

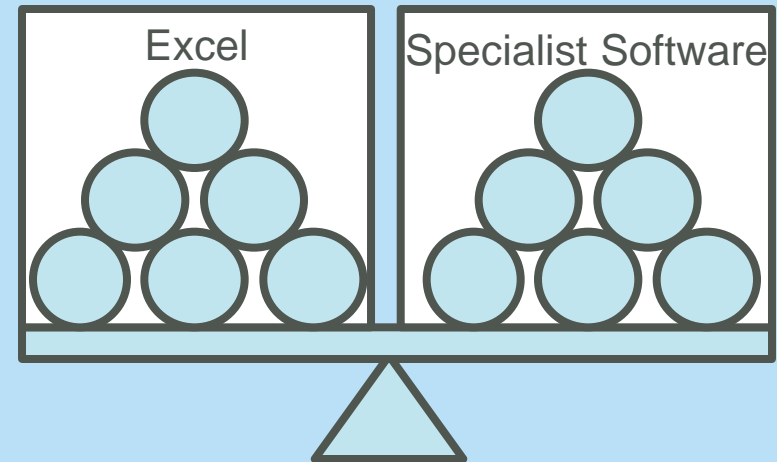
SCAF 2012

Cost Estimating Challenge:

Team BMT

Bristol 24th April

Oliver Markwardt
Dave Hedley



BMT Group

- An international network of subsidiaries providing engineering, design and risk management consultancy
- Wholly independent partner providing customers with access to expertise around the globe
- Heritage of research and technology which drives significant ongoing investment in R&D and development of future talent
- Formed in 1985 through Government privatisation of maritime research and technology organisations
- Held in beneficial ownership for the staff
- 2009 turnover ~ £142 million
- Over 1200 staff in 29 subsidiary companies in Europe, North America and Asia



BMT Reliability Consultants Ltd.

We help our customers to
optimise through-life performance and cost,
and minimise risk

Risk Assessment

Supportability

Availability
Reliability
Maintainability

Cost
Engineering

Information Management & Software Solutions

Data Collection & Analysis

The Challenge

Extracts from SCAF brief

- “the objective is to prepare a parametric model for the estimation of **commercial vehicles**.”
- “The company has a strategy to produce **more tailored vehicles** for the consumer and as a result the head of sales and marketing would like to equip forecourt sales staff with **a quick pricing tool** rather than the price list that is presently used.”

Roles

- Renault Commercial Vans Dealership
- Dave Hedley – Head of Sales
- Oliver Markwardt – Chief Cost Estimator

Parametric Approach

Data Source

- Renault, 2012 Commercial Van Price List

Data Normalisation

- No data normalisation undertaken

Data Analysis Technique

- Microsoft Excel
- Specialist Software – Minitab

Model Creation and Build

- Demonstration of regression equation

Assumptions and Exclusions

- Repeat analysis annually with the latest price list
- Inputs to the parametric model are within the range of current price list values
- Assumed no specified (tailored) overhead. All parts are interchangeable

Data

Renault Commercial Vehicles

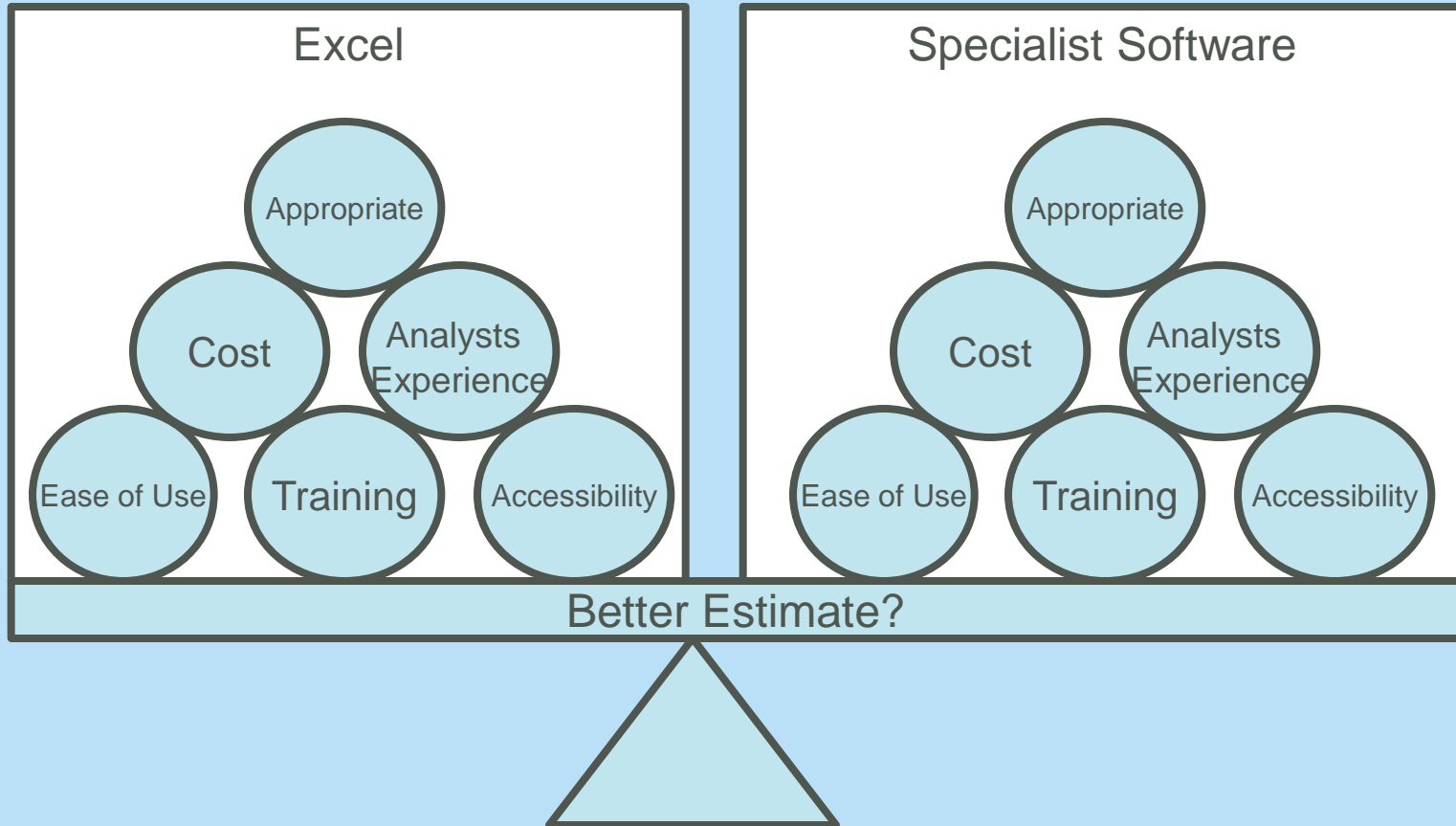
- Renault Price Guide 1st April 2012
 - Editions of Vans (Core, Sport, Special Edition)
 - Horse Power (HP)
 - CO₂ Level (g/km)
 - Miles Per Gallon (g/km)
 - Load Volume (m³)
 - Payload (kg)
 - Engine Size (cc)
 - Total Retail Price (£)

Observation

- Has the Head of Sales provided the Chief Cost Estimator the right data?



Right Tool for the Job?



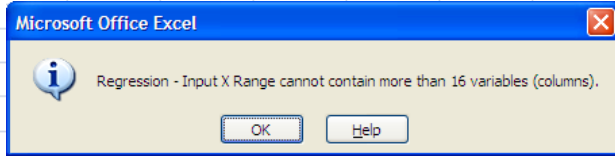
"Microsoft has repeatedly proved itself incapable of providing reliable statistical functionality." McCullough (2008)

Chief Cost Estimator Methodology

Using Excel

1. Prepares the Data in columns
2. Hold back Data points for validation purposes
3. Enable Data Analysis Toolpak and performs multiple Regression Analysis

	A	B	C	D	E	F	G	H	I
1	SUMMARY OUTPUT								
2									
3	Regression Statistics								
4	Multiple R	0.956744							
5	R Square	0.915359							
6	Adjusted R Square	0.91121							
7	Standard Error	1619.999							
8	Observations	108							
9									
15									
16									
		Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 90.0%	Upper 90.0%
17	Intercept	-9097.47	1351.243	-6.73267	9.99E-10	-11777.6	-6417.28	-11340.4	-6854.5
18	Sport	2085.341	396.7963	5.255444	8.14E-07	1298.297	2872.384	1426.687	2743.995
19	HP	70.62013	10.94107	6.454592	3.71E-09	48.91857	92.32168	52.45872	88.78153
20	CO2	71.83988	10.50615	6.837886	6.05E-10	51.00097	92.67878	54.4004	89.27936
21	Payload	2.688624	0.683096	3.935936	0.000152	1.333705	4.043542	1.554731	3.822516
22	Size	4.40454	1.293492	3.405155	0.000947	1.838905	6.970175	2.257434	6.551646



Using Specialist Software

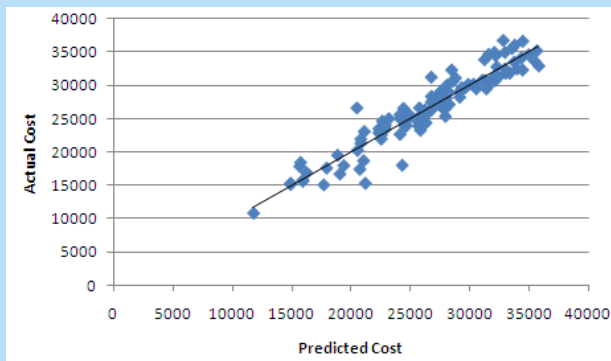
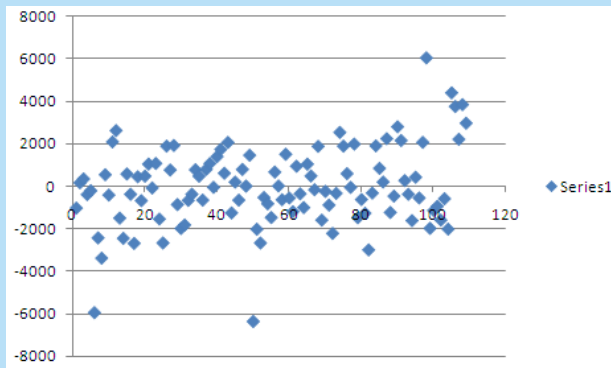
1. Prepares the Data in columns
2. Hold back Data points for validation purposes
3. Run Stepwise Regression and Best Subset analysis

Vars	R-Sq	R-Sq(adj)	Mallows Cp	S	H	M	3	g	e	C	r
1	74.6	74.4	190.6	2921.6	X						
1	72.0	71.7	221.1	3068.8						X	
2	83.1	82.8	93.6	2393.9	X						X
2	83.1	82.8	93.7	2394.7	X	X					
3	87.4	87.1	45.3	2075.3	X	X					X
3	87.0	86.7	50.0	2108.0	X	X					X
4	90.4	90.0	13.1	1825.1	X	X	X				X
4	89.6	89.2	21.7	1893.6	X	X					X
5	90.9	90.5	8.7	1780.9	X	X	X				X
5	90.9	90.4	9.3	1785.7	X	X	X	X			X
6	91.3	90.8	6.1	1750.4	X	X	X	X			X
6	91.2	90.6	8.1	1767.1	X	X	X	X	X		X
7	91.3	90.7	8.0	1757.9	X	X	X	X	X	X	X

Chief Cost Estimator Methodology

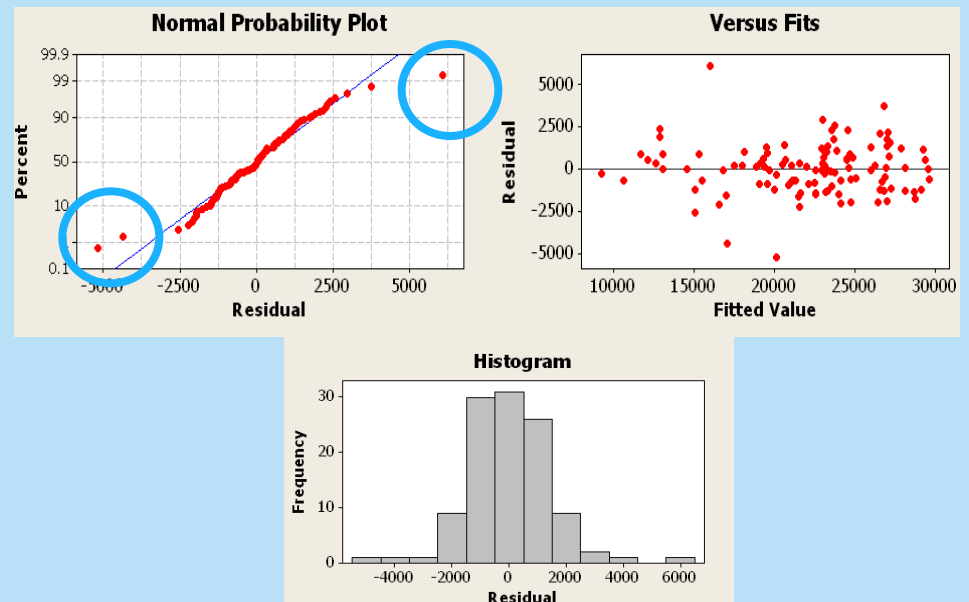
Using Excel

4. Manually plot residuals and Actual vs. Predicted Cost



Using Specialist Software

4. Analyse pre-created graphs



Observations

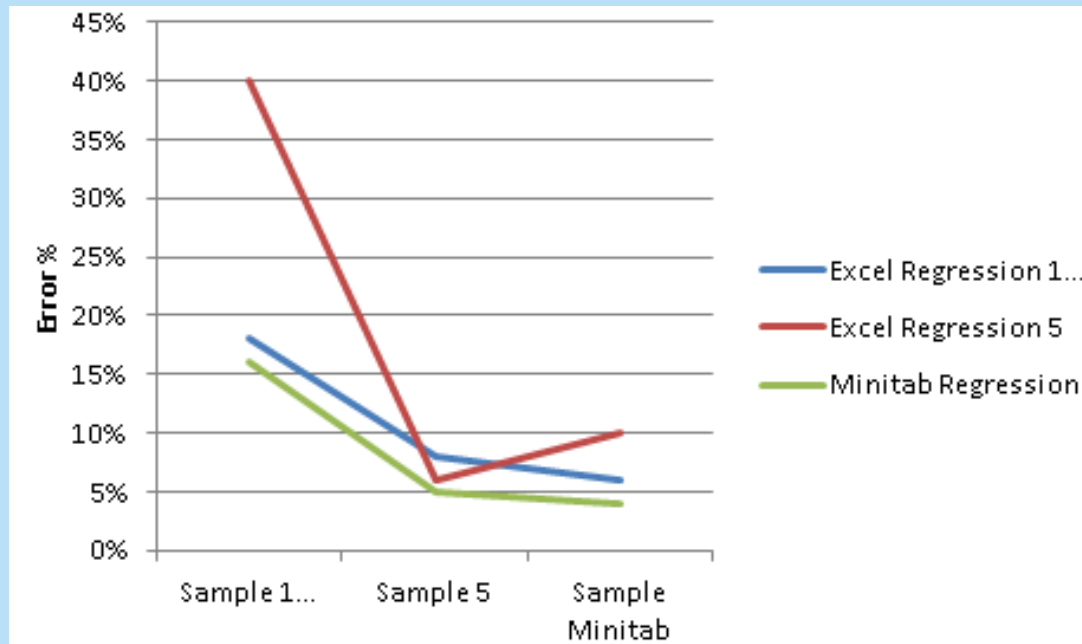
Excel Toolpak Shortcomings

- Data Analysis Toolpak not installed with standard setup.
- Inflexibility – Slightly different analysis is hard work.
- Graphs – Lack of Diagnostic graphs, user creation of graphs required.
- Algorithms – No information about the nature of the numerical algorithms.
- Collinearity – Excel does not compute collinearity measures and consequently doesn't warn user when it's present.
- Requires data in “tabular” form, rather than in “list” form, which encourages bad practice for data storage.
- Analysis toolpak is limited to 16 columns, i.e. 16 variables.
- Missing values handled inconsistently, and sometimes incorrectly.
- No log or other record to track what you have done.

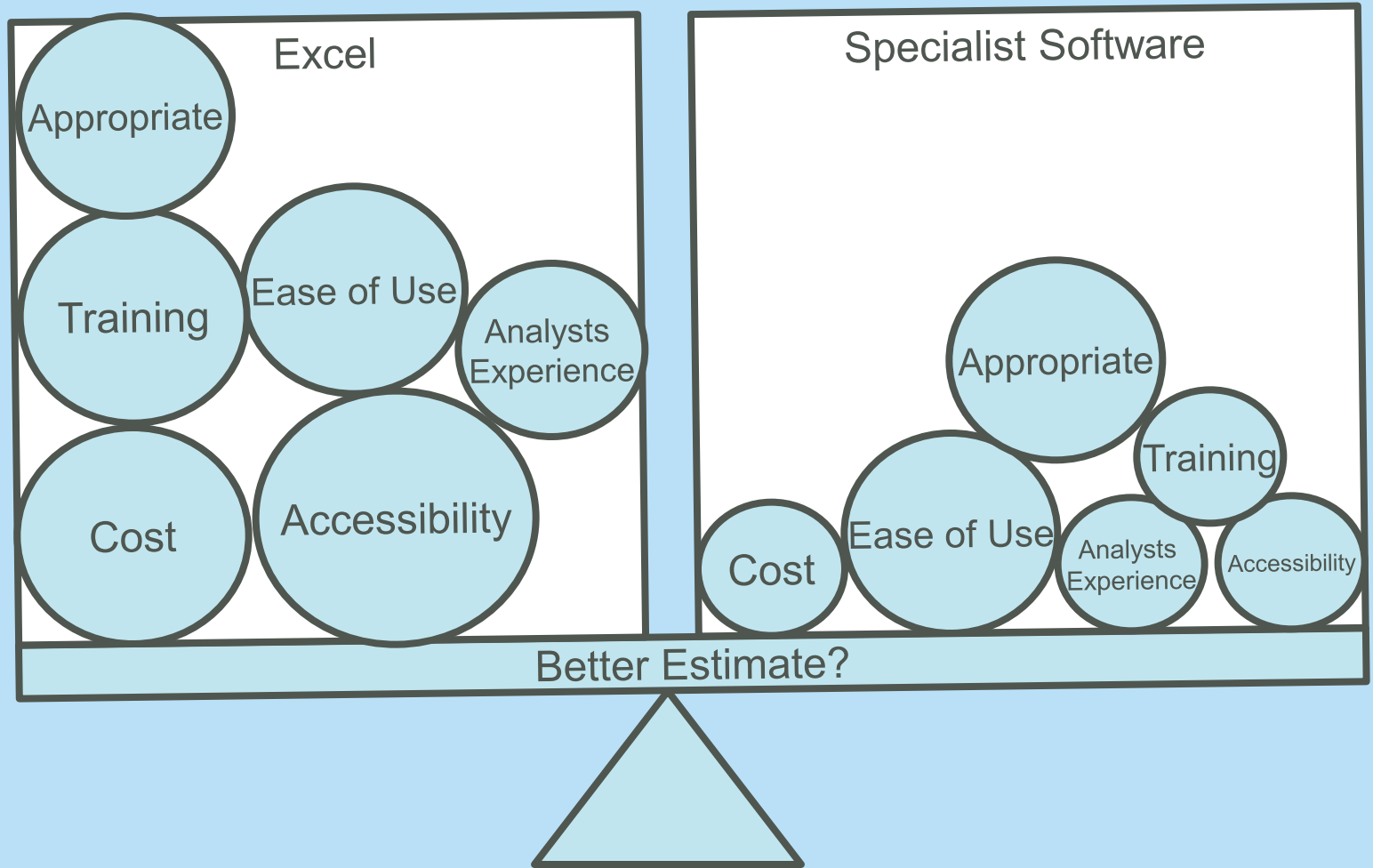
Comparison of Models

Excel vs. Specialist Software

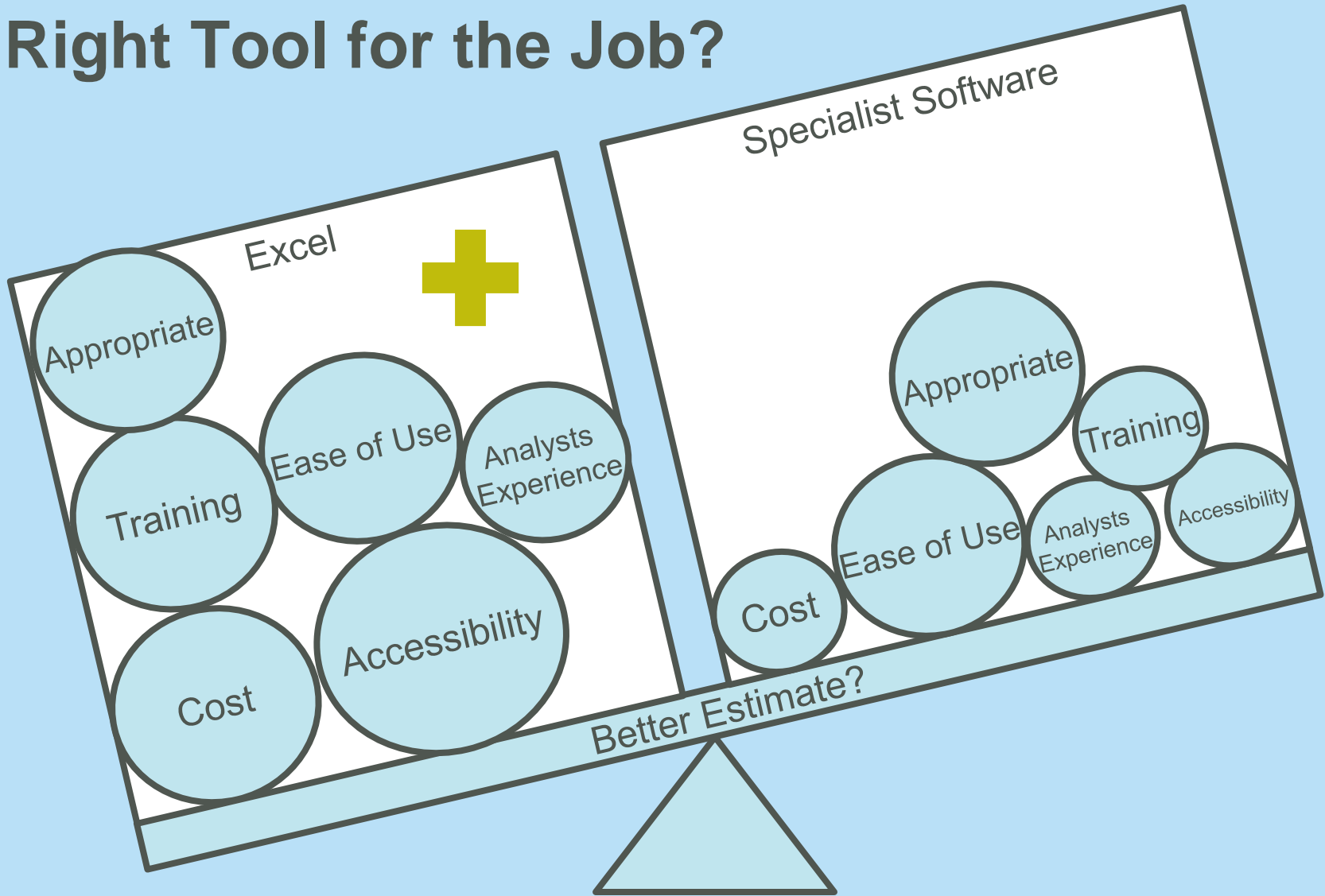
- The regression equations were tested using the data points held back from the analysis.
- The best Excel Regression was comparable to the optimised regression developed from the specialist software package.



Right Tool for the Job?



Right Tool for the Job?




The Model

Regression Equation

- 9097.47 + 2085.341 (**Sport Edition**) + 70.62013 (**Horse Power**) + 71.83988 (**CO2**) + 2.688624 (**Payload**) + 4.40454 (**Engine Size**)

Quick Pricing Tool

		Data Range
Sport	<input type="checkbox"/>	
HP	115	75-150
Engine Size	1996	1461, 1996, 2298
CO2	202	128-260
Payload	1026	650-2254



Lower	Most Likely	Upper
£23,465	£25,085	£26,705

Conclusions

- The Excel statistical analysis using a relatively easy data set for simple data analysis was comparable to the specialist software package results.
- However:
 - Excel is not a statistical data analysis package and was not principally developed to conduct advanced statistical analysis. The Data Analysis ToolPak is an “add-in” enables a few quick calculations.
 - Extensive analyses may encounter difficulties due to the following limitations:
 - Lack of flexibility;
 - Defining your own graphs, functions, formulae which is prone to error;
 - No record of what you did to generate results.

Head of Sales

Initial reaction:

- Tool requires careful use to avoid customer disappointment
- Showroom users need training in interpretation and presentation of results

Was the initial question the best?

- **Should tool be used to estimate best choice for customer based on:**
 - high level parameters
 - key considerations
 - Customer history &/or circumstances e.g. trade-in, fleet contracts

Thank you

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