



Buttons, Sliders and Dials: Implementing Metrics in DSS

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INTRODUCTION

This paper follows our paper last year, which dealt with metrics and measurement in Decision Support Systems (DSS). This year we turn our attention to implementation details—how metrics can be implemented in DSS, with particular attention to the features that managers want and need, and what, in our view, are the ‘indications for the future’ in DSS user interfaces.

As our title suggests, the implementation of metrics and measurements in a Decision Support System relies heavily on display and data manipulation techniques and the functions and features available in the system. Many authors have stated that data is THE issue in DSS, and we do not disagree—without good data there is no basis for good decision support. But we go a step further, to state that the CONVERSION of data into meaningful information that can serve as the basis for action is the REAL issue in DSS. This statement brings us squarely to the questions of how data is portrayed, what models are used to organize, parse, and interpret data, and the analytical methods that will be used by the decision maker.

A statement attributed to Gideon Gartner, founder of the Gartner Group and the Giga Information Group, captures the main idea:

Many companies will develop more explicit strategic intelligence systems, with a bias towards converting information to action.

There are several important concepts embedded in this short quote:

Explicit: Implies clear, unequivocal information that enables decision-makers to act quickly and with confidence and knowledge.

Strategic: Points toward the opposite of short-term, mundane, and operational. Rather, managers need information that helps with long-term decisions and issues that are important to future success; information that supports conceptual and visionary leadership activities.

Intelligence: Indicates aptitude, brainpower and acumen when thought of in the context of individual intelligence. More importantly for this discussion, intelligence implies collecting, processing and disseminating information about the future environment, e.g., the enemy’s resources and capabilities in a military environment, or a competitors resources, capabilities and skills, and likely future moves in a competitive marketplace.

Converting: Involves information that can assist in planning change, in adapting to new circumstances, in altering procedures or processes, or translating from one (known) context to another about which there is considerable uncertainty. In the context of decision support, we often want to convert or change historical data into information about the future, e.g., convert a series of data points on quarterly sales for the past three years into a forecast of quarterly sales for next year. The data are clear, but how to interpret and convert the data points often is not. Is there seasonality that should be considered? Are the products represented in the historical sales figures the same ones that we will carry into the future? Is the competitive environment the same as in the past? Are we stronger or weaker with the current product line in that environment? One can think of many examples where simple extrapolation or regression against dependent variables would lead to nonsense.

Action: In a decision support context, action implies change. All management decisions eventually lead to change of some sort—a manager whose decisions never change anything is just occupying (expensive) space, s/he can always be replaced with a cheaper do-nothing. Change is the critical determinant of the value of information in a decision support system—the converted information must lead the manager to a decision that leads to, or perhaps a path or series of actions that, in the end, will change something. Thus, actionable information is an essential ingredient that must assist the manager and lead to appropriate conclusions.

To make the point about the importance of action more forcefully, we quote our paper from last year’s IRMA International conference:

If the information from a decision support system cannot serve as the basis for action (i.e., cannot first help the decision-maker to decide to do something, and then help to decide what to do) the information will not be used and the system will therefore be useless.¹ (Boldface emphasis added.)

In the following sections, we delve into specific examples of several different techniques and models for portraying and interpreting data.

SENSITIVITY

Consider first a straightforward example of a homeowner who is transferred and must sell a house and buy a new one. For most of us, on a monthly budget that approximates our total income, the principal focus in this decision would be on the difference between the old mortgage payment and the new one. This difference is created by several interacting values; the selling price of the old house and the purchase price of the new one, the mortgage rate on the new mortgage, whether a real estate agent is used to sell the old house, etc. But again, for most of us, all of these factors come together in a single ‘target value’ that is the only thing that the decision-maker is interested in: the monthly payment difference.

Figure 1 shows the main screen of a ‘mortgage calculator’ to assist with a home sale and purchase decision as described above.² Here we see basic data entered in the cells to the upper right, the amount due on the current mortgage and the current monthly payment.³ The key indicator, the payment difference, is prominently displayed under the new mortgage payment in the upper right. The model is currently set with the following assumptions:

Old house will sell for \$195,000

New house will cost \$250,000

New mortgage will be 25 years at a rate of 6.5%

Real estate fee to list and sell old house will be 6%

In Figure 2, the report accessed by the ‘View Report’ button in Figure 1 shows that these assumptions lead to a net for the old house (after the real estate agent’s fee is deducted) of \$183,300 and \$62,242 of equity after the mortgage for the old house is paid off.

In this decision, an important consideration is the sensitivity of the target variable to the assumptions that have been set. Note that the model makes it easy for the decision-maker to test sensitivity by simple sliding the scroll bars for the decision variables. Understanding the sensitivity would be important, for example, if the \$302.99 monthly payment increase is simply too much. Imagine that the decision-maker says “not a penny more than \$150 more per month!”

What if the old house is sold without a real estate agent—is that enough to bring the difference down to no more than \$150 per month? Sliding the scroll bar to a zero real estate fee with all other assumptions the same indicates a difference of \$223.99 per month as shown in Figure 3, a significant reduction, more than most people would think, but not enough.

How about a 30-year mortgage rather than a 25? That will reduce the monthly payment on the new house, but will it be enough? As we see in Figure 4, a 30 year mortgage just makes it!

As one last example, let us assume that our homeowner has found a dream house, but it is \$260,000. What interest rate will make it possible to keep the monthly payment difference under \$150? Sliding the new house price scroll bar up to \$260,000 starts the process. Then, as shown in Figure 5, sliding the new house mortgage rate scroll bar down until the monthly

payment difference drops below \$150 answers the question; in this case a rate of just under 6% does the trick.

In summary, what we see in this example is not so much models or conversion of data, but *tools* to permit the user to quickly and easily *explore* the sensitivity of the decision variables, in an attractive, environment that needs little or no explanation. Despite the simplicity of this proto-type, it produces interesting, perhaps even powerful, results to assist the decision-maker.

EXCEPTIONS

Exception reporting and analysis is the basis for much management decision-making. Managers love exceptions because, once they find one, they know what to do—ask ‘WHY?’ and start digging for answers. The following example is an Executive Information System (EIS) prototype for a national chain of retail stores.¹ Metrics and reports in this system are based on the Balanced Scorecard methodology.² Exception reporting in this system is highlighted with color formatting on performance indices that are below a set performance level. Figure 6 shows the opening screen of the EIS.

Choosing the Financial Scorecard selection from the opening screen, the user is led to the screen shown in Figure 7. The data is clear and comprehensive, with break-outs of data for different divisions and store categories. Note the buttons to the left of the screen—the user can easily drill down to regional data screens, and from there to state screens. A drill-down through the South-east Region screen to the screen for Virginia is shown in Figure 8. Note that individual store data is shown at this detail level, but layout, formatting and exception reporting is similar to that of the top-level screen, a helpful feature to build user familiarity, comfort and acceptance.

Accessing the Help file at the bottom of the financial scorecard screen leads to the screen in Figure 9. Definitions for ‘exceptions’ are found here. Such help files and definitions are useful to users, but are appropriately placed like this—easily accessible but not intrusive to regular users of the system.

The button at the bottom of the screen in Figure 7, Top and Bottom Five Stores, is particularly interesting. Results of pushing that button are shown in Figure 10. If managers want exceptions to work on, this feature gives it to them. With the push of one button, the manager sees the top and bottom performing stores. We encourage our students and clients to build such features into their systems. Indeed, our vision of the ultimate DSS would have permanent Top 5 and Bottom 5 buttons on every screen. If the manager was looking at sales by region, the buttons would display the top and bottom sales regions. Sales people? The buttons would lead to top and bottom performers. Products? Package sizes? Margins? Each would automatically lead to the correct top and bottom list. This is true decision support—make exceptions, rankings, sorts, etc., immediately available in whatever category the manager is looking at in real time.

Space restrictions prevent us from describing many other features of this rich prototype, but we highlight one of the other scorecards that focus on internal processes. A DSS should focus the user’s attention on a small number of metrics that relate to critical success factors. In this company, there are essentially two ways to go wrong at the store level—have the wrong mix of merchandise available for sale (e.g., too many red, small, not enough blue, medium) or mismanage the store process and end up with too many damaged, unsaleable goods. The Process Score-card screen shown in Figure 11 gives data on these variables with color coding similar to the Goal Performance Index: In this case, store process rates of greater than 2.5% and ordering rates of less than 90% are formatted in bold red.

A summary of this example is an easy task—give the user the kinds of features that we see here: clarity, focus on only the most relevant data, straightforward navigation with no confusion cul-de-sacs or alleys, attractive, easy-to-understand screens with help when needed, and clear, relevant metrics.

AGGREGATE INDICATORS

We end with one more example that has no detail, only a suggestion of future opportunity. Figure 12 shows the opening screen from an early beta version of another Balanced Scorecard DSS, with the four Balanced Scorecards

in an attractive multi-screen display. This screen is more than a pretty picture or just a general menu of choices. Each individual screen has three ‘lights,’ and each light can take on one of four colors, red, yellow, green or grey (off). The idea is that the lights on the four screens will be a ‘dashboard,’ sometimes called a ‘cockpit,’¹ for the user, available immediately on opening the application. As in other color-coded decision support systems, red will be a warning that there are significant exceptions; or that trends are deteriorating, yellow will mean little or no change from previous values, green will mean an improving situation. An off, or grey, light will mean ‘no current values’ or ‘not available’ or ‘not measured’ or perhaps ‘data is not conclusive.’

A dashboard usually portrays the status of a few key variables or, in more recent systems, a weighted average other combination of key variables that have meaning to the business. In this case the three lights on each scorecard are indented to, together, portray an overall impression of the status of that scorecard, ranging from three green lights to three red lights. Combinations of green, yellow, grey and red would signal lower-level areas that need review and invite the user to dig or drill further. Imagine, for example, that there is a measure of corporate performance in each scorecard area for the last year, for the last six months, and for the last month, and each can be compared to the previous period. Three green lights might indicate improved performance in all three time periods, yellow, yellow, green might indicate the last year and last six months are flat compared to the previous periods, but the last month is up—a hopeful trend. A manager would likely want to drill down to find the source of the recent up-tick in performance, and maybe send a note to the responsible manager.

This is only blue-sky thinking—the particular protocols and models behind the lights are not yet worked out. But this example points us towards the future, when DSS dashboards, with just a glance, will assist managers to determine where to look and the severity of problems they are likely to encounter in their analysis and exploration.¹

We end with a quote from our 2002 IRMA International Conference paper: *There are many unknowns, but one thing is sure: rapid progress in DSS will be made, with or without those of us in the academy who are interested in contributing.*² Managers need help to cope with contemporary problems, and it is an exciting time to contribute.

ENDNOTES

¹ *Metrics and DSS: Do we have the DSS cart ahead of the measurement horse?* William K. Holstein and Jakov Crnkovic, Proceedings of the 2002 Information Resources Management Association International Conference, May 19-22, 2002, Seattle, Washington.

² This DSS Prototype was developed in Excel by a team of undergraduate students at The College of William and Mary in 1999. The team members included Qianqian Guo, Ben Alexander, Joseph Zapf, Rey Pascual and Mathew Talley.

³ The assumption here is that the home seller/buyer will invest all of the equity from the old house into the down payment for the new house, and will neither add nor withdraw any cash from the two transactions.

⁴ This EIS Prototype was developed in Excel by a team of MBA students at The College of William and Mary in 1999. The team members included Beth Bacon-Williams, Linda Broll, Dawne Galdi, Cathy Grady, Mark Letchworth and Susan Nootnagel

⁵ For further information on the Balanced Scorecard, see www.bscol.com, the web site for the Balanced Scorecard Collaborative, hosted by the originators of the idea.

⁶ Much recent discussion in DSS has centered around General Electric’s effort to install cockpits in all of their operating divisions. See, for example, “GE Capital’s Dashboard Drives Metrics To Desktops,” *InformationWeek*, Apr 22, 2002, <http://www.informationweek.com/story/IWK20020418S0005>.

⁷ For more general information on dashboards and cockpits, see the web site of the Global Rhythm Institute at <http://grinstitute.mougayar.com/Dashboard>.

⁸ See Endnote 1.

Figure 1. Mortgage Calculator with sliders and pull-down menu

HOME PURCHASE ASSISTANT Note: Red numbers with parenthesis are negative numbers: (\$1,000) = - \$1,000

How much more (or less) will you pay per month? Summary

Current Mortgage Due New House Monthly Payment
 Current Monthly Payment Monthly Payment Difference

Data required for the computation of new monthly payment: Min Indicate your values Max

Current House Selling Price
 Current House RE Fee %
 New House Price
 New House Mortgage Rate
 Length of Payment (year) --Click to view your complete Home Purchase report!

Figure 2. Report Screen for mortgage calculator

Current Mortgage Due	\$121,058.00
Current Monthly Payment	\$964.77
Current House Selling Price	\$195,000.00
Current House RE Fee %	6.0%
Current House Net	\$183,300.00
Equity for New House	\$62,242.00
New House price	\$250,000.00
New House Mortgage Rate	6.5%
Length of Payment (years)	25
New House Monthly Payment	\$1,267.76
Monthly Payment Difference	\$302.99

Note: Red numbers with parenthesis are negative numbers: (\$1,000) = - \$1,000

Click to get back to the Home Purchase Assistant!

This button goes back to the entry form

This button closes the program.

Figure 3. Mortgage Calculator with revised assumptions

HOME PURCHASE ASSISTANT Note: Red numbers with parenthesis are negative numbers: (\$1,000) = - \$1,000

How much more (or less) will you pay per month? Summary

Current Mortgage Due New House Monthly Payment
 Current Monthly Payment Monthly Payment Difference

Data required for the computation of new monthly payment: Min Indicate your values Max

Current House Selling Price
 Current House RE Fee %
 New House Price
 New House Mortgage Rate
 Length of Payment (year) --Click to view your complete Home Purchase report!

Figure 4. Mortgage Calculator with further revised assumptions

HOME PURCHASE ASSISTANT Note: Red numbers with parenthesis are negative numbers: (\$1,000) = - \$1,000

How much more (or less) will you pay per month? Summary

Current Mortgage Due New House Monthly Payment
 Current Monthly Payment Monthly Payment Difference

Data required for the computation of new monthly payment: Min Indicate your values Max

Current House Selling Price
 Current House RE Fee %
 New House Price
 New House Mortgage Rate
 Length of Payment (year) --Click to view your complete Home Purchase report!

Figure 5. Mortgage Calculator with still further revised assumptions

HOME PURCHASE ASSISTANT Note: Red numbers with parenthesis are negative numbers: (\$1,000) = - \$1,000

How much more (or less) will you pay per month? Summary

Current Mortgage Due New House Monthly Payment
 Current Monthly Payment Monthly Payment Difference

Data required for the computation of new monthly payment: Min Indicate your values Max

Current House Selling Price
 Current House RE Fee %
 New House Price
 New House Mortgage Rate
 Length of Payment (year) --Click to view your complete Home Purchase report!

Figure 6. Opening screen for an EIS based on Balanced Scorecard Metrics

Balanced Scorecard
Executive Information System

[Financial Scorecard](#)

[Processes Scorecard](#)

[Customer Scorecard](#)

[Innovation/Learning Scorecard](#)

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Figure 7. Top-level financial Scorecard

Financial Scorecard - April 30, 2003

	YTD Actual Sales	YTD Goal	GPI	Sales Last Week	Goal Last Week	GPI
Nationally	\$1,893,640,000	\$1,690,000,000	1.12	\$633,500,000	\$519,470,000	1.22
Northeast	\$425,000,000	\$500,000,000	0.85	\$250,000,000	\$300,000,000	0.83
Southwest	\$29,140,000	\$47,000,000	0.62	\$23,500,000	\$9,400,000	2.50
Southwest	\$682,000,000	\$620,000,000	1.10	\$310,000,000	\$465,000,000	0.67
Midwest	\$705,000,000	\$470,000,000	1.50	\$23,500,000	\$12,925,000	1.82
Northwest	\$49,500,000	\$50,000,000	0.99	\$25,000,000	\$25,000,000	1.00
International	\$3,000,000	\$3,000,000	1.00	\$1,500,000	\$1,425,000	1.05
Co-Owned	\$662,774,000	\$676,000,000	0.98	\$221,725,000	\$292,677,000	0.76
Franchises	\$416,600,000	\$507,000,000	0.82	\$139,370,000	\$104,527,500	1.33
Division 2	\$530,219,200	\$338,000,000	1.57	\$177,380,000	\$168,511,000	1.05
On-Line Sales	\$284,046,000	\$169,000,000	1.68	\$95,025,000	\$57,015,000	1.67

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Figure 8. Drill down to State of Virginia Financial Scorecard screen

Virginia Financial Scorecard by Store						
	YTD Actual Sales	YTD Goal	GPI	Sales Last Week	Goal Last Week	GPI
Center Mall	\$192,437	\$181,746	1.06	\$33,004	\$37,013	0.89
Dulles Village	\$396,073	\$403,880	0.99	\$78,423	\$82,250	0.95
Oak Fair Mall	\$74,042	\$100,970	0.73	\$22,974	\$20,563	1.12
Eisenhower Center	\$237,982	\$242,328	0.98	\$42,971	\$49,350	0.87
Potomac Center	\$152,078	\$161,552	0.94	\$31,600	\$32,900	0.96
Newport Village	\$187,635	\$181,746	1.03	\$24,050	\$37,013	0.65
Tysons City	\$522,087	\$565,433	0.92	\$160,600	\$114,793	1.40
Reston Valley	\$161,974	\$181,746	0.89	\$18,050	\$30,000	0.60

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Figure 9. Help file accessed from Financial Scorecard with definitions of exceptions

Financial Scorecard
 The Financial Scorecard values represent the Goal Performance Index.

Goal Performance Index (GPI): Defined as the Current Performance / Financial Goal.
 This is set to monitor weekly and fiscal year performance.

- GPI=1 Goals are being met exactly.
- GPI<1 Goals are not being met.
- GPI>1 Goals are being exceeded.

As a warning indicator, all GPIs less than 0.76 are color-coded in **bold red text**.

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Figure 10. Financial Scorecard data on Top and Bottom Five Stores, accessed from Financial Scorecard screen

	YTD Actual Sales	Percent of Average
National Average	\$315,606,667	
TOP FIVE		
South Coast Plaza (Costa Mesa, CA)	\$473,410,000	150%
Westlake Center (Seattle, WA)	\$394,508,333	125%
First City Center (Dallas, TX)	\$347,167,333	110%
Port Authority (New York, NY)	\$315,606,667	100%
Colonial Mall (Myrtle Beach, SC)	\$252,485,333	80%
BOTTOM FIVE		
Maine Mall (South Portland, ME)	\$126,242,667	40%
Glenbrook Square (Fort Wayne, IN)	\$123,086,600	39%
Southgate Mall (Missoula, MT)	\$119,930,533	38%
West Acres Mall (Fargo, ND)	\$63,121,333	20%
The Summit (Birmingham, AL)	\$31,560,667	10%

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Figure 11. Process Scorecard screen

PROCESSES SCORECARD		
	Store Process-Reject %	Ordering Process-Sale %
Nationally	2.1%	92.3%
Geographically:		
Northeast	5.0%	75.0%
Southeast	2.5%	90.0%
Southwest	1.5%	95.0%
Northwest	1.0%	99.0%
Midwest	1.0%	97.5%
International	6.0%	72.0%
Business Units:		
Co. Owned	1.9%	95.0%
Franchises	2.4%	90.0%
Division 2	2.0%	88.0%

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Figure 12. Opening screen of a DSS with 'dashboard lights'



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