

Reducing Spreadsheet Errors

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Athens, Georgia

Environmental Benefits Analysis Seminar
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Overview

- Acknowledgements:
 - Environmental Benefits Analysis (EBA) Program
 - Reviewers: Kelly Burks-Copes, Sarah Miller, Craig Fischenich, Jodi Staebell, Virgil Langdon
 - Example Providers
- Presentation Overview:
 - Spreadsheets, Error Rates, and Model Certification
 - Planning Spreadsheets
 - Avoiding Errors
 - Finding Errors
 - Self-Improvement
 - USACE Examples

Why discuss spreadsheets?

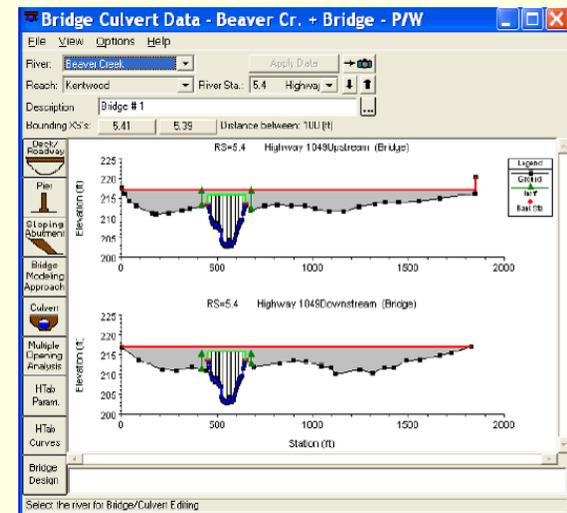
Strengths	Shortcomings
<ul style="list-style-type: none">■ Inexpensive to develop■ Readily available■ Transferable to a broad user base■ Simple, logical interfaces■ Easily understood and applied without extensive training■ Built-in tools and third-party add-ins provide computational power without extensive programming■ Current spreadsheet programs have many capabilities previously associated with more sophisticated software (e.g. optimization routines)	<ul style="list-style-type: none">■ False sense of confidence due to the easy output of “answers”■ Can quickly become complex■ Error rates can be high (90% of spreadsheets, 1-5% of cells)■ Troubleshooting and error checking may be time-consuming and difficult (as is the case with all computer programs)■ Written quality assurance and control techniques are not often applied due to reliance on self-policing

Spreadsheets & Model Certification – A match made in heaven?

- USACE EC-1105-2-407 – Model Certification
 - All planning models must be peer-reviewed and certified
 - Model = “a representation of a system for a purpose”
 - Spreadsheets are often used to represent systems and inform decisions ranging from dredging schedules to restoration outcomes to budget allocation.

	Aquatic												Nonforested Wetland											
	SM Buffalo			Wadzyne			Shovelnose			Puddletfish			Flathead		Ave HSI	TY	Acres	AARHs	Mallard	Canada Goose	Ave HSI	TY	A	
	HSI	HSI	HSI	HSI	HSI	HSI	HSI	HSI	HSI	HSI	HSI	HSI	HSI	HSI	HSI	HSI								
6	Baseline	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0	3007	30				
10	Without Project	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	1	4786	39	0.10	0.10	0.10	1
11		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	10	4786	431	0.10	0.10	0.10	10
12		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	25	4786	718	0.10	0.10	0.10	25
13		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	50	4786	1197	0.10	0.10	0.10	50
14		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01							
15																								
16																								
17																								
18	With Project	0.01	0.01	0.75	0.01	0.60	0.60	0.56	0.55	0.01	0.01	0.01	0.01	0.60	0.67	0.01	0.31	1	430	213	0.39	0.47	0.43	1
19		0.01	0.01	0.75	0.01	0.60	0.60	0.56	0.55	0.01	0.01	0.01	0.01	0.60	0.67	0.01	0.31	2	1761	344	0.46	0.53	0.49	2
20		0.01	0.01	0.75	0.01	0.58	0.60	0.56	0.55	0.01	0.01	0.01	0.01	0.62	0.65	0.01	0.31	3	2591	839	0.44	0.51	0.47	3
21	Alternative A - Pump & Gate	0.01	0.01	0.75	0.01	0.58	0.60	0.56	0.55	0.01	0.01	0.01	0.01	0.62	0.65	0.01	0.31	4	4786	1311	0.43	0.50	0.47	4
22		0.01	0.01	0.75	0.01	0.58	0.60	0.56	0.55	0.01	0.01	0.01	0.01	0.62	0.65	0.01	0.31	5	4786	1498	0.41	0.48	0.45	5
23		0.01	0.01	0.75	0.01	0.58	0.60	0.56	0.55	0.01	0.01	0.01	0.01	0.64	0.63	0.01	0.31	6	4786	1498	0.43	0.50	0.47	6
24																								
25																								
26																								
27	With Project	0.01	0.01	0.75	0.01	0.60	0.60	0.56	0.55	0.01	0.01	0.01	0.01	0.60	0.67	0.01	0.31	1	1415	310	0.39	0.47	0.43	1
28		0.01	0.01	0.75	0.01	0.60	0.60	0.56	0.55	0.01	0.01	0.01	0.01	0.60	0.67	0.01	0.31	2	1753	498	0.46	0.53	0.49	2
29		0.01	0.01	0.75	0.01	0.58	0.60	0.56	0.55	0.01	0.01	0.01	0.01	0.62	0.65	0.01	0.31	3	3500	836	0.44	0.51	0.47	3
30	Alternative B - Pump & Gate & Islands	0.01	0.01	0.75	0.01	0.58	0.60	0.56	0.55	0.01	0.01	0.01	0.01	0.62	0.65	0.01	0.31	4	4775	1308	0.43	0.50	0.47	4
31		0.01	0.01	0.75	0.01	0.58	0.60	0.56	0.55	0.01	0.01	0.01	0.01	0.62	0.65	0.01	0.31	5	4775	1495	0.41	0.48	0.45	5
32		0.01	0.01	0.75	0.01	0.58	0.60	0.56	0.55	0.01	0.01	0.01	0.01	0.64	0.63	0.01	0.31	6	4775	1495	0.43	0.50	0.47	6
33																								
34																								
35	With	0.01	0.01	0.75	0.01	0.60	0.60	0.56	0.55	0.01	0.01	0.01	0.01	0.60	0.67	0.01	0.40	1	1415	397	0.39	0.47	0.43	1

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Reducing Errors

- High error rates suggest that thorough checking, testing, and auditing are uncommon
- Four Key Techniques for Reducing Errors:
 - Planning spreadsheet development
 - Avoiding errors during development
 - Finding errors
 - Self-improvement

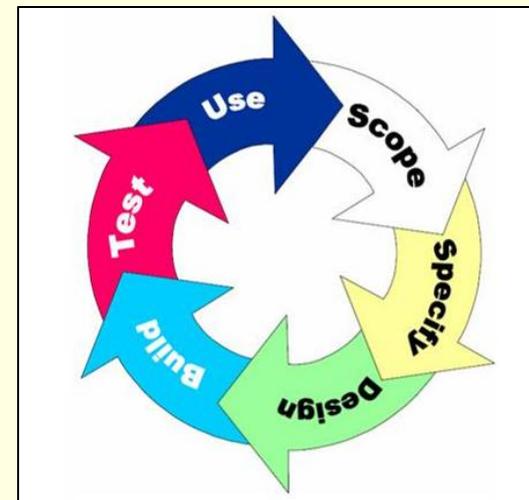
Planning Development

Who uses spreadsheets?

- Sponsor – assigns the task
- Developer – designs the spreadsheet
- Auditor – checks the validity and verifies results
- User – inputs data and operates the model
- Reader – uses the results of the model to inform decisions

What constitutes a “good” spreadsheet?

- Simple
- Relevant
- Adaptable
- Reliable
- Appropriate



Avoiding Errors: General

- Work in groups
- Build complex spreadsheets in stages and test results as you go
- Fix problem immediately – Avoid “quick fixes”
- Take advantage of Visual Basic for Applications (VBA)
- Document your work

	A	B	C	D	E
1	Length (ft)	Kyle McKay: Maximum length of the property. Measured by S.K.McKay in GIS on 5 May 2009.			
2	Width (ft)				
3					
4	Area (ft ²)	500			

Microsoft Excel - HYDROCAL_2008-11-04.xls

Model Name: HYDraulic ROughness CALculator (HYDROCAL)

Developers: Kyle McKay and Craig Fischenich
 U.S. Army Engineer Research and Development Center, Environmental Laboratory
 Athens, GA
 706-850-1974
 kyle.mckay@usace.army.mil

Model Version: HYDROCAL v1.0
 Date of Last Update: November 4, 2008

Objective of Model: Create a tool to estimate hydraulic roughness

Instructions: Check Boxes of models you would like to use
 Input parameters in green cells
 Enjoy the results in the blue cells

Waiver: This model is provided for free as part of the USACE Technical Note "Robust Prediction of Hydraulic Roughness" by S. Kyle McKay and J. Craig Fischenich
 Neither the authors nor the US Army Corps of Engineers accepts responsibility or liability for the model's use by third parties.

Color Coding Key:
 Input (Green)
 Calculated (Yellow)
 Linked to Another Sheet (Orange)
 Output (Blue)
 Model Error (Red)

Model Estimates Manning's n
 All units are SI

HYDraulic ROughness CALculator (HYDROCAL): User's Manual

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 Craig.J.Fischenich@usace.army.mil

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Avoiding Errors: General (cont)

- Descriptively name cells, rows, columns, worksheets, and workbooks
- Use reference styles and locations correctly.
- Use security features
- Delete extraneous information and cells
- Be forewarned. Copy/paste and autofill errors are common

	A	B	C	D	E	F	G
1	Input			x	y		
2	Calculation			-10	200		
3				-9	0		
4	$y = ax^2 + 2bx$			-8	$=B8*(D4^2)+2*B9*D4$		
5				-7	0		
6	a	2		-6	0		
7	b	0		-5	0		
8				-4	0		
9				-3	0		
10				-2	0		
11				-1	0		
12				0	0		

Avoiding Errors: Logic and Calculation

- Complicated expressions are potentially hazardous
- Avoid “hard-wiring” constants into formulas
- Maintain a common interval for calculation
- Arrange inputs close to calculations
- Reserve circular references as error detection tools. Learn to apply GoalSeek and Solver instead.

	A	B	C	D	E
1	x	2		Input	
2	y	8		Calculation	
3					
4	$y = x^2 + 2x$				
5					
6					
7					
8					
9					
10					

Solver Parameters

Set Target Cell:

Equal To: Max Min Value of:

By Changing Cells:

Subject to the Constraints:

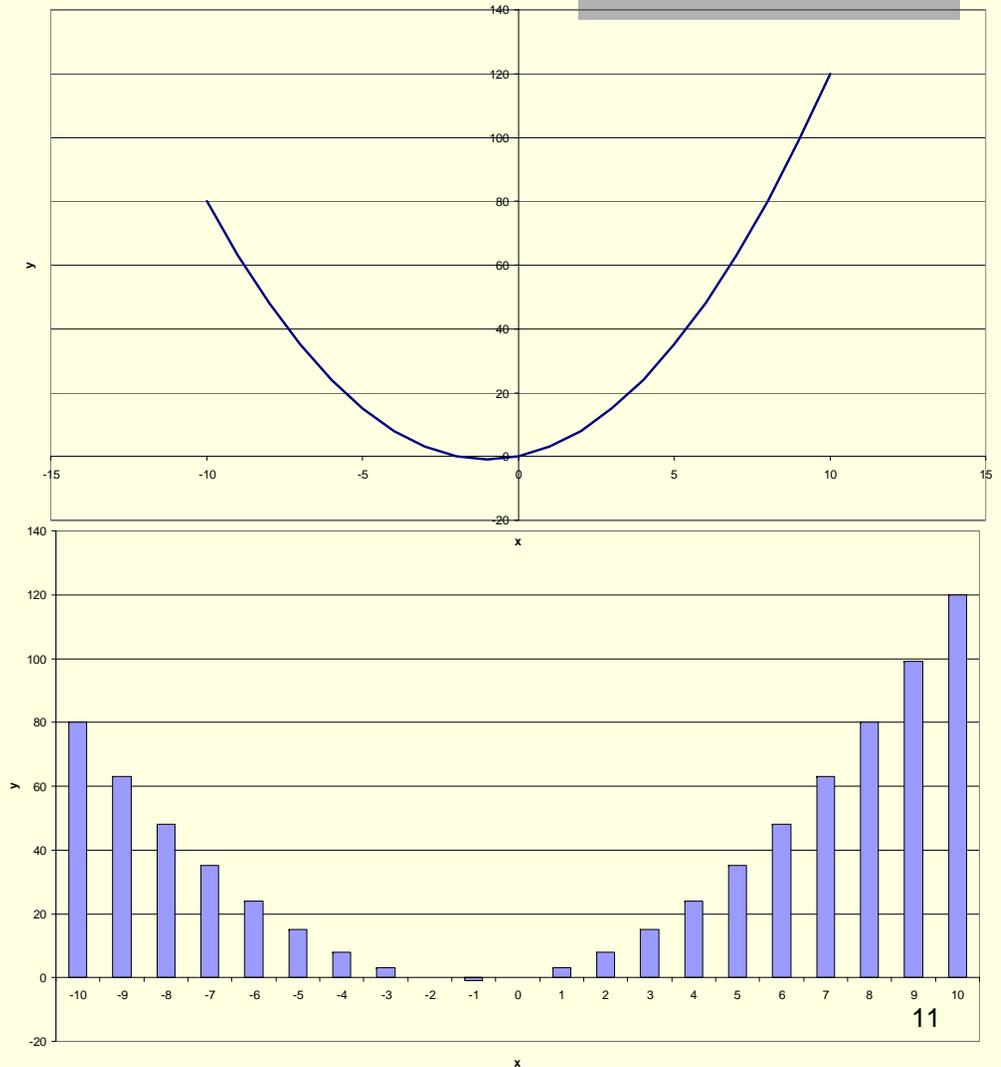
Avoiding Errors: Formatting and Labeling

- Make your spreadsheet read top-to-bottom & left-to-right
- Do not turn the grid off
- Format for function, not for decoration
- Organize your spreadsheet based on functionality (e.g. input, calculation, output)
- Remember significant figures
- Make blank cells look blank

	A	B	C	D	E
1	Length (ft)	10		Input	
2	Width (ft)	50		Calculation /Output	
3					
4	Area (ft ²)	500			

Avoiding Errors: Figures

- Use the right chart for the job
- Consider changing chart location
- Modify charts such that all data sets are visible
- Think twice about scale on charts



Finding Errors

- Who should look for errors?
 - THE WHOLE TEAM: Developers, Auditors, Users, Readers
- Review during construction
- Use cross-checks and validation points
- Test spreadsheets
- Inspect all formulas
- Use auditing tools (next slide)

	A	B	C	D
1	Length (ft)	10		Input
2	Width (ft)	50		Calculation /Output
3				
4	Area (ft ²)	=B1*B2		
5	Perimeter (ft)	=2*B1+2*B2		

How are audits conducted?

Auditing Tools

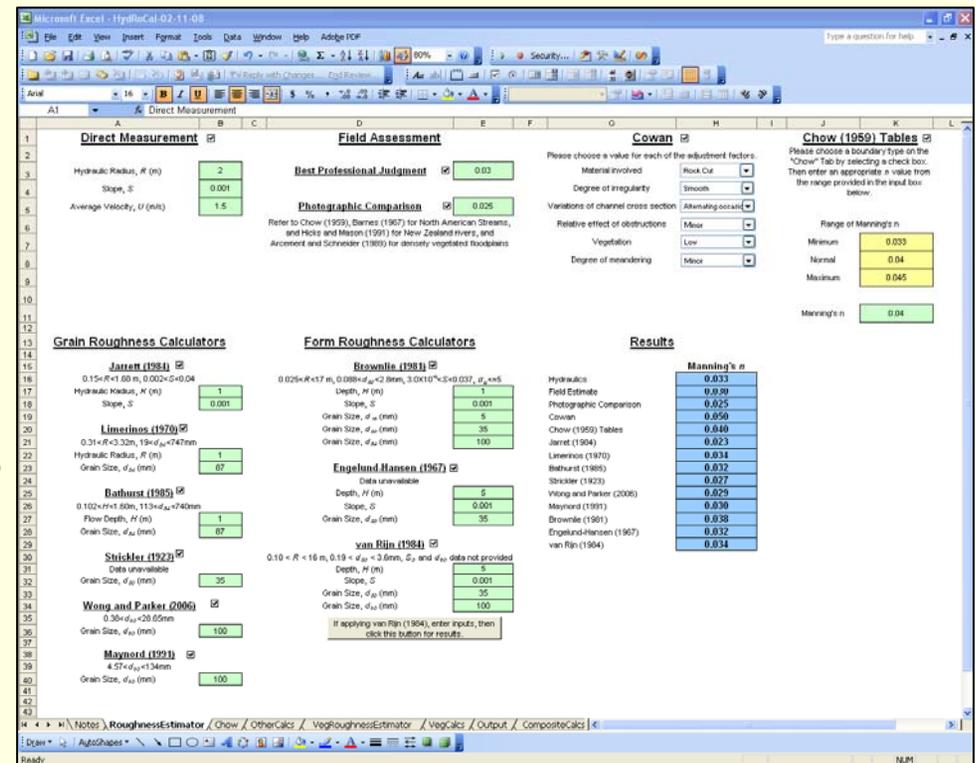
- Microsoft Excel Built-In Auditing Tools
 - “Formula Auditing” toolbar
 - Warning messages
- XL Analyst – <http://www.xlanalyst.co.uk>
- Spreadsheet Professional – www.spreadsheetinnovations.com
- Operis Analysis Kit – www.operis.com/oak.htm
- Spreadsheet Detective – <http://www.spreadsheetdetective.com/>
- XLSior – www.xlsior.com

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6	Overall Risk Rating = 83% Higher value means more chance of defects. Low risk rating is not the same as defect free																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
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What about other errors?

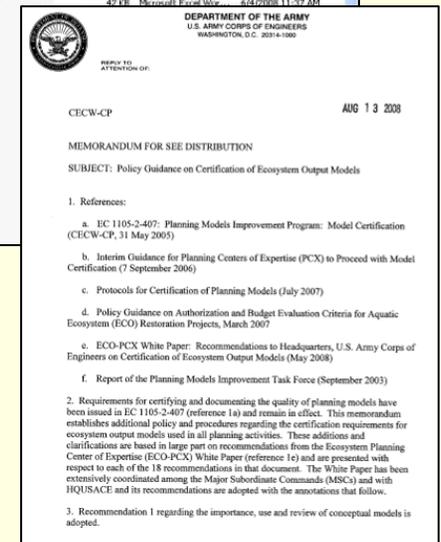
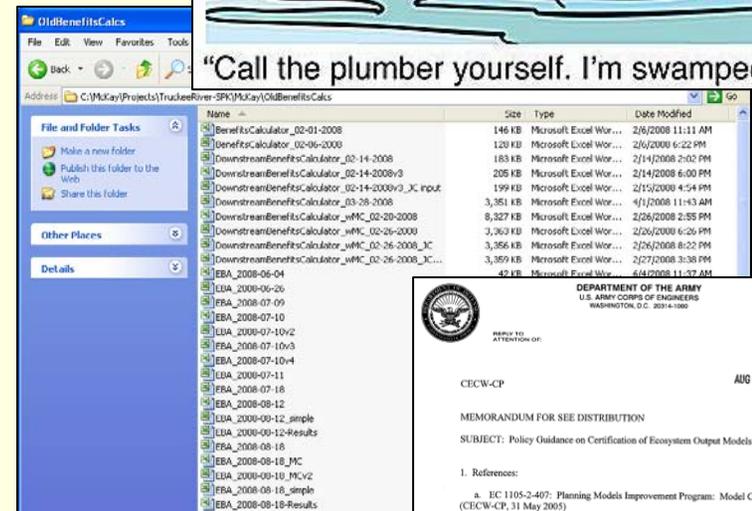
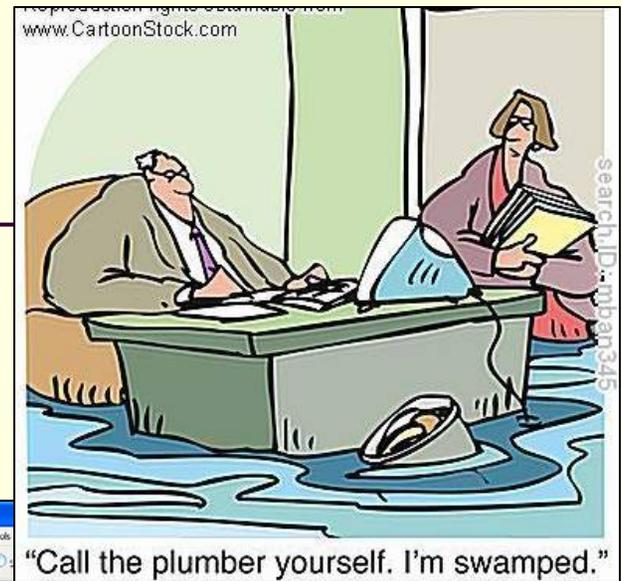
- Many errors lie outside the realm of what model developers can control

- Data errors
- Input errors
- User errors
- Inappropriate application
- Conceptual errors
- Misinterpretation of results
- Deliberate errors



Self-Improvement

- Be humble
- Be consistent
- Don't be caught by avoidable errors
- Stay organized
- Be a student of spreadsheets
- Develop corporate policy (e.g. Model Certification initiative)
 - Risk-based
 - Train developers, users, and readers in potential hazards, avoidance, and self-audit.
 - Modeler accountability must be addressed.
 - Train auditing specialists



AAHU Calculator 2

Microsoft Excel - McKay_Wetland_AAHU_6_3_09.xls

File Edit View Insert Format Tools Data ApproveIt Window Live Meeting Help

Type a question for help

Security...

Reply with Changes... End Review...

Ac abl

Microsoft Excel

This workbook contains links to other data sources.

- If you update the links, Excel will attempt to retrieve the latest data.
- If you don't update the links, Excel will use the previous information.

Note that data links can be used to access and share confidential information without your permission and possibly perform other harmful actions. Do not update the links if you do not trust the source of this workbook.

Update Don't Update Help

		Aquatic																			
		Criter 1			Criter 2			Fish 1			Fish 2			Fish 3			Ave HSIs	TY	Acres	AAHUs	Criter
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6	Baseline	0.0	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0	3007	30	0.10
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18	Alternative A	0.01	0.01	0.75	0.01	0.58	0.60	0.56	0.55	0.01	0.01	0.01	0.01	0.62	0.65	0.01	0.31	3	3591	839	0.39
19		0.01	0.01	0.75	0.01	0.58	0.60	0.56	0.55	0.01	0.01	0.01	0.01	0.62	0.65	0.01	0.31	4	4786	1311	0.46
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21		0.01	0.01	0.75	0.01	0.58	0.60	0.56	0.55	0.01	0.01	0.01	0.01	0.62	0.65	0.01	0.31	6	4786	1498	0.41
22		0.01	0.01	0.75	0.01	0.58	0.60	0.56	0.55	0.01	0.01	0.01	0.01	0.64	0.63	0.01	0.31		4786	1498	0.43
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28	Alternative B	0.01	0.01	0.75	0.01	0.60	0.60	0.56	0.55	0.01	0.01	0.01	0.01	0.60	0.67	0.01	0.31	1	1415	318	0.39
29		0.01	0.01	0.75	0.01	0.60	0.60	0.56	0.55	0.01	0.01	0.01	0.01	0.60	0.67	0.01	0.31	2	1753	498	0.46
30		0.01	0.01	0.75	0.01	0.58	0.60	0.56	0.55	0.01	0.01	0.01	0.01	0.62	0.65	0.01	0.31	3	3580	836	0.44
31		0.01	0.01	0.75	0.01	0.58	0.60	0.56	0.55	0.01	0.01	0.01	0.01	0.62	0.65	0.01	0.31	4	4775	1308	0.43
32		0.01	0.01	0.75	0.01	0.58	0.60	0.56	0.55	0.01	0.01	0.01	0.01	0.62	0.65	0.01	0.31	5	4775	1405	0.41

Ready NUM

Where else can I go for spreadsheet best practices?

- Microsoft Office Online, <http://office.microsoft.com/en-us/excel/default.aspx>
- European Spreadsheet Interest Group (EUSPRIG), www.eusprig.com
- John Walkenbach, Spreadsheet Expert, <http://spreadsheetpage.com/>
- Ray Panko, University of Hawaii, <http://panko.shidler.hawaii.edu/>
- John Raffensperger, University of Canterbury, <http://www.mang.canterbury.ac.nz/people/jfraffen/>
- Stephen Powell, Dartmouth College, <http://mba.tuck.dartmouth.edu/pages/faculty/steve.powell/>
- Systems Modeling Ltd., <http://www.sysmod.com/>
- Richard Brenner, <http://chacocanyon.com/smm/>

Conclusion

It's good to ask 'Is your spreadsheet right?' but confidence comes from answering the question 'How do you know your spreadsheet is right?' That's a really tough question. If all you can say is that you're a Spreadsheet Super Man, you should hang up your blue tights and red cape and stop writing spreadsheets. But it would be most impressive if you could say:

I followed accepted best-practice in developing my spreadsheet. I designed my work carefully, and reviewed it when I was finished, using a commercial auditing tool. I tested the spreadsheet using known results, according to a written test plan, and compared to other similar work. Knowing that the result was important, I had Bob, Mary and Joe peer-review my work. There could still be mistakes, but I was at great pains to prevent them.

What's your answer?

Phillip Bewig (2005)

Questions and Feedback

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Environmental Benefits Website

<http://cw-environment.usace.army.mil/eba/>

Current and Forthcoming Publications:

McKay. (2009). Reducing Spreadsheet Errors. ERDC TN-EBA.

Fischenich. (2009). Monte Carlo Simulation in Excel. ERDC TN-EBA.



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Reducing Spreadsheet Errors

By: S. Kyle McKay

OVERVIEW: Increasing computational power and memory capacity in desktop computers has resulted in access to numerical techniques previously unavailable to many users. Although computational capabilities have increased, many users are unable to take full advantage of this power due to limited programming expertise. Spreadsheets offer these users a means to capitalize upon computational potential without extensive training, though spreadsheet models can confer risks due to high error rates and lack of quality control. Table 1 presents several strengths and weaknesses of using spreadsheets as numerical tools for the masses.

Strengths	Shortcomings
<ul style="list-style-type: none">• Inexpensive to develop• Easily available• Transferable to local user base• Simple logical interfaces easily written and applicable to routine tasks• Built-in tools and help pages provide computational power without extensive programming• Current spreadsheet programs have many capabilities previously associated with more sophisticated software (e.g., integration routines)	<ul style="list-style-type: none">• Table size or complexity due to the easy addition of "answers"• Capacity become complex• Error rates are high• Troubleshooting and error checking may be time-consuming and difficult (as in the case with different user-developed programs)• Varies greatly in accuracy and control techniques are not often applied due to reliance on copy/pasting

Both researchers and practitioners have cautioned users about high rates and consequences of errors in spreadsheets (Panko 2005; Payer 2007; Powell et al. 2009). Computer programming and finance literature have shown that, regardless of complexity, errors generally occur in approximately 90% of spreadsheets (Panko 2005; Powell et al. 2008b) and 1-5% of cells (Panko and Sprague 1998; Panko 2005; Powell et al. 2009). People typically commit undetected errors in approximately 0.5% of simple mechanical tasks (e.g., typing) and error rates increase with complex logical tasks (e.g., programming; Panko 2005). Consequently, if five percent of cells contain errors, then complex spreadsheets with thousands of cells are likely to contain mistakes.

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