Twenty principles for good spreadsheet practice

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Foreword by Filtered

Congratulations to ICAEW and the IT Faculty on the successful launch of the seminal spreadsheet principles work.

The Filtered team has enjoyed a close relationship with the Institute's IT Faculty team for almost four years and it's a delight to see both ICAEW and colleagues in our industry celebrate the launch of what we believe is a transformative accomplishment which will significantly enhance the work of accountants and non-accountants around the world.

Reducing risk is essential for businesses of all sizes. We have all read about some of the horror stories of spreadsheet errors costing multi-nationals billions. But what about the thousands of pounds lost unnoticed every day by ordinary businesses around the world as a result of spreadsheet error, miscommunication and the like?

ICAEW's Twenty Principles are an excellent first step to help firms of all sizes avoid such losses. The Principles have been written in such a way as to enable you to interpret and adopt as you think best. We think they form an excellent basis and catalyst for this kind of better spreadsheet thinking and practice.

Finally, and as advocates of these principles and lovers of spreadsheets ourselves, we urge you and your teams to continue (or in some cases start) enjoying the huge benefits that can be derived from good spreadsheet use. Spreadsheets have helped us to solve or at least better understand countless business problems over the years.

They also serve as a wonderful vehicle for teaching the next generation about business, critical thinking and mastering data.

Marc Zao-Sanders
Managing Director

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Preface

Like it or not, spreadsheets are in use everywhere. They have become the lingua franca of business; no matter what your system or requirement, a spreadsheet can connect people like no other business tool.

However, the use of spreadsheets is not without risk, and approximately 90% of spreadsheets contain mistakes. Material errors such as incorrect models, sending out sheets with hidden columns or careless use of formulae, have been well publicised alongside the embarrassment and financial loss that arise as a result.

In addition, there is a serious problem of waste arising from spreadsheets that are created inefficiently or carelessly. 65% of members of the Excel Community are self-taught, and with no formal methodology there is a risk that sub-optimal models and processes become the norm.

This is why ICAEW's Excel Community Advisory Committee came together to develop *Twenty principles for good spreadsheet practice* that look to reduce spreadsheet risk and inefficiency in all organisations regardless of size or sector.

I would like to thank all the members of the committee for developing these principles, and would encourage readers to act on the recommendations in this report.

Michael Izza
Chief Executive Officer, ICAEW

Why twenty principles?

Many spreadsheets evolve over time without well-structured design or integrity checks, and are poorly documented. Making a relatively simple change can often take a long time, have unexpected consequences and/or result in errors from incorrect calculations or input assumptions, as famously illustrated by debacles such as the bidding process for the West Coast mainline franchise.[1]

The purpose of these principles is to help reduce the amount of time wasted, and the number of errors caused, by businesses (including accountancy practices) as a consequence of the way they and their employees use spreadsheets.

There are several points to emphasise. First, no set of principles or standards can guarantee freedom from error. The design, maintenance and operation of spreadsheets are still carried out by humans.

Secondly, this document is not only about 'good spreadsheet design'. The business environment in which spreadsheets are created, maintained and used is at least as important. So the first four principles are ones we believe should be adopted by an organisation before anyone starts to work on any individual spreadsheet-using project. They are intended to create a framework, and to instil attitudes, which encourage best-practice to flourish. These principles are addressed not only to those directly involved in the design and use of spreadsheets but also to those with managerial responsibility, including responsibility for management of risk. They may also be of interest and relevance to those with responsibility for audit.

Third, these are 'principles', not 'standards'. By way of example, Principle 2 requires clarity and consistency in the use of formatting. This could mean using a particular cell colour to denote cells allowing user input. There might be any number of different corporate standards, or publicly available standards, that adhere to this principle. One standard might specify pink as the colour for input cells; another might specify green. Either would satisfy the principle.

Finally, this set of principles is not meant to be comprehensive, nor is it meant to be very detailed. Deliberately it focuses mainly on traditional formula-driven spreadsheet construction, which still accounts for the vast majority of spreadsheet use, rather than on pivot tables, structured references etc. It is a 'top 20' list, with each principle set out simply and concisely, and with some explanation and illustration added.[2] It would of course be possible to provide much more detail than this, and to produce a much longer document. These principles are intended to be very widely applicable, and are intended to cover projects of all shapes and sizes and degrees of complexity. As technology, and the ways people use it, evolves, the priorities set out here may need to change, and so the IT Faculty intends to keep these principles under regular review.

[1] In October 2012, at significant cost to the taxpayer, the Department for Transport had to withdraw the contract to run the West Coast Mainline rail service from the company that had 'won', after it was discovered that there had been errors in the way the bids had been assessed. It was widely reported (for example theguardian.com/politics/2012/oct/05/west-coast-civil-servant-transport) that the spreadsheet used for the calculations was seriously flawed.

[2] Excel 2013 is used for the illustrations. If you are using an earlier version, some of the screenshots will look different, and some features may not be available.

The twenty principles
explained and illustrated

The spreadsheet's business environment

	A	B	
11	Total sales	10000	=
12	Total sales	10000	=
13			
14			
15			

1. Determine what role spreadsheets play in your business, and plan your spreadsheet standards and processes accordingly

If you have spreadsheets that play a key or critical role in your organisation, ensure that they are developed and tested, managed and monitored to an appropriate level. Spreadsheets that form part of an organisation's key business processes will need to be managed differently from ad hoc spreadsheets for short-term use by an individual.

2. Adopt a standard for your organisation and stick to it

This might be one that is developed in-house, or adopted from outside and shared with other organisations. A common standard within an organisation facilitates collaboration, aids understanding and saves development time. The standard should include, among other things, consistent conventions on use of cell formatting.
This may be achieved by using the 'cell styles' feature as illustrated below.
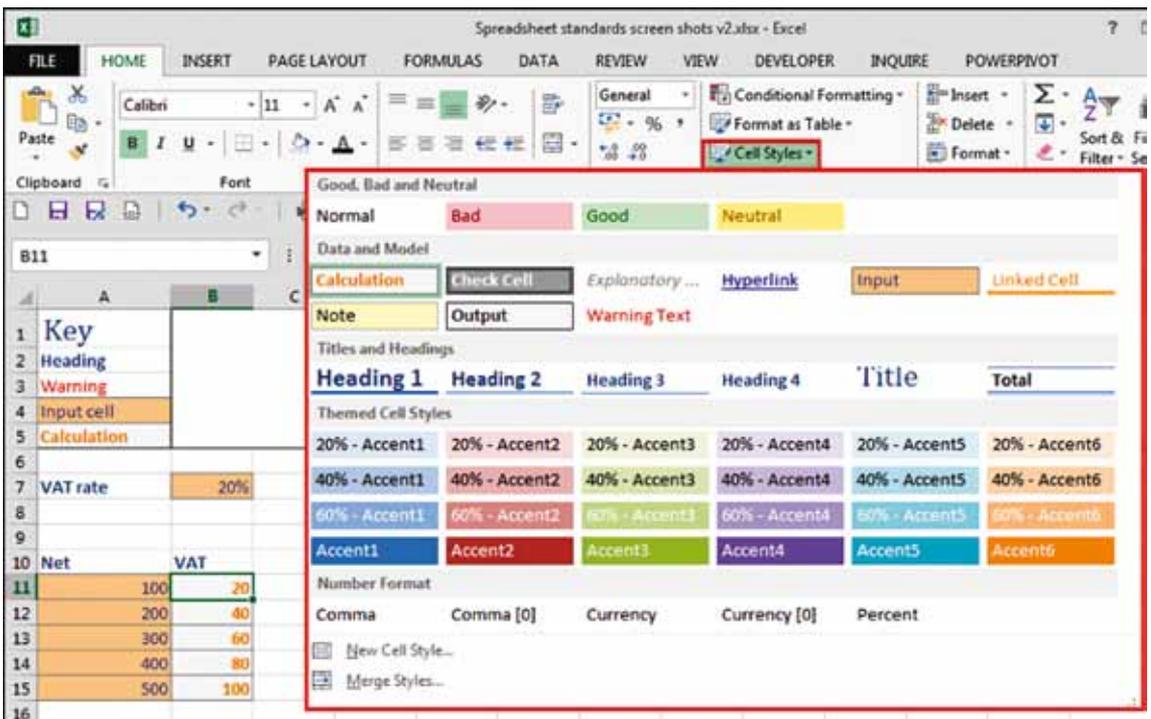
Trademark acknowledgements: Excel is a registered trademark of Microsoft Inc. Screenshots reprinted by permission from Microsoft Corporation.

3. Ensure that everyone involved in the creation or use of spreadsheets has an appropriate level of knowledge and competence

For anyone designing, developing or maintaining (as distinct from just using) a spreadsheet, this will include: awareness of the range of functions available, clear understanding of such basic concepts as relative and absolute cell references, and an appreciation of the importance of carefully checking the results of functions.

4. Work collaboratively, share ownership, peer review

The extent of collaboration and review needed will depend on the size and complexity of your organisation and of each project.

The twenty principles explained and illustrated

Designing and building your spreadsheet
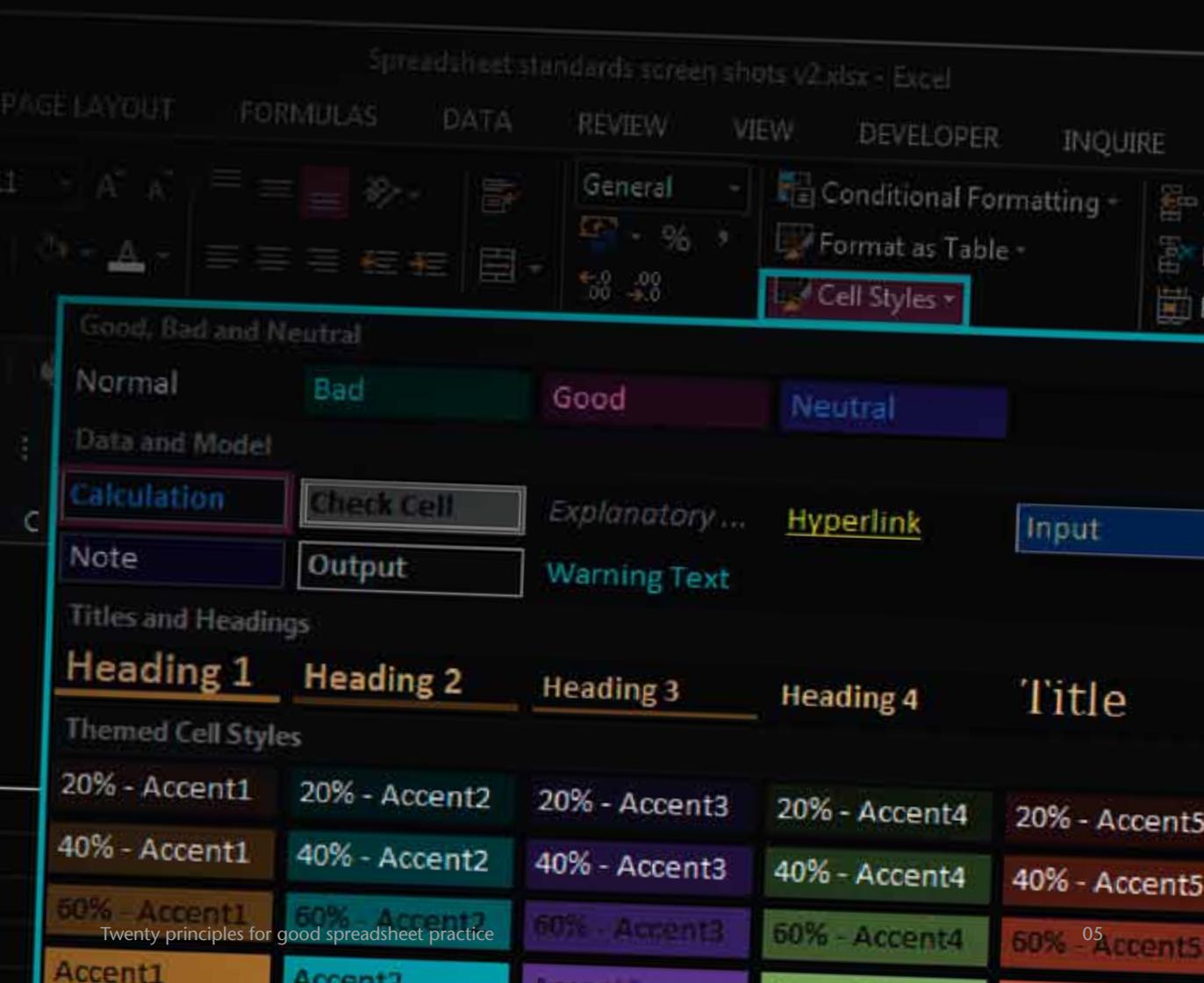
5. Before starting, satisfy yourself that a spreadsheet is the appropriate tool for the job

Spreadsheets are not the answer to every problem. A lot of time can be wasted, and errors caused, by using a spreadsheet when some other application would be more appropriate. Very often the more appropriate tool might be a word processor (if it's a table of text), a database (if it's processing large quantities of similar data items) or an existing software package (if it's to undertake well-established processes, such as bookkeeping, for which specialist packages are readily available). Even if a spreadsheet is still the right answer it's worth looking for existing templates before starting a new one from scratch.

6. Identify the audience. If a spreadsheet is intended to be understood and used by others, the design should facilitate this

If the only 'audience' envisaged is yourself, you might perhaps justify less explanation and help. Even so, good documentation is helpful if you come back to a spreadsheet a while after you created it; and many spreadsheets come to have a much wider audience than originally intended. Ensure that adequate instructions, validation and help are included to promote ease of use and avoid input errors. Even if parts of a spreadsheet are 'locked', keep calculations visible.

7. Include an 'About' or 'Welcome' sheet to document the spreadsheet

This should give such basic information as author, purpose, version number, and description of general approach. Also include explanations of colour codes and other formatting conventions, any sources of input data (with, where appropriate, hyperlinks to the original data), and any macros and what they do. The more complex the workbook, or the more it needs to be shared, the greater the requirement for good documentation. Conversely, a simple spreadsheet to be used only by the person who designs it might be less rigorously documented.

	A	B
1	Key	
2	Heading	
3	Warning	
4	Input cell	
5	Calculation	
6	Explanatory text	
7	Author	James Page
8	Purpose	Provide interactive analysis of company's sales data
9	Version	1.02
10	General approach	The data is accessed via a refreshable link direct to the company's sales system. A set of PivotTables is used to summarise the data to produce the analysis required to provide the figures for an interactive dashboard

Sheet tabs: About | Index | Assumptions | Che ...

8. Design for longevity

Design spreadsheets to adapt to any reasonably foreseeable future changes in values (tax rates, etc) or volume (eg, items in a data set) of data used in calculations. However, the need for adaptability should be balanced against following the Agile principle of 'The simplest thing that could possibly work'.

	A	B	C	D
11	Total sales	10000	=SUM('Dept A:Dept D'!B1)	✓
12	Total sales	10000	='Dept A'!B1+'Dept B'!B1+'Dept C'!B1+'Dept D'!B1	✗
13				
14				

In the first example above, if an organisation were to add a new department, a new worksheet could be added anywhere between DeptA and DeptD (DeptC1, for instance), and there would be no need to change the formula as the new worksheet would automatically be picked up by the formula. In the second example above, the formula would need to be changed every time a new worksheet is added.

9. Focus on the required outputs

Work backwards: be clear about the purpose of the spreadsheet, what outputs achieve that purpose and therefore what inputs and logic are required to derive the outputs.

# 10. Separate and clearly identify inputs, workings and outputs

A properly structured spreadsheet will be easier to understand and to maintain.
If pivot tables are used, it may be possible to relax this principle, but clarity remains crucial. Design to ensure that any input should be entered only once.

	ShipNa ▾	ShipAd ▾	ShipCity ▾	ShipRe ▾	ShipPos ▾	ShipCo ▾	Custom ▾	Custom ▾	Addres ▾
14	Ernst Hanc	Kirchgasse	Graz		8010	Austria	ERNSH	Ernst Hanc	Kirchgas
15	Ernst Hanc	Kirchgasse	Graz		8010	Austria	ERNSH	Ernst Hanc	Kirchgas
16	Ernst Hanc	Kirchgasse	Graz		8010	Austria	ERNSH	Ernst Hanc	Kirchgas
17	Ernst Hanc	Kirchgasse	Graz		8010	Austria	ERNSH	Ernst Hanc	Kirchgas
18	Split Rail E	P.O. Box !	Lander	WY	82520	USA	SPLIR	Split Rail E	P.O. Box
19	Split Rail E	P.O. Box !	Lander	WY	82520	USA	SPLIR	Split Rail E	P.O. Box
20	Chop-suey	Hauptstr. ;	Bern		3012	Switzerlan	CHOPS	Chop-suey	Hauptstr.
21	Chop-suey	Hauptstr. ;	Bern		3012	Switzerlan	CHOPS	Chop-suey	Hauptstr.
22	Chop-suey	Hauptstr. ;	Bern		3012	Switzerlan	CHOPS	Chop-suey	Hauptstr.
23	La maison	1 rue Alsa	Toulouse		31000	France	LAMAI	La maison	1 rue Als

◄ ► ... **Data** | Summary | Report ... ⊕ ⋮
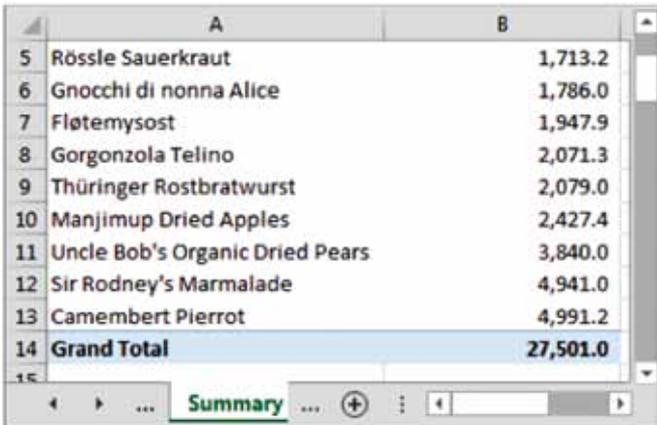
	A	B
5	Rössle Sauerkraut	1,713.2
6	Gnocchi di nonna Alice	1,786.0
7	Fløtemysost	1,947.9
8	Gorgonzola Telino	2,071.3
9	Thüringer Rostbratwurst	2,079.0
10	Manjimup Dried Apples	2,427.4
11	Uncle Bob's Organic Dried Pears	3,840.0
12	Sir Rodney's Marmalade	4,941.0
13	Camembert Pierrot	4,991.2
14	**Grand Total**	**27,501.0**

◄ ► ... **Summary** ... ⊕ ⋮

◄ ► ... Data | Summary | **Report** ... ⊕ ⋮
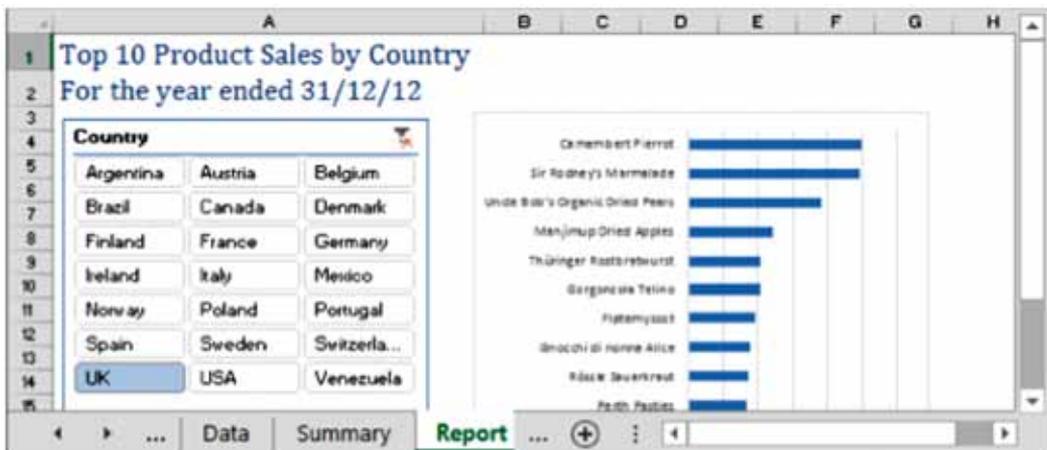
11. Be consistent in structure

Use the same columns for the same things in each workbook, especially when working with time series. A consistent convention within a workbook reduces the risk of error where one sheet refers to another. For example, a common convention is that time flows horizontally from left to right (and a specific column is always 'Year 1') and calculations flow vertically from top to bottom. Such a structure will help to avoid circular references.

12. Be consistent in the use of formulae

On any worksheet use the smallest practicable number of different formulae. Where it is necessary to use different formulae, ensure that groups of cells using the different formulae are clearly separated.

In the left-hand example above, the formula =$A15*B$11 in cell B15 has been copied across and down to all the cells in the range B15:D24, whereas in the right-hand example, because the $ sign was not used, a formula had to be entered manually into each of the 30 cells in turn. This significantly increased the risk of error and the time needed to review the worksheet. 'Go To Special' – 'Column differences' is an error-checking process looking for inconsistencies. In the left-hand example it generates the message 'No cells were found', meaning that there are no inconsistent formulae; in the right-hand example cells K16:K24 remain highlighted, showing that the formulae in that range are different from the one used in K15 at the top of the column.

13. Keep formulae short and simple

Shorter formulae are easier to build (and therefore less likely to contain errors) and easier to understand and to review. Stage a calculation through multiple cells rather than build a long, complex formula.

	A	B	C	D	E	F	G	H
11		Search for position of -	Number of characters in cell	Start of value (from right)	Value (as text)	Value		
12	Sales-10000	6	11	5	10000	10000		
13	Cost of sales-2000	14	18	4	2000	2000		
14	Admin expenses-3100	15	19	4	3100	3100		
15		=SEARCH("-",A14)	=LEN(A14)	=C14-B14	=RIGHT(A14,D14)	=VALUE(E14)	✓	
16								
17		Value						
18	Sales-10000	10000						
19	Cost of sales-2000	2000						
20	Admin expenses-3100	3100						
21		=VALUE(RIGHT(A20,LEN(A20)-SEARCH("-",A20)))					✗	
22								

14. Never embed in a formula anything that might change or need to be changed

Instead, put such values into separate cells and reference them. This ensures that values enter the spreadsheet only once, and if change is needed would happen in just one place. It also allows for all formulae cells to be locked without denying access to input values.

In the left-hand example above, the VAT amounts in B15:B24 and E15:E24 have been calculated by a formula and the cells in those ranges have been locked and the sheet protected (which is why clicking into one of them produces the message displayed). In the right-hand example, the formulae in the equivalent cells included the VAT rate as a figure rather than as a reference to a cell containing the rate. In this example, if the VAT rate were to change, each formula containing the VAT rate as a figure would need to be identified and changed manually – running the risk of introducing errors in the rate entered or in the actual formula. Additionally, in the right-hand example the formulae were not protected, and they appear to have been manually overwritten by mostly wrong values.

15. Perform a calculation once and then refer back to that calculation

Do not calculate the same value in multiple places (except perhaps for cross checking purposes). This reduces risk of error, and is more efficient, since fewer calculations are being performed.

16. Avoid using advanced features where simpler features could achieve the same result

In particular, avoid using programming code unless necessary – in which case ensure that it is clearly documented within the code itself, as well as in a documentation worksheet. Similarly, avoid circular references, and control and document any exceptions. Do not change the software's key default settings (for example, do not turn off automatic recalculation) unless essential, in which case include a prominent message to warn users.

The twenty principles
explained and illustrated

Spreadsheet risks
and controls

17. Have a system of backup and version control, which should be applied consistently within an organisation

The appropriate levels of backup and version control will depend on the organisation and the nature of the work, but there should always be, at the very least, a reliable means of preserving, identifying and restoring earlier versions of a workbook.

18. Rigorously test the workbook

The level of testing required will depend on the size, complexity and criticality of the workbook, with riskier workbooks needing a greater degree of independent testing.

	01/04/1991	01/07/1998	01/12/2008	01/01/2010
Exempt	1.00%	10.00%	100.00%	1000.00%
Zero	2.00%	20.00%	200.00%	2000.00%
Standard	3.00%	30.00%	300.00%	3000.00%
Reduced	4.00%	40.00%	400.00%	4000.00%

Type	Date	VAT rate	Net	Gross
Exempt	01/04/1991	1.00%	1.00	1.01
Zero	01/04/1991	2.00%	1.00	1.02
Standard	01/04/1991	3.00%	1.00	1.03
Reduced	01/04/1991	4.00%	1.00	1.04
Exempt	30/06/1991	1.00%	1.00	1.01
Zero	30/06/1991	2.00%	1.00	1.02
Standard	30/06/1991	3.00%	1.00	1.03
Reduced	30/06/1991	4.00%	1.00	1.04
Exempt	01/07/1998	10.00%	1.00	1.1
Zero	01/07/1998	20.00%	1.00	1.2
Standard	01/07/1998	30.00%	1.00	1.3
Reduced	01/07/1998	40.00%	1.00	1.4
Exempt	30/11/2008	10.00%	1.00	1.1
Zero	30/11/2008	20.00%	1.00	1.2
Standard	30/11/2008	30.00%	1.00	1.3
Reduced	30/11/2008	40.00%	1.00	1.4

This example illustrates the use of 'trace precedents', which shows all the cells which affect the value of the currently selected cell and 'trace dependents', which shows all the cells containing formulae that refer to the active cell.

19. Build in checks, controls and alerts from the outset and during the course of spreadsheet design

These checks might include, for example, tests to ensure that a balance sheet balances, assets do not depreciate below zero, and so on. One approach would be to build in a set of audit tests to check validity and use flags to signal compliance or non-compliance. Use a master flag to summarise all the individual flags and place it prominently (on the output sheet, or even throughout the workbook eg, on sheet headers) so that users are bound to see it.

Checks

Analysis check	OK			
Interest rate	OK	InterestRate		
	£			
Blues	25,000		Interest rate upper limit	10%
Rock	12,000		Interest rate lower limit	2%
Classical	7,000			
Soul	6,000		Interest rate	8%
	50,000			
UK	30,000			
USA	12,000			
Rest of World	8,000			
	50,000			

Checks 🔴

Analysis check	OK			
Interest rate	🔴 Interest rate is above upper limit by 2.00%	InterestRate		
	£			
Blues	25,000		Interest rate upper limit	10%
Rock	12,000		Interest rate lower limit	2%
Classical	7,000			
Soul	6,000		Interest rate	12%
	50,000			
UK	30,000			
USA	12,000			
Rest of World	8,000			
	50,000			

In the second of the two examples above, the actual interest rate that has been input is 12%, which is 2% above the upper limit – hence the warning 'red spots' and the explanatory error message.

20. Protect parts of the workbook that are not supposed to be changed by users

The level of protection will vary according to the nature of the spreadsheet and the kind of use/users it will have. It might include locking whole worksheets, all cells containing formulae, or everything except designated input cells.
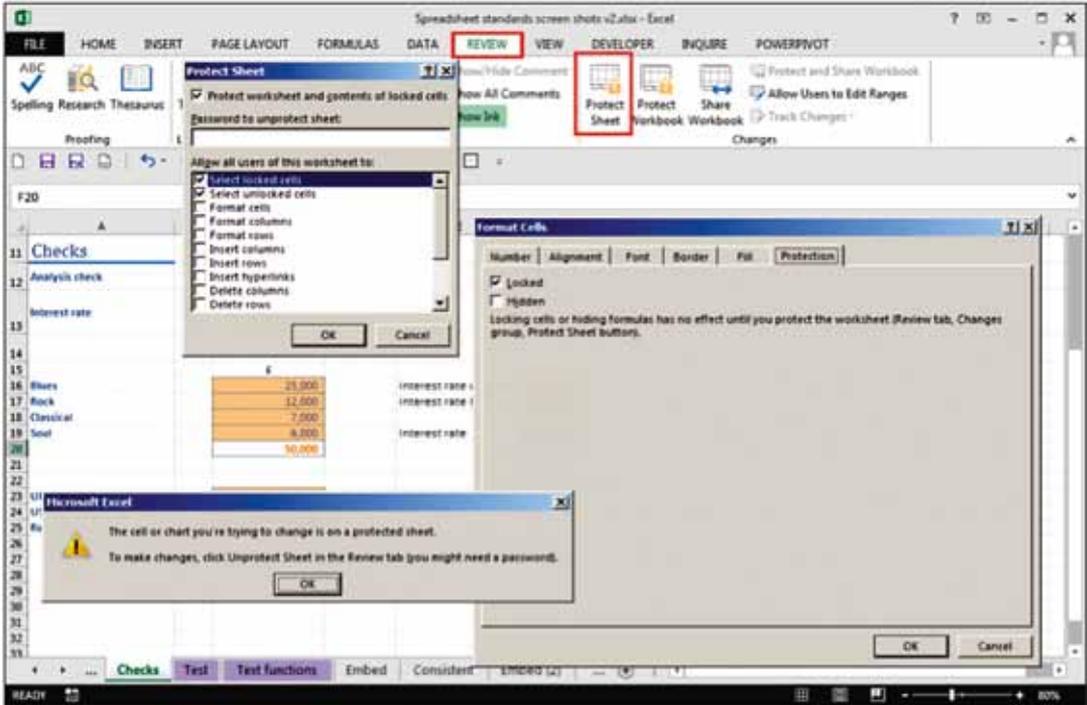
Acknowledgments

Twenty principles for good spreadsheet practice is the result of debate among members of the IT Faculty's Excel Community Advisory Committee, who saw the document through a number of drafts over several months, and then took on board comments from the wider ICAEW membership and the public. The members of the Excel Community Advisory Committee are as follows:

Christopher Blunn	Grace Frank
Tom Brichieri-Colombi	Mazars
Roland Brook	Smith & Williamson
Grenville Croll	EuSpRIG
Daniel Emkes	Harrow School
Glen Feechan	needaspreadsheet.com
Simon Hurst	The Knowledge Base
Alistair Hynd	Baker Tilly
Tony Lee	Global Aerospace
David Lyford-Smith	BDO
Adrian Maconick	Finsbury Solutions
Sanjay Magecha	Financial Visibility
Vinit Patel	Filtered
Rishi Sapra	KPMG
John Tennent	Corporate Edge
Paul Wakefield	Paul Wakefield
Dave White	White Bruce

Recognition of spreadsheet standards

The IT Faculty has developed a scheme whereby spreadsheet standards, and other products and services such as training, can be formally recognised as compliant with the Twenty Principles.

So far, one such standard has been submitted for recognition, and has been successful. That is the FAST Modelling Standard: see www.fast-standard.org.

The FAST Modelling Standard is recognised by ICAEW as being compliant with its *Twenty principles for good spreadsheet practice*.[1]

The twenty principles in brief

The spreadsheet's business environment

1. Determine what role spreadsheets play in your business, and plan your spreadsheet standards and processes accordingly.

2. Adopt a standard for your organisation and stick to it.

3. Ensure that everyone involved in the creation or use of spreadsheets has an appropriate level of knowledge and competence.

4. Work collaboratively, share ownership, peer review.

Designing and building your spreadsheet

5. Before starting, satisfy yourself that a spreadsheet is the appropriate tool for the job.

6. Identify the audience. If a spreadsheet is intended to be understood and used by others, the design should facilitate this.

7. Include an 'About' or 'Welcome' sheet to document the spreadsheet.

8. Design for longevity.

9. Focus on the required outputs.

10. Separate and clearly identify inputs, workings and outputs.

11. Be consistent in structure.

12. Be consistent in the use of formulae.

13. Keep formulae short and simple.

14. Never embed in a formula anything that might change or need to be changed.

15. Perform a calculation once and then refer back to that calculation.

16. Avoid using advanced features where simpler features could achieve the same result.

Spreadsheet risks and controls

17. Have a system of backup and version control, which should be applied consistently within an organisation.

18. Rigorously test the workbook.

19. Build in checks, controls and alerts from the outset and during the course of spreadsheet design.

20. Protect parts of the workbook that are not supposed to be changed by users.

Excel is one of the most popular end-user tools in the accountant's portfolio. Spreadsheets enable us to quickly and flexibly perform analysis that otherwise would be difficult or time-consuming; however, there is a tendency to place undue trust in them. ICAEW's Excel Community provides a 'one-stop shop' for accountants who want to use Excel better and understand and minimise spreadsheet risk.

For more information about the Excel Community, please visit icaew.com/excel For more information about the IT Faculty, please visit icaew.com/itfac

ICAEW is a world leading professional membership organisation that promotes, develops and supports over 142,000 chartered accountants worldwide. We provide qualifications and professional development, share our knowledge, insight and technical expertise, and protect the quality and integrity of the accountancy and finance profession.

As leaders in accountancy, finance and business our members have the knowledge, skills and commitment to maintain the highest professional standards and integrity. Together we contribute to the success of individuals, organisations, communities and economies around the world.

Because of us, people can do business with confidence.

ICAEW is a founder member of Chartered Accountants Worldwide and the Global Accounting Alliance.

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