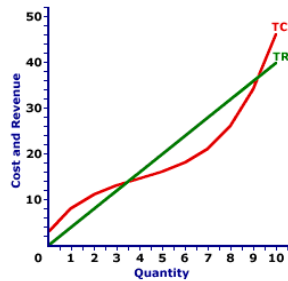
- Our group is part of the Boeing Commercial Airplanes Estimating Organization
- New Cost Estimating Group for Commercial Aviation Services Material Management (CAS MM)
- Chartered by upper management to develop common Estimating tools
 - Statistically based Data Driven Estimates
 - Cost Estimating Relationships (CERs)
 - Central Library



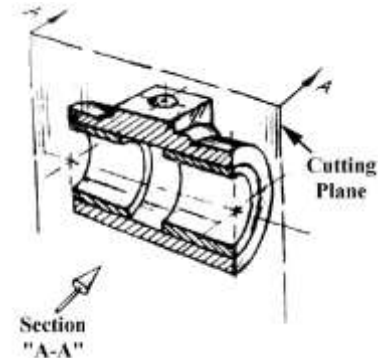
Our Group Challenges

A CER Development Process for Spares Estimating

- Spares environment vs. Production
- Multiple Databases - How do we find/get access to all the information that we need.



- Cost Data
- Engineering Data
- Sales Data
- Part Drawings



- Further education in Statistical Analysis/CER Development
- Developing a Process within our group which corresponds to the BCA Estimating Plan
- Getting a seat at the table – Detail Part/Assy Estimating vs. sections of or whole aircraft
- Cohesiveness between Generations

Our Education - What is a CER?

A CER Development Process for Spares Estimating

- **Cost Estimating Relationships (CER's)**
- **A fundamental estimating tool used by cost analysts.**
- **Mathematical expressions relating cost as the dependent variable to one or more independent cost driving variables.**
- **Can take numerous forms, ranging from informal rules of thumb or simple analogies to formal mathematical functions derived from statistical analysis of empirical data.**

Our Education - History of Parametric Cost Estimating

A CER Development Process for Spares Estimating



- World War II – caused demand for military aircraft
- Statistical Estimating – T.P. Wright – learning curve
- 1950's Rand - CER

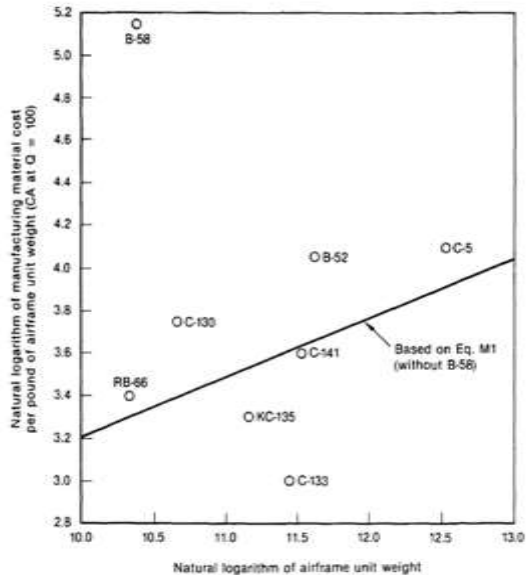
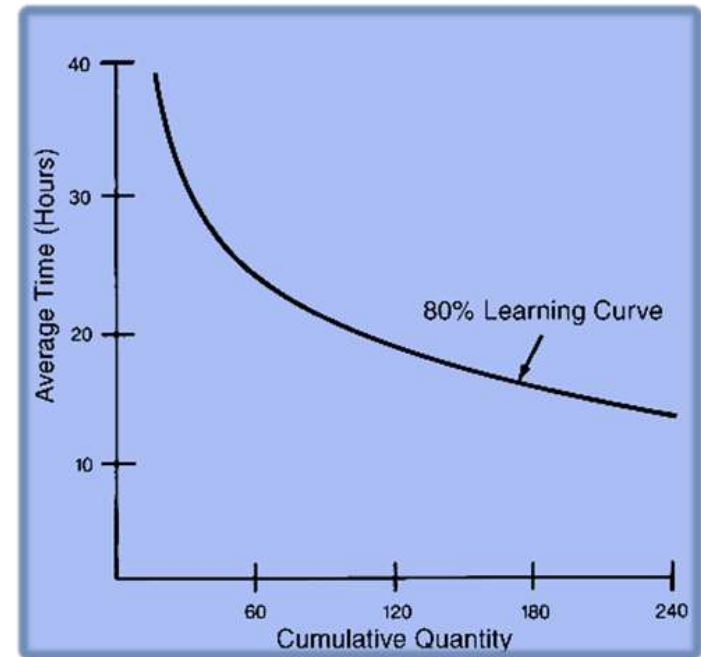


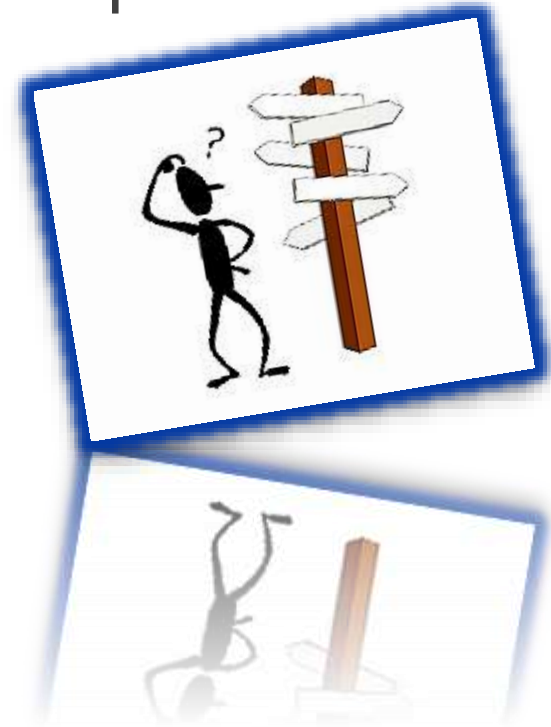
Fig. 6—Manufacturing material cost per pound as a function of airframe unit weight



What Does an Estimating Community Look Like Without CERs ?

A CER Development Process for Spares Estimating

- No standard way of analysis
- Pocket or desk drawer mentality
- SME input without statistical backup
- Untraceable analysis History
- Un necessary rework
- Difficult to assess risk



What are the Advantages of CER's - Why Standardized Estimating Tools?

A CER Development Process for Spares Estimating

- Consistent approach to estimate development
- Versatility – CERS can be quickly modified
- Sensitivity – our cost analysis output could change if we changed suppliers or lot sizes etc.

➤ Statistical output –

COLOR KEY	
Statistical Grade	Strong
Statistical Grade	Good
Statistical Grade	Caution
Statistical Grade	Weak

QUALITY METRICS EVALUATION	
P Value	0.00
F Ratio	11.99
R ²	0.50
CV	189.1%
Sample Size	14
Max Standardized Residuals	1.3
Min Standardized Residuals	(2.0)
Max Cook's Ratio	33.26

- Objectivity - based on historical data
- Shared Knowledge - CER's centrally located and maintained

Our Plan

A CER Development Process for Spares Estimating

➤ ***Develop a CER process within our group that aligns with the overall BCA Estimating CER development plan***

First Steps:

- *Know Our Customer Needs*
 - Accurate and timely cost for spares as a basis for spare part price
- *Identify Our Team Needs*
 - Advanced education in statistical analysis
 - New Analytical Software training - Jmp
 - Understand what we already have in our data
 - Network of experts

Our Plan - Developing the Process

A CER Development Process for Spares Estimating



➤ Examine how our group might design a CER process

- **Tools**

- **Software**

- **Jmp**
- **At Risk**
- **Excel**
- **Access**

- **Internal Databases**

- **Engineering Data**
- **Cost Data**
- **Several Sources**

- **Team Network**

- **Contact List**

- ✓ **Statistical Specialists**
- ✓ **Engineering**
- ✓ **IT**
- ✓ **Supplier Management**
- ✓ **Other Estimators**

- **Methods**

- **Data Analysis**
- **Parametric Estimating**

- **Education**

- **ICEEA**
- **In house**

- **Worksheet**

- **CER Task Flow**

- **CER**

Part Segmentation

A CER Development Process for Spares Estimating

What are the cost drivers for certain part types?

Cookie Example

Cookie 1
Ingredients Type A
Process Type A
Size -Small

\$1.00



Cookie 2
Ingredients Type A
Ingredients Type B
Process Type B
Size - Medium

\$2.10



Cookie 3
Ingredients Type A
Ingredients Type C
Ingredients Type E
Process C
Size - Medium

\$3.50



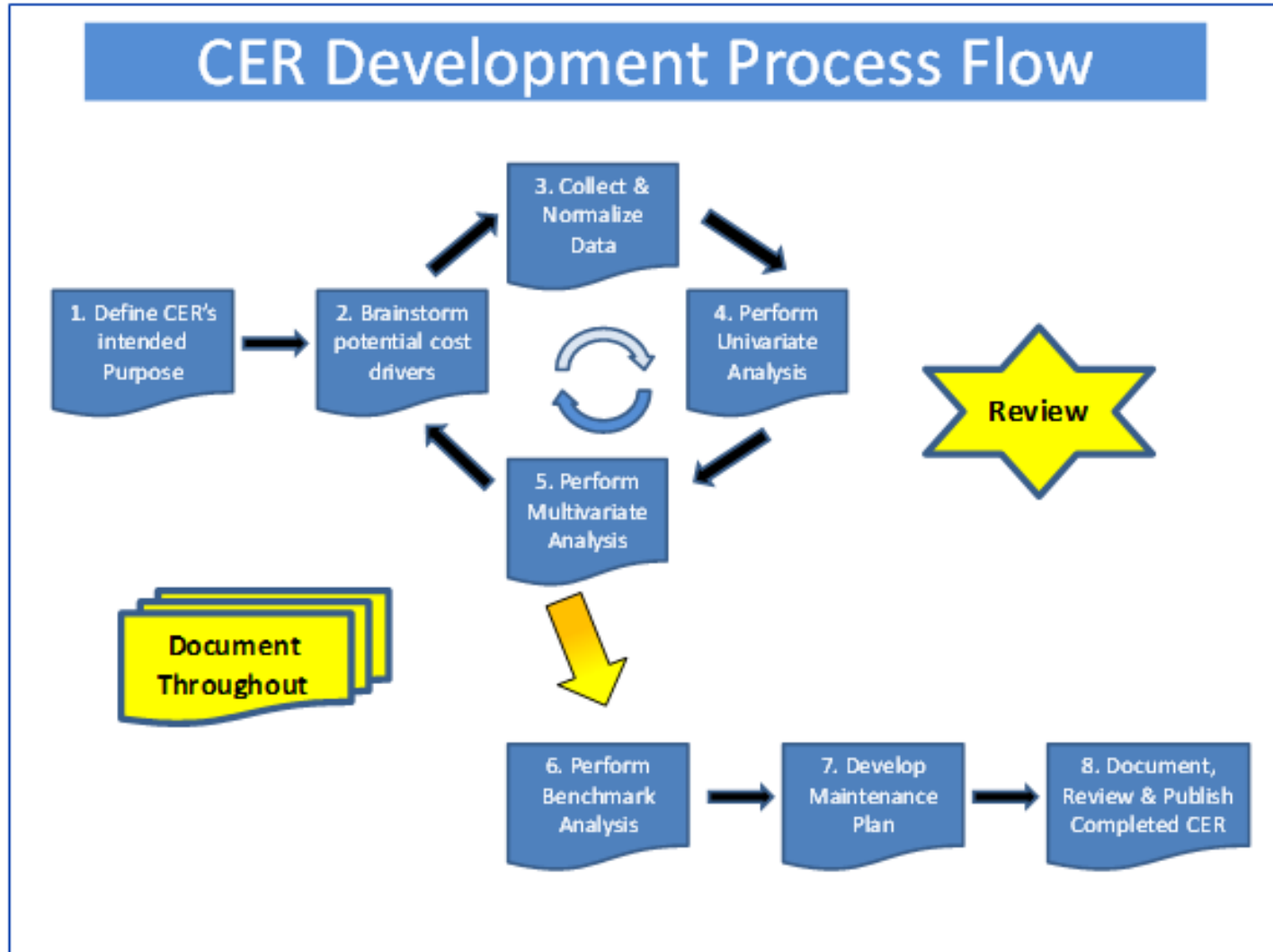
Cookie 4
Ingredients Type A
Ingredients Type D
Ingredients Type E
Process Type D
Size - Med

\$4.50



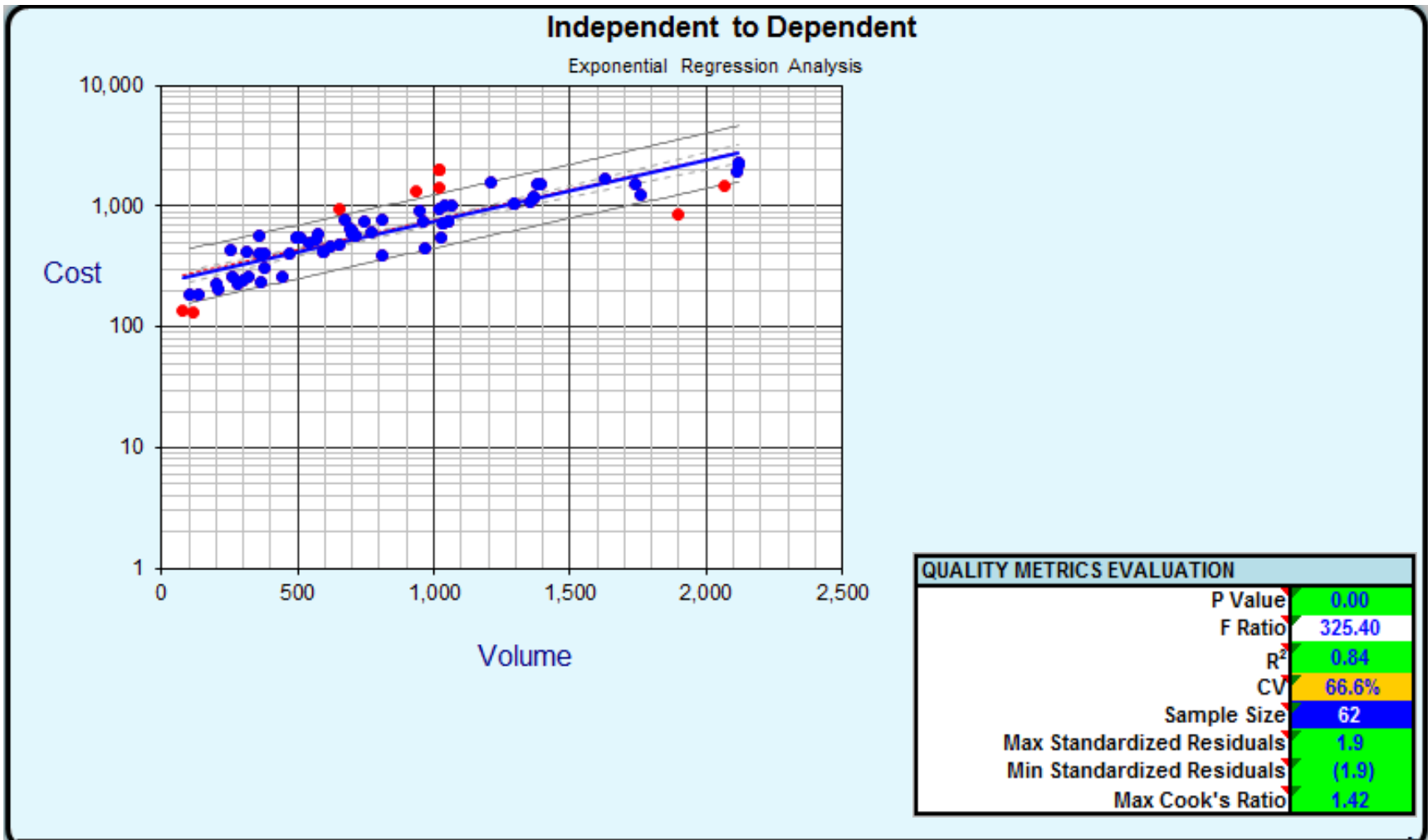
Eight Step Process for CER Development

A CER Development Process for Spares Estimating



Total Commodity CER – Same Part Type 2 Material Types

A CER Development Process for Spares Estimating

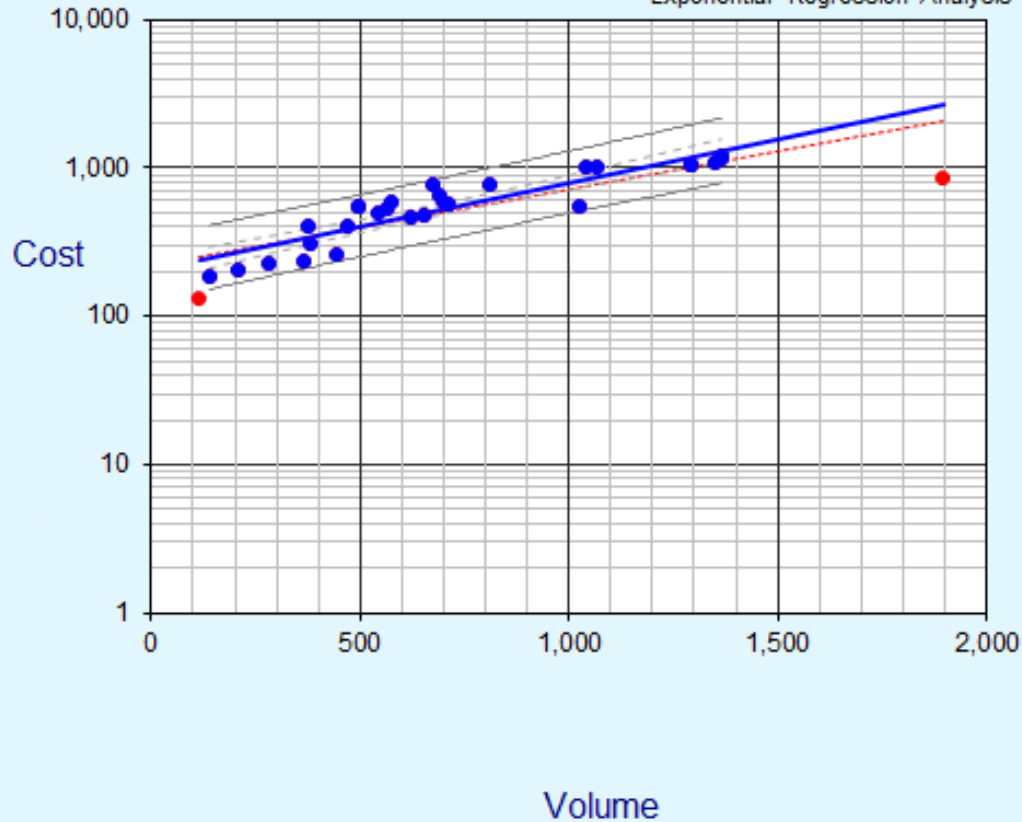


Sub-Commodity 1

A CER Development Process for Spares Estimating

Independent to Dependent

Exponential Regression Analysis



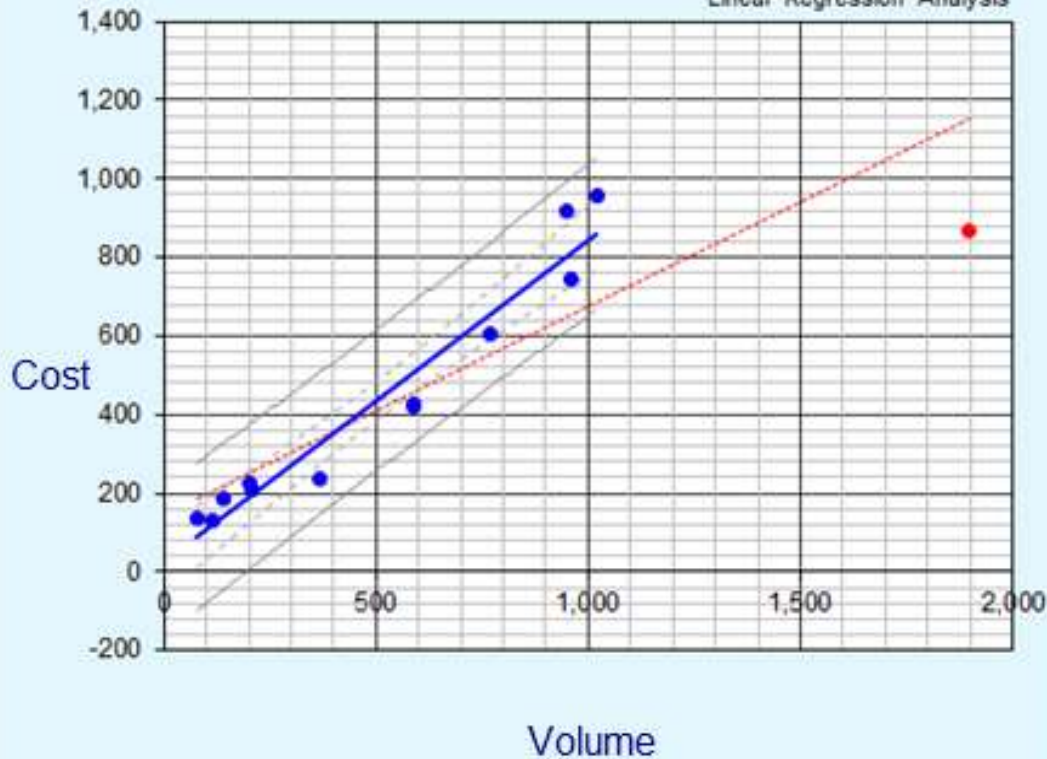
QUALITY METRICS EVALUATION	
P Value	0.00
F Ratio	128.35
R ²	0.83
CV	49.4%
Sample Size	29
Max Standardized Residuals	1.8
Min Standardized Residuals	(1.7)
Max Cook's Ratio	1.30

Sub-Commodity 2

A CER Development Process for Spares Estimating

Independent to Dependent

Linear Regression Analysis



QUALITY METRICS EVALUATION	
P Value	0.00
F Ratio	159.31
R ²	0.94
CV	69.9%
Sample Size	12
Max Standardized Residuals	1.6
Min Standardized Residuals	(1.2)
Max Cook's Ratio	1.03

Conclusion

A CER Development Process for Spares Estimating

This presentation has demonstrated the path that a Spares Cost Estimating group has taken using education, research, analysis and teamwork to advance our CER development skills and process. We continue to perfect our process in order to provide well founded cost estimates to our customers.

Questions

A CER Development Process for Spares Estimating







CER Process Worksheet

A CER Development Process for Spares Estimating

CER Process Worksheet (Step-by-Step guide)		
Process Step	Description	Detail/Notes
1. Define purpose of CER		
Cost Item to be measured?		
Estimate Use	The estimate that this CER is being created for, if there is one	
Simple or Complex CER.	Simple- rates, factors, ratios; Complex - bi/multi-variate	
2. Brainstorm/Define Potential Cost Drivers		
Variables -	What are the anticipated Variables?	
Definition of Variables -	What does the variable represent	
Identify SME's -	Names, what site - job title	
SME interview findings -	SME Hypothesis, suggested variables	
SME Interview Date -		
Hypothesis of Independent Variable Relationship w/ Dependent Variable		

CER Process Worksheet

A CER Development Process for Spares Estimating



3. Data Collection		
Cost Data -	(Represents cost in dollars) and hours associated with Activities (labor) or Materials	
Technical Data -	(Cost Data) (requirements or physical characteristics of systems, may drive cost	
Programmatic Data -	(Cost Driver) - Program Parameters that explain and drive cost	
Define Data Collection Sources -	(I.E. VCD, TSPED, Wirs etc.)	
Normalize Data -	Primary Data (obtained from Original Source - unaltered-unchanged) -Secondary Data (Normalized/Adjusted for inflation,	
4. Univariate Analysis		
Perform Univariate Analysis	Single stream of data, one variable (e.g. Weight) - (Types of Analysis) Mean, Standard Deviation, Median, Mode, Distribution. Tools include Histogram, Summary Stats	

CER Process Worksheet

A CER Development Process for Spares Estimating

5. Multivariate Analysis		
Perform Bivariate Analysis -	Data which has dependent and independent variables (e.g. cost & weight) - Understand the relationship between a pair of variables. Independent with the dependent and independent with other independent. Types of analysis: R2, Correlation, Mean Squared Error, T-Statistics, p-value, residuals. Tools include Correlation, Scatter plotting and Regression Analysis.	
Perform Multivariate Analysis -	independent variables (e.g. cost & weight) - Understand the relationship between a pair of variables. Independent with the dependent and independent with other independent. Types of analysis: R2, Correlation, Mean Squared Error, T-	
6. Benchmark Analysis		
Perform Benchmark Analysis -	Validate results of CER by comparing to known information - consistent with other known historical points and/or other companies/industries?	

CER Process Worksheet

A CER Development Process for Spares Estimating

7. Develop Maintenance Plan		
Maintenance Plan -	Who will perform the maintenance - which org? How often?	
Time Frame -	How often will CER be reviewed/updted?	
Historical Record of Maintenance -	Record review dates and changes to CER (updated Data etc)	
Maintenance Notes -	Make note of changes/updates to CER - new data?	
8. Document Review & Publish Completed CER		
Complete the CER Documentation Sheet and submit CER for Publishing	Search the Boeing Intranet for BCA- Estimating & Pricing/PFA - Next click on the CERs, Models & Tools link at top of page - Then click on the CER Documentation Sheet - after completeing, e-mail the sheet to GRP BCA CER User Group.	