

Going Beyond Spreadsheets: how visual modeling can enhance decision analysis

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Background and Overview

Spreadsheets have been around since the late 1970s. They were an instant sensation. Among other things:

- They were intuitive.
- They transformed the way people analyzed data.
- They were extremely easy and cost effective to deploy.

Over the years, spreadsheets have evolved and matured, but the basic form and substance of spreadsheets has hardly changed. While new features and capabilities continue to be added to spreadsheets, for the most part spreadsheet technology has reached a plateau. This is typical of a highly successful product.

**THE MORE THINGS
CHANGE THE MORE THEY
REMAIN THE SAME**

The principal changes you see to spreadsheets tend to be incremental. The kinds of improvements you may notice would be things like better support for multiple languages, connecting to web based resources, and PivotTables being able to handle a greater number of rows.

Such enhancements or faster calculation speed only serve to more tightly bind the spreadsheet paradigm to what it's been all along. The technology is, to be sure, terrific. However, it is becoming clear that new approaches and paradigms should and are beginning to emerge.

THE NEXT KILLER APP

At some point, the next “Killer App” will be introduced and it will entirely usurp Excel and traditional spreadsheets. How will that Killer App manifest itself? It will contain three crucial ingredients. Not surprisingly, these are the same ingredients that allowed spreadsheets to be labeled a Killer App a couple of decades ago.

- The Killer App will be intuitive to understand and use.
- It will totally transform how data analysis is done.
- It will be extremely easy and cost effective to deploy.

There are a lot of vendors with non-spreadsheet products who would lay claim to these attributes, but these features alone do not qualify an application as a Killer App.

A myriad of products introduce major innovations and are signaling a paradigm shift. However, most of these promising technologies and products focus on a tightly defined application or use. This funneling or narrowing of scope makes them particularly effective tools, but their applications find use in a restrictive range.

It is far more revealing when the use and innovations involving products and technologies are being shaped more by the user community than by the original developers.

Spreadsheets and Decision Analysis

It’s worth a moment to reflect on the different ways spreadsheets are used in decision analysis. Table 1 outlines representative examples.

TABLE 1. Common forms of Decision Analysis using spreadsheets

Type	Detailed Description	Additional Comments
Binary and Discrete Decisions	Often takes the form of a Yes/No type of questions.	Often this lends itself to statistics hypothesis testing.
Analog Decisions	Often takes the form of “How Much?” such as in a financial projection or forecast.	Uncertainty analysis and sensitivity analysis can be easily incorporated into analog decisions.
Data Folding (or Digital Origami)	Often takes the form of PivotTables, multidimensional analysis, or drilling down.	Drill down or sub-sectioning data is important.
Search	Can be as simple as using Excel functions like VLOOKUP, or could be a full blown system connecting to back-end databases and servers.	Data exchange using XML and Web Services are being used.

TABLE 1. Common forms of Decision Analysis using spreadsheets

Type	Detailed Description	Additional Comments
Optimization	Can be as simple as using the Goal Seek facility of Excel, or may entail involved mathematical techniques.	When performing large scale optimizations, Excel is usually used to shuttle information back and forth to 3rd party analysis engine that does all the hard work.
Verification	Spreadsheets can be used in summarizing, analyzing, reconciling complex data.	Challenges exist with incomplete information, incorrect assumptions & formulas, inconsistent data (relationships that point to conflicting outcomes), and redundant information.

The one thing that may become clear is that sophisticated decision analysis is often accompanied by a tool or technology that requires sophistication on the part of the user to apply it. The major exception to this rule is the digital dashboard.

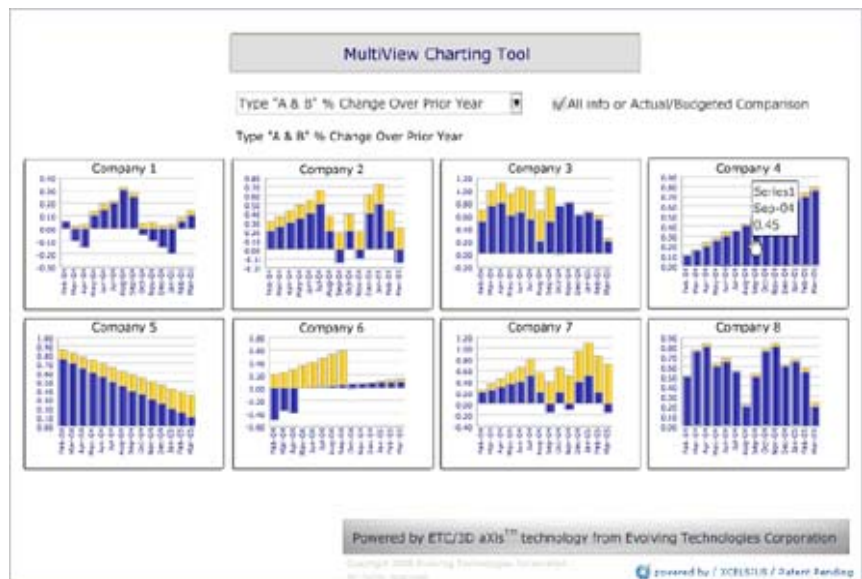
Digital Dashboards & Visual Models

The very notion of a digital dashboard is to provide a single point from which all relevant information can be seen, interpreted, and acted upon. Though traditional spreadsheets are capable of providing dashboard-like functionality, it requires some effort to go from a static report to one that is highly interactive.

SAMPLING OF DIGITAL DASHBOARDS AND VISUAL MODELS

FIGURE 1. Dashboard allowing simultaneous view of Key Performance Indicators and metrics

Generic Dashboard. There are many types of dashboards. They often display Key Performance Indicators or metrics (as shown in Figure 1).

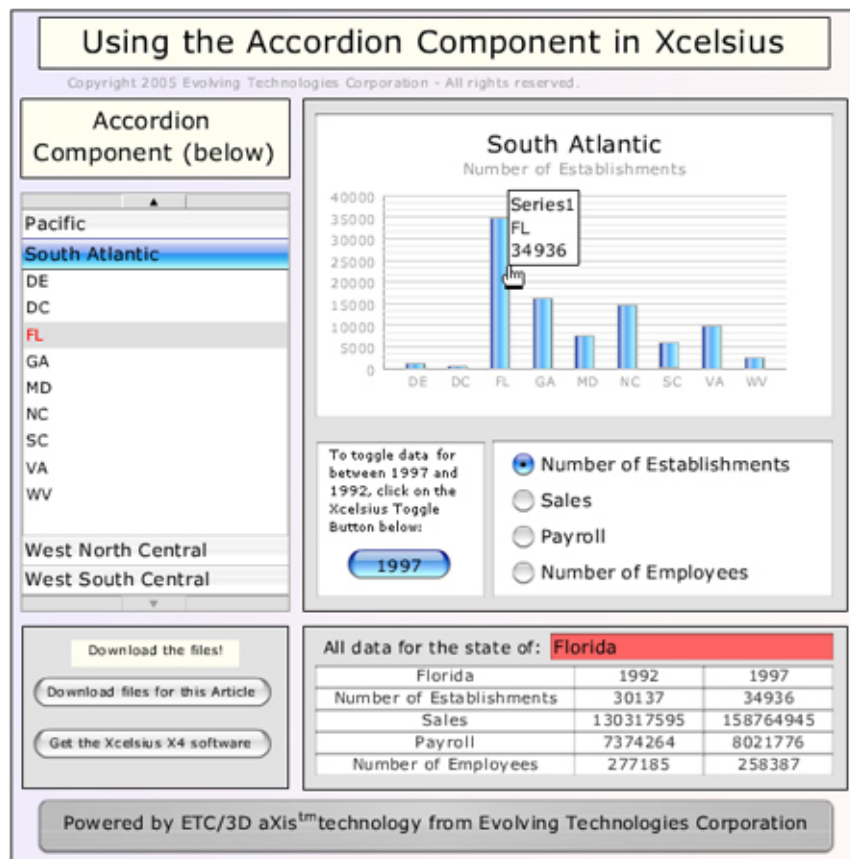


Digital Origami. While it is nice to have a single panel on which to view everything, the information that a decision maker may need to examine may be complex. Figure 2 shows a browsing tool based on an “Accordion” style organizer. In this scenario, there are a variety of broad based categories. For each of these categories there are subcategories.

There are two key features to notice:

1. The items selected in the categories and subcategories create a context from which to do further analysis. In the example illustrated in Figure 2, clicking on a specific state (FL) automatically retrieves a swath of data for that state.
2. The items that will be treated as categories and subcategories can be determined at runtime. It becomes possible to turn the subcategory into a category, allowing for further drill down, if the data is available.

FIGURE 2. *Accordion Data Viewer*



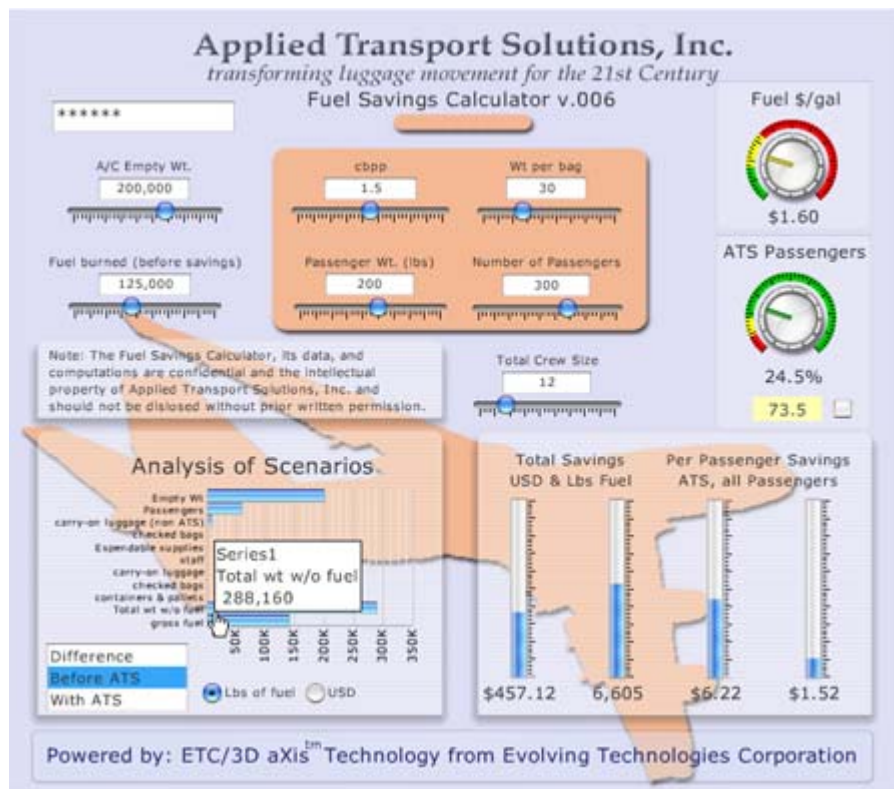
Visual Modeling Dashboard. A dashboard can be connected to the underlying dataset or model. So why not utilize the underlying model to create an interactive visual model? It would allow you to change the underlying data, and see the results immediately on the dashboard. Figure 3 shows a Fuel Savings Calculator for airlines that does this.

You will notice that there are various knobs and sliders to adjust the underlying assumptions in the model. Basically, this visual model connects to an Excel spreadsheet and database to calculate estimates of fuel and cost savings.

This fuel savings tool is both a dashboard and a visual model. While it assembles and retrieves data for presentation, it also harnesses the computational facilities of an underlying spreadsheet model and allows the user to adjust assumptions using sliders, dials and other visual input interfaces.

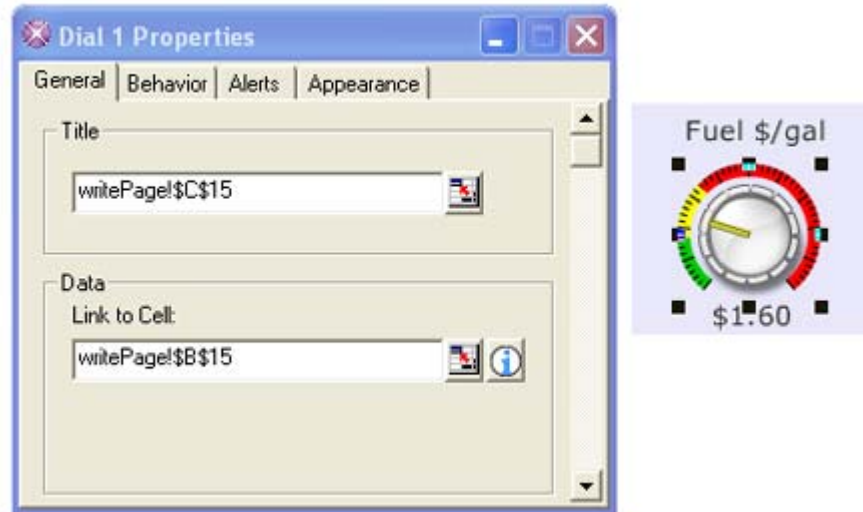
In this visual model there are pick lists, check boxes, and radio buttons that allow for context switching. Context switching is important, as it allows multiple views and scenarios to dynamically change during the decision analysis.

FIGURE 3. Fuel Savings Calculator



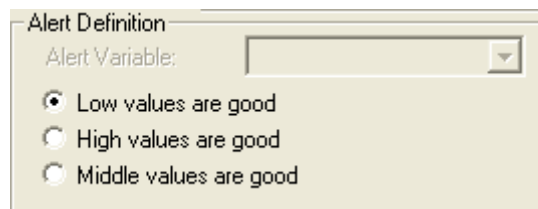
Another feature to notice is that there are automatic alert levels integrated into the visual model components (Figure 4).

FIGURE 4. Components connect to an underlying spreadsheet model



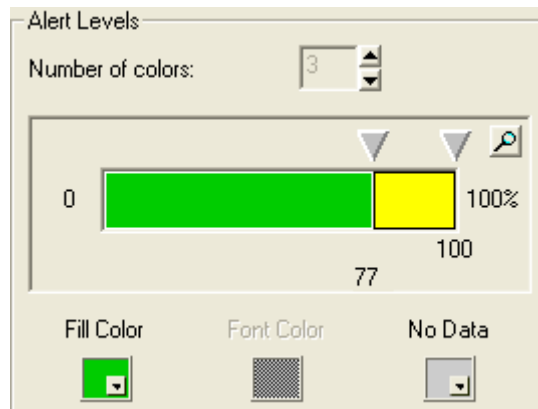
These components routinely allow for the incorporation of colored alerts (Figure 5). In this case, the needle or dial indicator changes color as values are changed.

FIGURE 5. Colors Scheme for Alerts needs to be specified



Alert values for each color can also be set, as is shown in Figure 6.

FIGURE 6. Alert Levels also need to be specified



NEW APPROACHES TO OLD PROBLEMS

The concept of visual modeling using the dashboard metaphor opens new avenues for decision analysis.

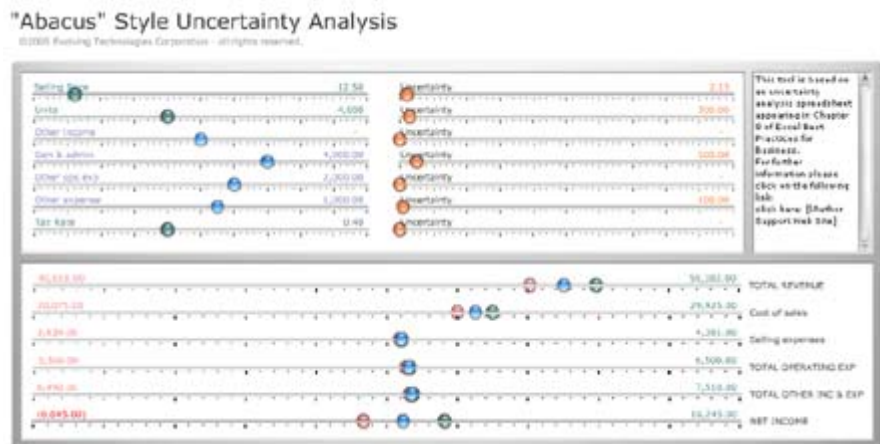
Sensitivity Analysis vs. Best/Worst Case. Consider a forward looking dashboard in which a number of assumptions can be set as well as the uncertainty for those estimates. If you are projecting expenses based number of units, as well as price to produce each unit, it is pretty easy to calculate your aggregate costs. In reality you know that there could very well be some variation or uncertainty on the number of units you will sell, as well as the cost per unit. What will be the bottom line impact of these uncertainties?

This problem is not as simple as it appears. It is tempting to say “Let’s just take the best case of all my options (and also let’s just take the worst case of all my options) and see what the point to.” The projection has got to be somewhere between this best and worst case scenario. It is true that your answer will be somewhere between your absolute best and absolute worst case scenarios. These uncertainties are, after all, unknowns that can’t be nailed down until your business operation is actually in progress or realized.

Throw in a little more reality into the mix; not only are your purchasing costs and number of units produced subject to uncertainty, so are a whole other host of factors; including operating expenses, and general & administrative expenses. Is it likely that all these *independent* uncertainties will conspire to all be beneficial or all detrimental at one time? Probably not; in which case your absolute best case or absolute worst case provide little aid in decision analysis. The chances are that the value for each item in your model will hover around an expected value and not veer to an extreme.

A mathematical technique called Addition in Quadrature has been applied to problems of this kind. An example of its use in financial analysis and spreadsheets can be found in **Excel Best Practices for Business** [ISBN: 076454120X]. Though the technique works well with spreadsheets, it works better in a visual modeling venue (see Figure 7).

FIGURE 7. *Abacus Style Visual Model that integrates uncertainty*



The central “beads” in the bottom panel represent expected values; while the beads to either side represent the spread or deviations from the expected values.

How Visual Models Extend Spreadsheets

There are many software applications that have spreadsheet-like qualities. Rather than trying to replicate what a spreadsheet can do, why not utilize what a spreadsheet already has to offer and extend it? Surely, this is a novel approach, but it turns out to be a very sensible one.

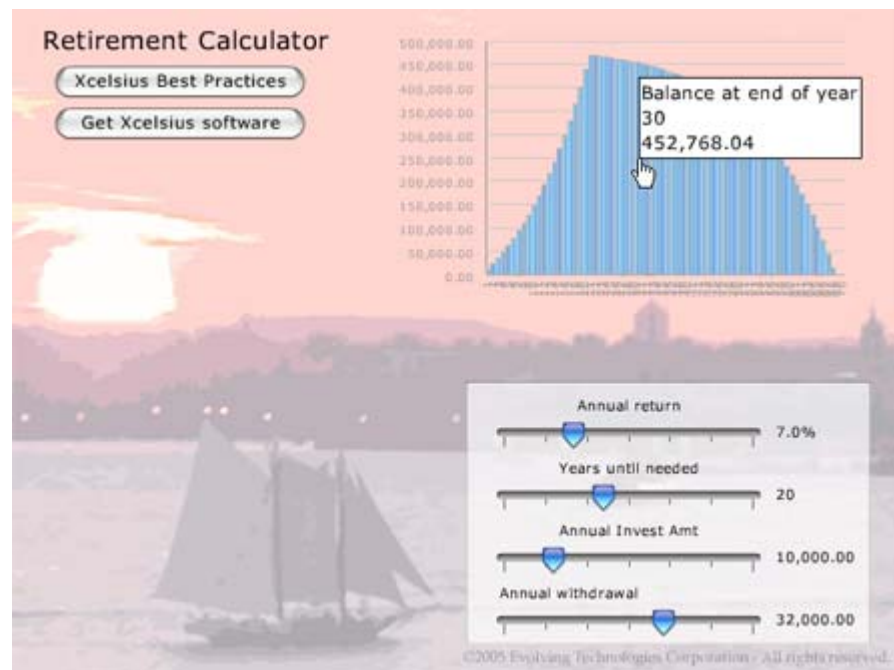
PEEKING UNDER THE HOOD

The basic idea of visual modeling as an extension of a spreadsheet is very simple. It simply involves having a ready made spreadsheet, identifying its inputs and outputs, and mapping it to visual components external to the spreadsheet.

Crystal Xcelsius, a product of Business Objects, is the visual modeling software that is used in the examples described. References at the end of this document list links to trial software you can download to test out the various visual models.

A quick way to understand the visual modeling technique is to deconstruct one. A simple and practical example for this purpose is a retirement calculator (see Figure 8).

FIGURE 8. *Sample Application: a visual retirement calculator*



It is easy to see the factors that drive the model. They are:

- Annual rate of return
- Years of saving
- Annual amount invested
- Annual amount of withdrawal from the retirement account

Matching the visual sliders are the assumptions used by an underlying spreadsheet (see Figure 9). As you move sliders on the visual model, the new data values for each of the items are inserted into the underlying spreadsheet model. The model is recalculated and results are returned to the visual presentation layer (the column chart in the top right corner of Figure 8). For completeness of the model, the initial balance is set to zero.

FIGURE 9. Drivers in the spreadsheet model

	A	B
1	XCELSIUS VISUAL MODEL	
2	Investment Planning Tool	
3	essential parameters for model	
4		
5	Initial Balance	0.00
6	Annual return	7.0%
7	Annual Invest Amt	10,000.00
8	Years until needed	20
9	Annual withdrawal	32,000.00

Deeper inside the model are the calculations (see Figure 10) that are used to generate the column chart appearing in Figure 8.

FIGURE 10. Computational Analysis

	A	B	C	D	E
1	XCELSIUS VISUAL MODEL				
2	Investment Planning Tool				
3	analysis page				
4					
5	Yr	start bal	additions	end bal	Y/E withdr
6					
7	1	0.00	10,000.00	10,700.00	0.00
8	2	10,700.00	10,000.00	22,149.00	0.00
9	3	22,149.00	10,000.00	34,399.43	0.00
10	4	34,399.43	10,000.00	47,507.39	0.00
11	5	47,507.39	10,000.00	61,532.91	0.00
12	6	61,532.91	10,000.00	76,540.21	0.00
13	7	76,540.21	10,000.00	92,598.02	0.00
14	8	92,598.02	10,000.00	109,779.88	0.00
15	9	109,779.88	10,000.00	128,164.47	0.00
16	10	128,164.47	10,000.00	147,835.98	0.00

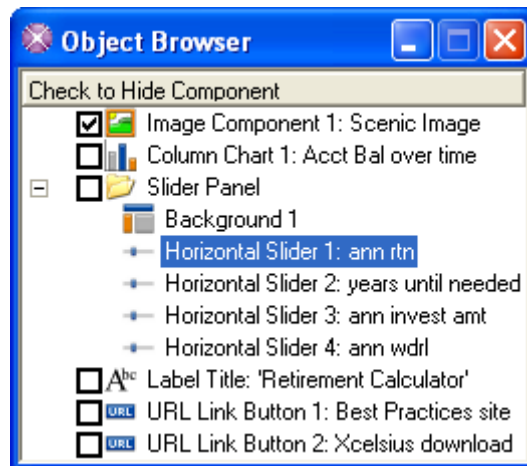
The formulas in the model are elementary interest calculations taking into account additions and withdrawals. Typically, the spreadsheet model should have some safeguards built in at the “spreadsheet” level. For instance, it would not make sense to end up with negative balances.

Deployment Issues

This is an important point. The spreadsheet model must have a requisite level of integrity and the inputs and outputs should be obvious enough to make the mapping process of the spreadsheet to the visual interface easy.

The mapping between spreadsheet and visual interface starts out at the interface level. All the components are specified in an Object Browser (see Figure 11). As components are grouped, compound objects are created, which allows for easier management during the visual model construction process.

FIGURE 11. *Object Browser holds all the components that interact with the calculation model*



Crystal Xcelsius provides a pallet of drag'n drop components that can be placed onto a canvas. When a component is positioned on the canvas, it can be double clicked on to define its properties, behavior, and appearance. An example was shown earlier in Figure 4.

Deployment Issues

Three factors play a role in the deployment of an Xcelsius Visual Model (XVM):

1. Preparing a spreadsheet for use within a visual model
2. Visual model design and deployment
3. Economics of preparing and maintaining software

SPREADSHEET PREPARATION

The essential idea for an XVM is to build upon a ready made spreadsheet. Ready made means that nothing further should have to be done with the spreadsheet.

- All the calculation formulas that would be utilized within the XVM should already exist in the spreadsheet.
- To facilitate the mapping between the visual presentation layer (components displayed on the canvas) and the underlying spreadsheet, it helps to identify within the spreadsheet all the essential inputs and outputs.

Concluding Remarks

- If the spreadsheet uses an Excel function that is not implemented in Crystal Xcelsius, it may be necessary to revise some of the spreadsheet formulas to remove this dependency.

DESIGN & DEPLOYMENT

The basic cycle for preparing an XVM is:

1. Create or use an existing spreadsheet as the basis for your model.
2. Prepare the spreadsheet for use with Crystal Xcelsius (revise formulas as necessary and make the model inputs and outputs easily identifiable).
3. Create an “image” of the spreadsheet within the Xcelsius work area. This is done by importing the spreadsheet.
4. Add the desired visual components onto the XVM canvas. Map them to the spreadsheet “image” and define their attributes, behavior, and appearance.
5. Test and validate the Xcelsius Visual Model within the development work area.
6. Export the XVM to desired presentation format (Flash/HTML, PowerPoint, or PDF).

There are features built into various versions of Crystal Xcelsius which enable extensive web centric capabilities, such as retrieving and sending XML information, utilizing Web Services, and collaboration services. The use of these extra facilities doesn't really entail changing the basic design and deployment cycle.

COST OF OWNERSHIP

You may have noticed that the word “Development” is conspicuously absent from ‘Design & Deployment’. This omission is intentional. At no point is it necessary for programmers to be coding an application.

Think of what is generally involved in preparing a Visual Basic Application that has the sophistication and interactivity of the dashboards and visual models. Think of how many lines of programming code, the level of testing and validation, and the overall amount of time and cost for a development project.

Removing the requirement for customized programming does lower the total life cycle cost. As with any software application, there is a learning curve involved with designing and deploying professional quality visual models and dashboards when using tools like Crystal Xcelsius. Other than following best practices and acquiring basic knowledge, there is no need (and actually no provision) for programming when using Crystal Xcelsius. These “best practices” are essential to keeping the cost of ownership low.

Concluding Remarks

Every now and then a technology comes along and completely revises how you do things. Visual modeling and dashboards are mind expanding technologies that unlock the computational facilities of a spreadsheet. We can't predict with certainty how spreadsheets are going to evolve, but it's a good bet that Microsoft's next generation technology will be strongly influenced by products like Crystal Xcelsius.

BACKGROUND

Loren Abdulezer is the CEO of Evolving Technologies Corporation and the author of Excel Best Practices for Business (ISBN: 076454120X, Wiley Publishing, Inc.). For further information go to the author support site <http://www.excelbestpractices.com> or <http://www.amazon.com/excel>.

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**REFERENCES &
DOWNLOADS**

Further information about Crystal Xcelsius can be found at:

<http://www.xcelsius.com>
<http://www.xcelsiusbestpractices.com>

Crystal Xcelsius software can be obtained at:

<http://www.xcelsius.com/freetrial>

Sample files described in this document can be found in the 'Sample Files' section of:

<http://www.xcelsiusbestpractices.com>

