

# Eusprig 2006 Commercial Spreadsheet Review

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## ABSTRACT

*This management summary provides an outline of a commercial spreadsheet review process. The aim of this process is to ensure remedial or enhancement work can safely be undertaken on a spreadsheet with a commercially acceptable level of risk of introducing new errors.*

## 1 INTRODUCTION

All successful software gets maintained (Glass, 2003). A key part to maintaining and enhancing any system is understanding how things work and how the different elements interrelate. Glass also suggests that it is more difficult to understand and maintain somebody else's work than to write from scratch (Glass, 2003).

Codematic will maintain/enhance/fix anyone's spreadsheet resources, whatever their history and current state. In order to do that as a commercial venture we need to develop a reasonable understanding of a spreadsheet in a very cost effective manner. This paper outlines the process used in the bid phase of fixed price break/fix quotes. The targets are business applications, generally of a financial nature, often as part of a Management Information System for a commercial organisation. The ideas may well be applicable elsewhere.

Most work is actually Excel based but the techniques could equally be applied in other spreadsheet applications such as Open Office Calc and Gnumeric. We also recognise the significant limitations of the spreadsheet paradigm (Murphy, 2005), and will recommend migration wherever appropriate.

Zapawa (2005) suggests the real value of a spreadsheet is the value of a good decision less the value of a bad decision based on its outputs. Another measure of spreadsheet value is the cost to develop the model – this can be millions of pounds (Croll, 2005). By either measure many spreadsheets are worth looking after.

## 2 BACKGROUND

Working with spreadsheets offers some unique challenges (for example they are generally a binary format which is more difficult to manage in a source control system). Although similar to mainstream software development in some ways, spreadsheets can also be quite idiosyncratic (Murphy, 2005). One significant barrier to understanding spreadsheets in general is the very flat object hierarchy:

<b>Spreadsheet</b>	<b>Text</b>	<b>Relational Database</b>	<b>High level code</b>
Cell	Word	Value	Instruction
Sheet	Sentence	Field	Line
Workbook	Paragraph	Record	Procedure
	Chapter	Table	Class/Module
	Document	Database	Application

Compared to other applications spreadsheets do not have many layers, this makes a gradual drill down from overview to detail difficult. Well designed spreadsheet models will often add more levels to make comprehension easier. One very useful additional layer is the analysis block, being a group of cells that perform a single analysis step.

Another issue specific to spreadsheets is the massive breadth of uses they are put to. From shopping lists to Currency Market trading applications and pretty much everything else, spreadsheets are ubiquitous in the business world and beyond.

### **3 PAPER OVERVIEW**

This paper discusses our review process, some of the tools we use and some of the reasons behind the decisions made. The primary aim of our review is to gain sufficient knowledge of a spreadsheet to:

- a. quote a fixed price to fix or enhance it
- b. Make the required changes whilst maintaining or enhancing the integrity of the model.
- c. Or recommend migration
- d. Or decline the opportunity if appropriate.

### **4 SPREADSHEET REVIEW STAGES**

The following are the main stages in our review:

1. Clarify the scope of the review – in particular the limitations.
2. Understand the spreadsheet in the wider context of the client organisations information systems
3. File Review
4. Workbook level review
5. Sheet summary
6. Inter-sheet interactions
7. Cell/Block level relationships

#### **4.1 Scope of review**

We look for insight into the abilities and attitude of the people who have been responsible for the spreadsheets development. The main question is: Is this the sort of model that can be maintained safely? Can it be maintained commercially? How important is the spreadsheet to the client? This is a superficial review, not a thorough, or complete, examination. We do not aim to ‘prove’ a model is correct, or fit for purpose, or even free from material error or fraud. Our aim is to be able to make the changes a client requires, at a price they are willing to pay. Proving a model is correct is a completely different activity. Our approach is based on the explicit assumption that the model we initially review is currently considered fit for purpose, or was until it broke.

The review assumes limited knowledge of the clients business or the purpose of the spreadsheet. These would be critical for a deep understanding, but not essential for most maintenance activities.

The client may provide additional documentation – this is likely to be out of date and irrelevant or even misleading.

Target times are really dependent on the complexity of the model, but half a day should be enough to quote. Significant further work may be required before the model can be safely edited.

#### **4.2 Spreadsheet context**

What is the spreadsheet used for? Do its outputs feed any other models? Do its outputs drive significant business decisions? Where do its inputs come from? How stable are those sources? How reliable? Does it use other technologies like databases or add-ins?

If the spreadsheet is tied closely to a back end system like a SQL Server database or Essbase, then an off-site review may be inappropriate.

#### **4.3 File Review**

All files from external sources are always scanned for viruses with the latest definitions before being allowed onto the Codemantic network.

The first step is actually outside Excel – it is reviewing the workbook properties in particular looking for any useful custom ones, and the protection status. If the workbook requires a password to open and it is not provided the review goes no further.

The review process is fairly destructive, so is always carried out on a copy of the source file. This copy also has any workbook structure passwords, worksheet protection and VBA protection removed to ease analysis.

#### **4.4 Workbook Level review**

The first step in the review is safety driven again – open the workbook with Macros and VBA disabled. Review any code for security threats and for general quality. Great insight can be gained from the code, and it often helps categorise the skill and experience level of the developer. Actual ability is less important than any apparent over confidence.

The next stage is to run XLAnalyst (free version available) to get a brief summary report. The key thing about XLAnalyst is its fast (generally just a few seconds), and gives a reasonable overview of some potential issues. The commercial version also produces a list of unique formulas which is very useful for classifying the model as complex or simple.

5		Workbook name: PLDemo.xls		E:\data\lect\PLDemo.xls				
6		Overall Risk Rating = 34% Higher value means more chance of defects. Low risk rating is not the same as defect free.						
7								
8		Summary Potential Risk Report		Results	Info	Example address	Example formula	Weighting (0-10, 10-critical)
9		<b>Factors suggesting a high risk of an error</b>						
10	2	Circular References	Not Found					10
11	2	Cells Displaying A Number But Storing Text	Not Found					10
12	2	Mixed Formulas And Values	Found			PhasingTable!\$C\$	=IF(MAX(C8:AP19)>2,"Warning some growths are more than d	10
13	2	Formulas Evaluating To An Error	Not Found					10
14	2	Hookups Expecting An Ordered List	Not Found					8
15	2	Hookups Expecting An Ordered List	Not Found					8
17		<b>Factors suggesting a significant risk of an error</b>						
18	2	Links To External Workbooks	Not Found					5
19	2	Presence Of Very Hidden Sheets	Not Found					5
20	2	Hidden Rows Or Columns	Found			PhasingTable!Colu	is hidden	3
21	2	"=" Construct	Not Found					3
22	2	Conditional Formatting	Found			North!\$E\$4	=D4+1	3
23	2	Use Of Pivot Tables	Not Found					3
25		<b>Factors suggesting complex logical modelling</b>						
26	2	Array Formulas	Not Found					8
27	2	Nested If Statements	Not Found					6
28	2	Use Of Sumif	Not Found					5
29	2	Use Of Database Functions (Dsum Etc)	Not Found					5
30	2	Use Of Indirect	Not Found					5
32		<b>Measures</b>						
33	2	Longest Formula	Within Limit	66		PhasingTable!\$C\$	=IF(MAX(C8:AP19)>2,"Warning some growths are more than d	7
34	2	Most Complex Formula	Above Limit	8		Total!\$P\$13	=IF(ROUND(SUM(D12:D12),0)<>ROUND(P12,0),"Cross Cast Er	7
35	2	Total Number Of Formulas	Above Limit	2,176				5
36	2	Total Number Of Unique Formulas	Above Limit	13				5
37	2	Workbook Size	Above Limit	132 Kb				5
38	2	No Of Worksheets	Above Limit	8				5
39	2	Total All Lines of VBA Code	Above Limit	290/9		290 Lines	In 9 Components	8
40	2	Largest Formula Result	Above Limit	2.5E+04		Total!\$P\$12	=SUM(P8:P11)	0
42		<b>System messages</b>						

1 XLAnalyst Unique Formula List report - Test Date: 25 February 2006 - 20:38:41			
2	Worksheet Name	Cell Address of first found	Formula <f> or Array Formula <af> (double click to Go
3	PhasingTable	\$R\$5	<f>=Q5+1
4	PhasingTable	\$C\$6	<f>=IF(MAX(C8:AP19)>2,"Warning some growths are
5	PhasingTable	\$C\$23	<f>=MAX(C8:AP19)
6	PhasingTable	\$C\$24	<f>=MIN(C8:AP19)
7	North	\$P\$8	<f>=SUM(D8:O8)
8	North	\$Q\$8	<f>=D8*PhasingTable!\$C8*PhasingTable!Q8
9	North	\$D\$12	<f>=SUM(D8:D11)
10	North	\$P\$13	<f>=IF(ROUND(SUM(D12:D12),0)<>ROUND(P12,0),"Cross Cast Error"

If a model receives a high XLAnalyst score then it is likely to be harder to work with, although a good overall design can more than outweigh a high score.

If XLAnalyst throws up any linked workbooks then if possible those are traced back through the (Clients) file system using an automated tool (Internal product). Tracing the links can uncover hidden circularity where through a series of files a cell references itself. This can be a very useful context setting exercise too – One client spreadsheet linked to 34 others, 14 of which were no longer available on the network. Update inconsistencies can also be highlighted here too, where a source file has a later saved date than a file that feeds from it.

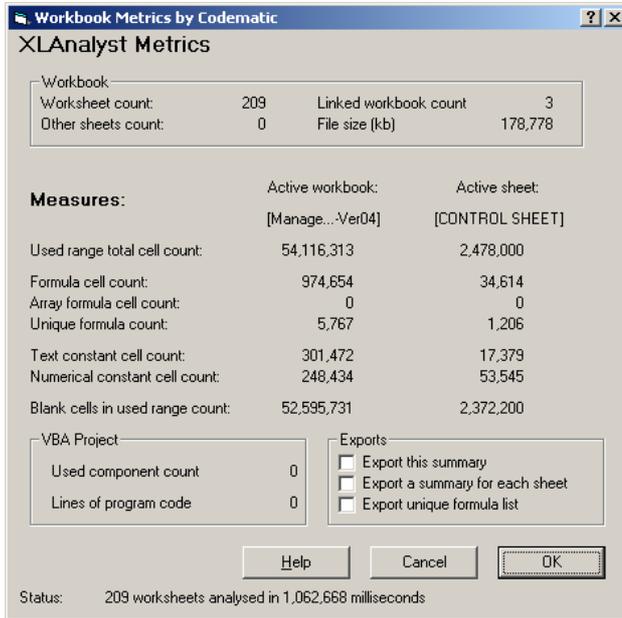
Review workbook metrics to get a sense of the type of workbook:

There are several interesting things in the following example:

1. Over 200 worksheets might suggest that potential design improvements could be made.
2. Almost a million formulas might suggest a database could be a more suitable tool for this system.
3. A very large number of blank cells in the used range would suggest some mild used range corruption, and sure enough resetting the last cell on each sheet reduced the file

size from 179Mb to 69Mb, and more importantly reduced the chance of more serious corruption later.

4. Finding the clients problem could be difficult in such as spreadsheet, this could end up as a migration job rather than a find and fix job.



Later on the exports will be used at the sheet level to summarize and give context at that level. More review effort will be spent of those sheets with more formulas and more unique formulas.

Once the workbook level context has been assessed the analysis gradually drills into the model one level at a time.

#### 4.5 Sheet Level Review

To help navigation around the model an index sheet is inserted. It contains hyperlinks to all sheets, any sheet level descriptions and the ability to group sheets together and hide and unhide them. It also makes tracking review status simple. (WorkbookStructure – available free). The workbook is reopened with macros enabled to allow the index sheet to work properly.

Use this sheet as an Index, and to control which worksheets are visible in this workbook.						Help>>>>>			
Worksheet	Description	Default address of cell containing description of each sheet		Description Source	Visible?	Worksheet groups			
		Refresh Sheets	Refresh All D details			lookups	hidden	All	
Click to follow Hyperlink Double click a description in this column to hide/unhide an individual sheet						Add 1s to rows in a column to enable			
(use back button of web toolbar to come back)						Optionally enter a (short) useful			
				Cell Address of sheet description		double click here to hide/unhide	visible	hidden	visible
<a href="#">WorkbookStructure</a>	Use this sheet as an Index, and to control which worksheets are visible in this workbook.				visible				
<a href="#">About</a>	Welcome				visible				1
<a href="#">CircRef</a>	Circular References				visible				1
<a href="#">TextNum</a>	Cells Displaying A Number But Storing Text				visible				1
<a href="#">FormConst%*2</a>	Mixed Formulas And Values				visible				1
<a href="#">FormError</a>	Formulas Evaluating To An Error				visible				1
<a href="#">VLook3</a>	Vlookups Expecting An Ordered List				visible	1			1
<a href="#">HLook3</a>	Hlookups Expecting An Ordered List				visible	1			1
<a href="#">Links</a>	Links To External Workbooks				visible				1
<a href="#">VHidSht</a>	Presence Of Very Hidden Sheets				visible		1		1
<a href="#">VHidSht2</a>	Presence Of Very Hidden Sheets				visible		1		1
<a href="#">HidRC</a>	Hidden Rows Or Columns				visible				1
<a href="#">EqPlus</a>	"=+" Construct				visible				1
<a href="#">CondForm</a>	Conditional Formatting				visible				1
<a href="#">PivTble</a>	Use Of Pivot Tables				visible				1
<a href="#">ArrForm</a>	Array Formulas				visible				1
<a href="#">NestIf</a>	Nested If Statements				visible				1



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	
1	Large Co P&L forecast																								
2																									
3																									
4	2005 Actuals/Forecast																								
5	Revenue	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act
6	Costs	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act
7	Revenue																								
8	Advertising Revenue	1269,300	186,332	401,505	50,239	714,545	169,0	237,154	192,544	73,034	191,120	259,954	211,257	249,555	219,305	184,32	401,505	50,239	214,545	169,0	237,154	192,544	211,257	249,555	
9	Circulation Revenue	180,045	173,724	214,41	830,744	197,11	325,343	75,533	310,535	216,339	304,434	140,140	55,844	23,445	139,045	173,724	214,41	230,744	197,11	325,343	75,533	310,535	216,339	304,434	140,140
10	Other Revenue	186,744	102,54	203,732	35,074	39,491	35,042	146,744	79,472	50,424	167,416	111,245	229,554	140,09	86,794	102,54	203,732	35,074	39,491	35,042	146,744	79,472	50,424	167,416	
11	Total Revenue	486,147	463,087	819,732	364,135	411,434	579,671	511,442	579,554	340,855	432,235	512,334	496,478	438,10	486,147	463,087	819,732	364,135	411,434	579,671	511,442	579,554	438,10	496,478	
12	Costs																								
13	Employment	259,071	412,075	249,495	359,374	181,851	250,324	219,37	331,402	173,709	104,045	70,952	403,332	237,122	243,078	12,2075	299,495	249,495	249,374	181,851	250,324	219,37	331,402	173,709	104,045
14	Newsprint	45,340	42,192	172,211	41,222	79,097	99,544	70,342	79,334	22,102	33,042	63,292	47,859	763,231	45,340	42,192	172,211	41,222	79,097	99,544	70,342	79,334	22,102	33,042	63,292
15	Other printing	72,240	50,559	79,732	38,043	53,850	4,383	10,709	89,124	35,340	54,032	56,003	19,793	465,457	72,240	50,559	79,732	38,043	53,850	4,383	10,709	89,124	35,340	54,032	56,003
16	Depreciation	123,934	151,704	32,701	33,062	19,159	40,304	3,200	102,231	6,684	77,574	33,332	110,334	54,424	123,934	151,704	32,701	33,062	19,159	40,304	3,200	102,231	6,684	77,574	33,332
17	Other	15,437	25,732	0,021	22,043	7,723	4,547	14,252	4,185	20,771	14,634	37,817	15,043	175,909	15,437	25,732	0,021	22,043	7,723	4,547	14,252	4,185	20,771	14,634	37,817
18	Total Costs	432,602	242,502	479,524	489,794	357,021	399,478	372,743	645,249	242,645	274,424	241,290	293,207	438,075	432,602	242,502	479,524	489,794	357,021	399,478	372,743	645,249	242,645	274,424	
19	Net margin contribution	53,545	220,585	340,102	-42,654	104,411	100,192	137,699	-15,615	17,004	332,395	264,937	203,271	190,523	53,545	220,585	340,102	-42,654	104,411	100,192	137,699	-15,615	17,004	332,395	264,937
20	ROS %	0.1101	0.4763	0.4148	-0.1165	0.2242	0.2105	0.2624	-0.0273	0.2289	0.5863	0.4957	0.4094	0.3021	0.1101	0.4763	0.4148	-0.1165	0.2242	0.2105	0.2624	-0.0273	0.2289	0.5863	0.4957

This step looks for layout logic, but also for values in the middle of formulas or text amongst numbers. If text and formulas are in clear blocks that may indicate a sound design, if they are all jumbled up the model may be harder to work with.

The next stage is to drill into the worksheets of a fresh version of the workbook and gain some understanding of what is happening at the formula level.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Large Co P&L forecast															
2																
3																
4	2005 Actuals/Forecast															
5	Act	Act	Act	Act	Act	Act	Act	Act	Act	Act	F/c	F/c	F/c	F/c	F/c	Total
6																
7	Revenue															
8	Advertising Revenue	260	187	402	50	215	160	287	183	74	101	260	211	497		
9	Circulation Revenue	130	174	214	231	157	325	76	318	216	305	148	56	350		
10	Other Revenue	87	103	204	85	90	85	140	70	50	167	111	230	440		
11	Total Revenue	486	463	820	366	462	580	511	580	341	663	618	496	286		
12	Costs:															
13	Employment	264	12	200	260	182	253	210	338	178	104	71	80	274		
14	Newsprint	46	92	67	41	70	97	71	80	22	23	68	68	763		
15	Other printing	78	51	80	38	60	4	61	50	35	55	56	20	685		
16	Depreciation	20	62	33	38	20	40	8	102	7	78	38	110	566		
17	Other	16	26	0	22	8	5	15	6	21	15	28	15	176		
18	Total Costs	433	243	480	409	357	300	374	595	263	274	261	293	381		
19	Net margin contribution	54	221	340	(43)	105	180	138	(16)	78	389	257	203	905		
20	ROS %	11.0%	47.6%	41.5%	(11.6%)	22.7%	31.1%	26.9%	(2.7%)	22.9%	58.6%	49.6%	40.9%	30.3%		

Map out all the cells flows in the sheet to see how the cells inter-relate. In many finance models the flow is to the right and downwards, other schemes may be appropriate. The main concern would be if the flows seemed almost random, such a model may be very difficult to modify safely.

The final part of the review is to step through some of the dependency trees. It is useful if the tool evaluates lookups and offsets and so on to show the actual cell being referenced. The aim here is to confirm the model works as expected based on the previous higher level work. Sometimes the dependency logic can be unclear, especially if some of the terminology is unfamiliar, this step can be very useful for generating questions for the client to help gain a deeper understanding of what the model does.

2005 Actuals/Forecast												
	4	5	6	7	8	9	10	11	12	Total	1	
£000's	Act	Act	Act	Act	Act	F/c	F/c	F/c	F/c		F/c	
Revenue												
Advertising Revenue	50	215	169	287	183	74	191	259	211	2,497	269	
Circulation Revenue	231	157	325	76	318	216	305	148	56	2,350	130	
Other Revenue	85	90	85	149	79	50	167	111	230	1,440	87	
<b>Total Revenue</b>	366	462	580	511	580	341	663	518	496	6,286	486	
Costs												
Employment	2	182	253	219	338	178	104	71	80	2,271	264	
Newsprint	41	79	97	71	89	22	23	68	68	763	46	
Other printing	38	69	41	61	59	35	55	56	20	695	78	
Depreciation	38	20	40	8	102	7	78	38	110	565	29	
Other	22	8	5	15	6	21	15	28	15	176	16	
<b>Total Costs</b>	409	357	399	374	595	263	274	261	293	4,381	433	
<b>Net margin contribution</b>	(43)	105	180	138	(16)	78	389	257	203	1,905	54	
ROS %	(11.6%)	22.7%	31.1%	26.9%	(2.7%)	22.9%	58.6%	49.6%	40.9%	30.3%	11.0%	

If the spreadsheet is reasonably well designed it should be possible to summarise the purpose of each sheet in a couple of sentences. This should be added, if not already there, somewhere (easy to find and maintain) in the sheet (A1 for example) and referenced by the index sheet. This is a useful way of measuring review progress. Once all the sheets have been reviewed it should be possible to quote or decline.

Fully detailed, comprehensive cell by cell review is not part of this process, but some elements of the model may require this additional analysis if the project is undertaken.

### 5 SUMMARY

This paper has briefly summarized one commercial approach to reviewing spreadsheets to gain some level of comfort with the analysis it performs.

The approach focuses on drilling down stage by stage, in a methodological manner, into the details of the model whilst maintaining some context.

The aim is to gain sufficient understanding to work on the model and be reasonably comfortable that new errors will not be introduced.

### 6 CONCLUSIONS

It is possible using various free tools and tools included with Excel to review a spreadsheet to a level of comfort that would permit a fixed price quote to find and fix a problem or apply an enhancement.

Whilst falling far short of ‘proving’ the correctness, or otherwise, of a model, the approach as outlined enables remedial work to be carried out within commercially acceptable risk boundaries.

### 7 REFERENCES

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