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A Model-Based Management Dashboard:

Harmonizing Management Efforts to Optimize the Enterprise

by Fred A. Cummins

This *Executive Report* proposes personalized dashboards for all managers in an enterprise as well as an active business model based on the Value Delivery Modeling Language (VDML). The report describes the VDML concepts and facilities that model the operation of the enterprise, the mechanisms for integrating the model with operational business systems, and, finally, the implications of the shared VDML model and modeling facilities to the future evolution of the enterprise.

Executive Report

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A Model-Based Management Dashboard:

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THIS ISSUE'S AUTHOR

Fred A. Cummins

IN THIS ISSUE

A conventional *executive* dashboard provides a window on key measurements of the operation of the enterprise. Implementation of the dashboard generally offers a particular viewpoint with access to current operating data to support that view. When the executive observes a change of concern, or the dashboard raises an alarm based on monitoring certain variables, the executive will likely turn to a staff member to look into the situation further since the dashboard does not contain the detail of related variables or more specific business operations.

Unfortunately, the data and exceptions of interest are not always the same, and top executives cannot address everything that deserves attention. To manage an enterprise most effectively, managers across the organization require data and awareness of exceptions within their own sphere of influence. Thus, a management dashboard system should be a tool to support enterprise management at all levels. It should provide data about current operations and highlight exceptions that require attention. Furthermore, to avoid working at cross-purposes, managers need a common understanding of the current state of the enterprise and how it works.

This *Executive Report* proposes the development of a model-based dashboard capability. While managers throughout the enterprise have their own domains of interest, a shared enterprise model — defined using the Value Delivery Modeling Language (VDML) — can align their individual views. For the proposed dashboard, the model is linked to sources of actual operating data, providing each manager with the data and alerts of interest to them. The dashboard interface enables managers to define those interests and, as required, to probe deeper into the operation of the enterprise in order to understand the source of variances, anticipate the consequences, collaborate across the enterprise, and explore remedial action.

Implementation of this dashboard capability requires a major investment to meet the occasional and somewhat unpredictable needs of an executive. However, a model-based, adaptable dashboard that meets the information needs of business leaders throughout the enterprise will

pay off with increased efficiency and innovation. Importantly, the model supports analysis of corrective action and operating improvements, empowering each manager to innovate within his or her area of responsibility. Furthermore, the model clarifies when managers should collaborate with other managers on shared challenges and opportunities with a shared understanding of their impact on the rest of the enterprise.

In this report, we will first discuss the concepts and facilities of VDML for modeling the enterprise. We will then examine the requirements of a model-based dashboard system that provides business insights based on current operational data in the context of a VDML model. Finally, we will consider the evolution of an enterprise that a model-based dashboard and its associated business modeling capabilities promotes and supports.

VDML MODELING CONCEPTS

VDML is a robust business analysis and design modeling language for businesspeople. It incorporates concepts from a number of business modeling and analysis techniques. VDML supports business analysis, design, decision making, and transformation planning from an enterprise, value-driven perspective. Managers will use VDML to gain insights and explore alternatives. They will be assisted by business analysts that build and analyze the models. Some managers will also become business analysts as they learn to appreciate the value of VDML as a management tool.

Work on VDML began when the Object Management Group (OMG) issued an RFP in the spring of 2009.[1] The focus of the initial submission (early in 2010) was value chain modeling in support of capability analysis. This offered the opportunity to evaluate business operations in terms of customer value and to identify potential improvements to capabilities as well as operating strategies. Participation of the NEFFICS project (Networked Enterprise transFormation and resource management in Future internet enabled Innovation CloudS) as well as participation of additional business modeling experts enhanced the scope of this work. The result is a modeling language that incorporates business modeling concepts from such techniques as the following:

- Value chain analysis[2]
- Value stream analysis[3]
- Capability analysis[4]
- Value network analysis[5]
- Resources, events, and agents[6]
- e3value[7]
- Possession, ownership, and availability[8]
- Business model cube[9]
- Business Model Canvas[10]

The VDML metamodel specification is stable, with current work focusing on refinements to notation (i.e., graphical displays) and reconciliation with related OMG modeling specifications. The VDML objective is to provide a modeling language that is business-oriented and supports analysis, design, and transformation with a focus on optimization of both customer value and business operations from an enterprise perspective. Value-creation modeling is a distinguishing feature of VDML. VDML offers a representation of the design of the enterprise that is meaningful to businesspeople and provides a basis for collaboration on challenges and opportunities.

A VDML model represents the design of the enterprise that includes measurements of operating variables and value contributions. These measurements are the basis for assessing the effectiveness of the business operation. Changes to the design or variables will be propagated to changes in the measurements that describe performance and customer satisfaction. Different scenarios can represent different operating circumstances, different product mixes, or different customer market segments along with their impact on values. Some of these same measurements provide or support the key performance indicators (KPIs) that a manager wants in his or her dashboard. As such, a VDML model with current data can support an adaptable dashboard as well as more in-depth analysis and resolution of concerns raised by the dashboard.

A VDML business model is composed of modeling elements representing several fundamental concepts. The following sections discuss those concepts and their relationships. This will provide a general understanding of the VDML business modeling capabilities both for support of the model-based dashboard and for support of related problem-solving, planning, and transformation efforts. Throughout this discussion, we will use a hypothetical small manufacturing company, Hypo Manufacturing, to illustrate VDML modeling.

Collaborations and Roles

The fundamental, structural concept of a VDML model is *collaboration*. A collaboration is a group of participants, working together for a shared purpose. An enterprise involves many networked collaborations, including collaborations with customers and suppliers. Roles within a collaboration define how each participant contributes to the collaboration. A participant can be an actor (e.g.,

person or automaton), a supporting collaboration, or another role. For example, an enterprise can assign a manager (role) of an organization (collaboration) as a member (role) of a taskforce (collaboration).

There are four specialized types of collaboration in VDML: an organization unit, a business network, a community, and a capability method.

Organization Unit

An *organization unit* is a collaboration that is relatively stable with associated resources, including people, facilities, and intellectual capital. The roles in an organization unit may be filled by people and/or other organization units, thus representing an organization hierarchy. Notably, some organization units in an enterprise, such as project teams and committees, do not fit the conventional organization hierarchy pattern. There also may be individuals who have roles in multiple organizations.

Figure 1 illustrates a partial organizational structure for the product development activities of Hypo Manufacturing. Each rectangle represents a collaboration. The fork icon indicates an organization-unit collaboration. The three-arrows icon (left side) represents a business network where representatives from Electronics Supplier and Hypo Manufacturing collaborate. An oval depicts a role. The large oval contains the role name with a solid line representing its collaboration. A small oval illustrates that the attached collaboration is within a role of the collaboration connected by the solid line; the role name is next to the small oval. A dashed arrow indicates that the role at the arrow tail fills a role at the head. For example, the manager role of the Electronics Group fills three other roles in the enterprise; he or she is also a member of the Electronics Design Liaison, the Design Review Committee, and the Manufacturable Committee. This person is a member of these other collaborations *because* he or she is manager of the Electronics Group.

Organization units typically have defined capabilities based on their resources, facilities, and intellectual capital. A business analyst can model the activities required for an organization unit to perform a specific capability as a *capability method*, discussed later in this report.

Business Network

A *business network* is a collaboration among economically independent business entities. This may represent customer relationships and relationships with suppliers or other business partners. Business networks focus on the exchange of products, services, money, and related values such as product quality and availability of field support.

Figure 2 illustrates a VDML view of a business network for a Hypo Manufacturing line of business (LOB). Each

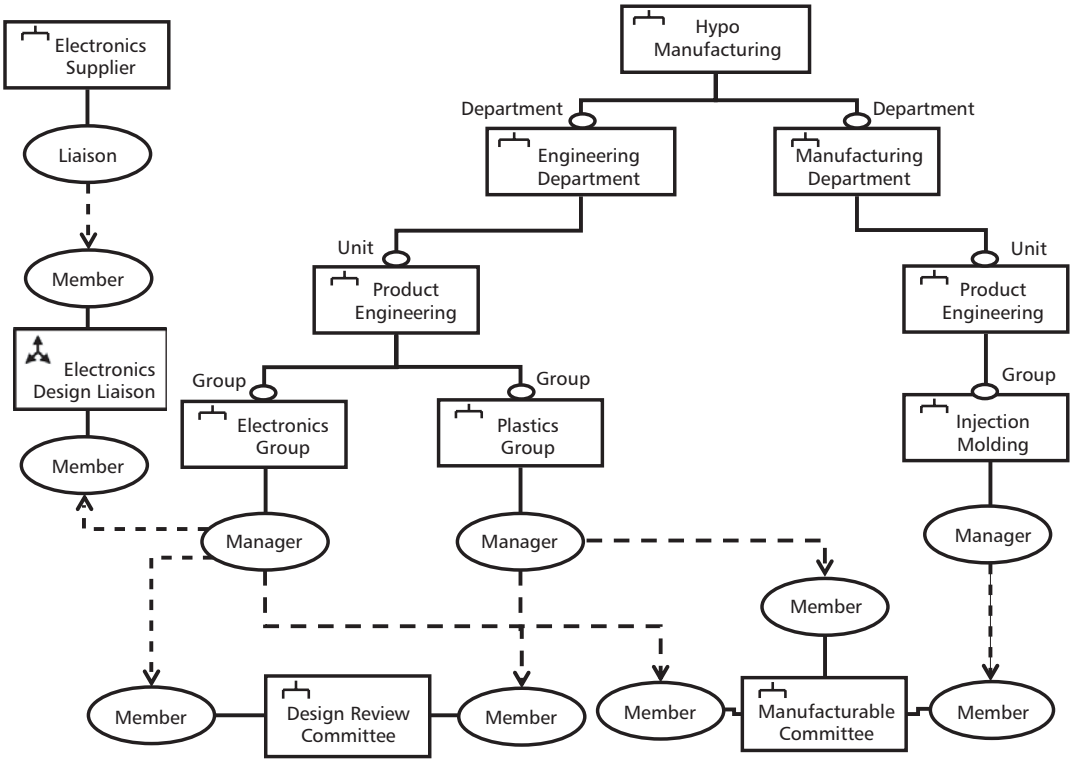

Figure 1 — Hypo Manufacturing organization chart in VDML.

oval depicts a role in the network and each square depicts a value proposition. A value proposition represents the values offered by a provider to a recipient (more about value propositions later). As shown in the figure, the LOB provides a product to the customer and the customer provides payment. The LOB acquires plastic and electronic parts from the two suppliers and provides payments to them. Each participant in a business network must perceive that it receives more value than it provides, or the network is not viable. In this case, the cost of the product offered by each supplier and the LOB is less than the payment each receives in return, but each product recipient considers the product (and its related value) to have more value than the price paid.

Community

A *community* is a loose association of members, such as a professional association, an industry standards group, a market segment, or employees with a common interest who share ideas. In Figure 2, the customer role represents a typical member of the community of customers. A particular business network transaction will engage one customer from the market segment community.

Capability Method

A *capability* is the ability to perform a certain kind of work. A *capability method* is a collaboration with defined roles and activities for applying a business capability to deliver a particular result. An organization unit may have a general capability, but it typically delivers more specific capabilities using its resources, facilities, and intellectual capital. Its capability methods define activities and resources required to perform the more specific capabilities.

A capability method can represent any form of repetitious, organized behavior, including adaptive processes that perform some activities only part of the time. Measurements associated with activities each represent an average per unit of production, so an activity may be engaged only once for one unit of production, but multiple times for another unit of production.

Figure 3 illustrates activities of a capability method performed by the LOB in the business network of Figure 2. Activities are the boxes with rounded corners. The inverted pyramids represent stores of orders coming in and products going out. Each activity has an expansion icon, a small box with a plus sign, indicating that it delegates to a participating collaboration.

A capability method design may be defined and maintained by the same organization unit that provides the capability or a by a different organization unit so the capability method specification can be shared. Next, we explore capability methods in greater detail in connection with activities and capabilities.

Activities, Deliverable Flows, and Stores

Within any collaboration, activities define what the participants do in their roles within the collaboration. Activities produce deliverables consumed by other activities, or stores. Most deliverables are consumed by activities or stores in the same collaboration, but some are the outputs to other collaborations, including external business entities.

Each activity requires a capability. The activity defines how that capability contributes to the particular collaboration. Each activity has a role assigned to one participant (i.e., the provider of the required capability). The role of one participant may be associated with multiple

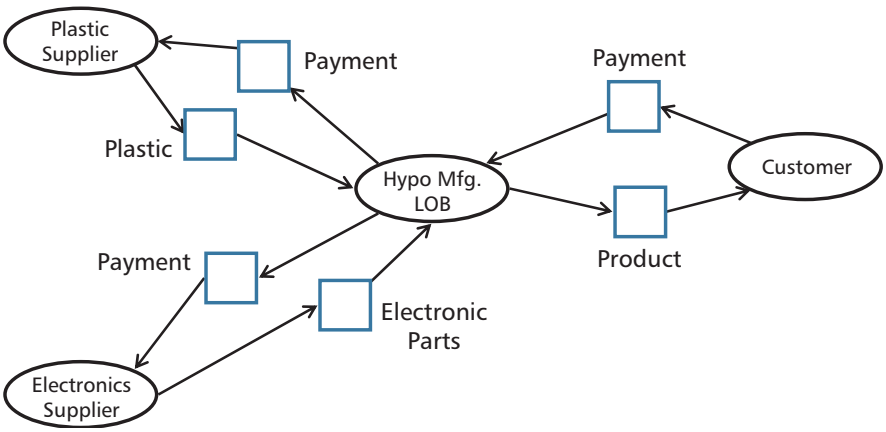

Figure 2 — A business network for a Hypo Manufacturing line of business.

activities in the collaboration. The participant must meet the capability requirements of each activity associated with that role.

A role may be filled by an actor (a person or automaton), or, where the work of the activity requires multiple participants, it may be filled by an organization unit with the required capability. The business analyst can define the work performed by the organization unit via a capability method that is engaged by the activity through *delegation*. In Figure 3, the Order Fulfillment activity delegates to the capability method of Figure 4. Where an activity delegates to a capability method, inputs to the delegating activity are passed to the performing capability method, and results are returned for further use within the parent collaboration. This mechanism supports the structuring of complex undertakings and can represent the use of shared services.

In Figure 4 (as in Figure 3), the arrows represent *deliverable flows*. The elements that flow are *business items*, including parts, orders, raw materials, tools, machines, and other things used or consumed. The inverted pyramids represent stores (i.e., holders of business items). The sideways pyramids represent input (on the left) or output (on the right) of the capability method through delegation. Business items can be passed as inputs and outputs of a collaboration. A person can be input to a collaboration as a business item to be assigned to a role.

To get a complete picture, from Figure 3 we see that the input to Order Fulfillment is an order and the output is a product, corresponding to the input and output of Figure 4. Figure 4 illustrates additional inputs from stores: plastic, electrical parts, fasteners, and packaging materials. Outside suppliers or other organization units supply these stores. Recall from Figure 2 how the business network depicts the suppliers of plastics and electrical parts.

Values and Value Propositions

Activities produce deliverables and also add values not shown on an activity diagram. *Value adds* contribute to *value propositions* and may be positive or negative. An activity, such as Injection Molding, may consume raw material and produce a part conveyed by a deliverable flow, as depicted in Figure 4. Associated values may be the cost per part, the probability of defects, the duration of the activity, or other characteristics that ultimately may be of interest to a customer or other stakeholder. Other values such as the durability or flammability of the plastic may come from the supplier. Each value-add contribution is expressed with a measurement, and for each type of value, measurements are aggregated if they are contributed by multiple activities. The formula of aggregation will depend on the nature of the value.

Figure 5 illustrates the aggregation of cost and defect value adds, depicted by dashed lines since this view does not represent a defined VDML diagram. Value adds and value propositions are typically displayed in tables. While this diagram depicts each activity as contributing to each value type, for some values, only certain activities may contribute. Where an activity

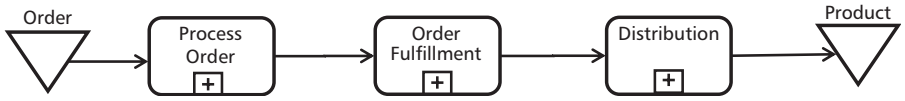

Figure 3 — Capability method supporting the business network.

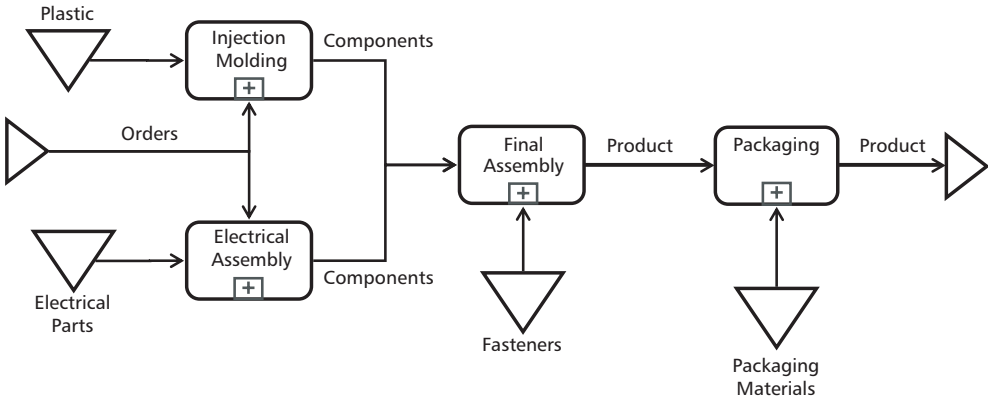

Figure 4 — Capability method for Hypo Manufacturing Order Fulfillment.

delegates to another collaboration, the delegation returns the aggregated values of the activities in the collaboration. In Figure 5, the aggregations are the additions of cost and defect rates. Each contribution is from a delegating activity and thus includes value contributions returned from the delegation. The values of interest will depend on the values of interest to the recipient of the value proposition as well as the values of interest to dashboard users.

In a normal VDML model, the value-add measurements are based on a unit of production, but are statistical measurements, not individual measurements. The cost of an activity is the average, or a statistical distribution of costs for individual units. For the dashboard, measurements for individual units will be reported and compared to upper and lower limits in order to identify exceptions. Some measurements will contribute to the KPIs of a manager's dashboard. Some measurements may only be of interest when there is a significant variance or exception, or there is a need for more information to address a concern.

Value contributions support value propositions. A *value proposition* is a package of values and deliverable(s) offered to a recipient, typically a customer, but a value proposition can also be offered to other stakeholders such as business owners or internal "customers." The value proposition incorporates those value contributions that are of interest to the recipient. The value proposition expresses its values from the recipient's perspective. For each type of value, the aggregated measure transforms to a level of satisfaction based on a formula for the particular recipient. An overall expected level of satisfaction can also be computed based on a weighted average of the value satisfaction levels.

Different customers or market segments may be interested in different values with different priorities, so separate value propositions can represent the levels of satisfaction for these different recipients. Value propositions may also be compared to the offerings of competitors to assess competitive position and evaluate changes that might yield competitive advantage.

Value Stream

The activities, deliverables, and values that contribute to a value proposition are characterized as the *value stream* for that value proposition. Essentially, value contributions and deliverable flows that feed the value proposition can be traced back to the activities involved and the capabilities they use to contribute to the value proposition.

Returning to Figure 5, we see a value stream for the Hypo Manufacturing LOB first represented in the business network in Figure 2. We can derive the value stream from the VDML model through identification of the activities that contribute to the value proposition offered to the customer. Other value propositions, such as to other stakeholders, may define different, overlapping value streams.

The full value stream for the Hypo Manufacturing LOB includes the expanded delegations of these activities as well as the suppliers to the stores of plastic and electrical parts depicted in Figure 4. The value contributions of suppliers will be taken from the measurements incorporated in their value propositions since Hypo Manufacturing is not expected to have access to the business design of its suppliers' internal operations.

Some of the collaborations in a value stream may involve shared capabilities that the enterprise uses more than once in the same value stream or in different value streams, potentially other LOBs. Consequently, when a shared capability changes or suffers a disruption, all value streams in which it participates will experience the impact. The values contributed by a shared capability will likely be different when an enterprise uses the

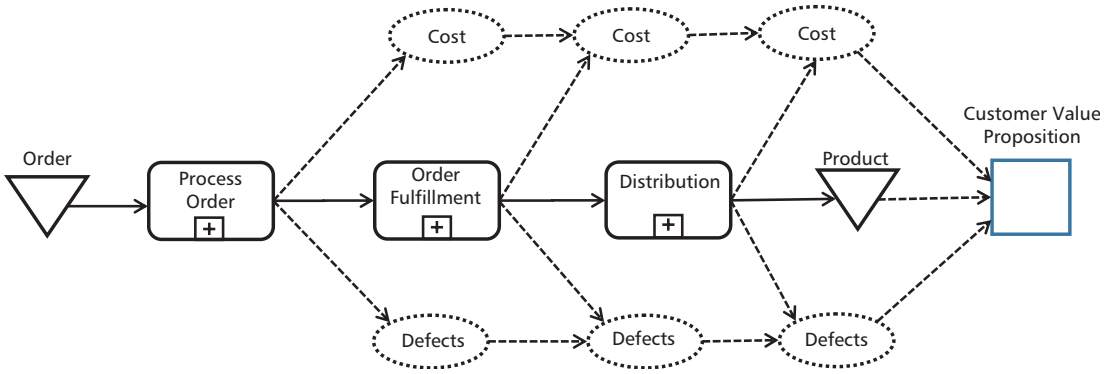

Figure 5 — Aggregation of activity value contributions.

capability in different contexts. We will address this difference in the discussion of measurements and scenarios later in this report.

When a value proposition indicates a poor level of satisfaction of a value, a business analyst can examine the value stream in order to identify the activities and thus the capabilities that contribute to that value, looking for potential improvements that could raise the satisfaction level. Again, if the focus is on a shared capability, there may be multiple value streams affected, and they may not all be affected in the same way.

Conversely, when a KPI of an activity or a collaboration exceeds acceptable limits, a business analyst can trace the effects to all affected value propositions and an associated decline in level of satisfaction may determine the urgency with which the enterprise should resolve the variance.

Capabilities

As indicated earlier, a *capability* is the ability to perform a particular type of work. An enterprise will have many capabilities. VDML supports a capability library for specification of a capability taxonomy. The taxonomy addresses two important requirements: (1) it helps a business analyst or planner determine if the enterprise currently has a needed capability; and (2) it provides consistent definitions and identifies similarities that help determine if multiple organizations provide the same capabilities, thus offering candidates for consolidation. Note that while different organization units may provide the same capability, each organization unit may have different qualities, such as location or capacity, that would justify redundancy.

Figure 6 illustrates a capability map. This is a popular way to represent a capability hierarchy. Enterprises often use a capability map as a "heat map," which highlights capabilities that require attention. A capability hierarchy may have the appearance of an organization hierarchy, but these are distinct perspectives. In an enterprise with LOB silos, capabilities may be scattered across lines of business, and within a silo, the organization structure may reflect other influences such as sharing of resources, geographical locations, or management of a critical path. Consideration of capabilities independent of organizational structure enables a more objective consideration of the work to be done and the values achieved.

In general, capabilities are offered by organization units that have the resources, facilities, intellectual capital, and responsibility to deliver the capability. A capability definition in the capability library identifies the organization units that offer that capability. An organization unit may assign a person or assemble a team to respond to each request for a capability, and there may be no formal pattern to the way work gets done. However, if there is a pattern to the work, a capability method should define it.

A capability method, as discussed previously, defines the roles, inputs, activities, stores, deliverables, and value contributions for delivery of the capability. It is

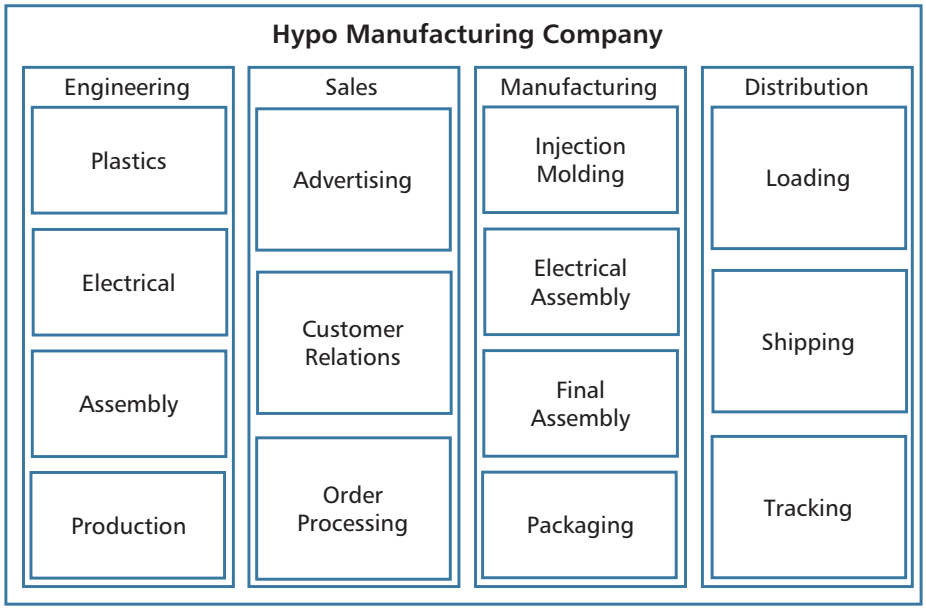

Figure 6 — Hypo Manufacturing capability map.

similar to a business process definition but does not get into the decisions and flows of control for individual requests. Instead, a capability method identifies statistical measures of the activities, stores, values, and flows over a number of occurrences. It may represent work that is somewhat unpredictable — sometimes characterized as case management — where the same activities occur in different sequences and sometimes not at all. The dependencies between activities (deliverable flows) are important because they define the value stream and the aggregation of value measurements. For example, "time to deliver" depends on the critical path of activities determined by deliverable flows.

Capability Management

Any collaboration can have roles, activities, deliverables, and value contributions. An organization unit generally has resources that can do more than one kind of work (i.e., provide more than one service under a general capability). Consequently, a business analyst can specify the activities, deliverables, and value contributions of organization units with capability methods that describe each of the more specific capabilities offered by the organization unit.

An LOB is an organization unit that delivers end products or services. LOB capability methods define the high-level value streams for each product or service. In an enterprise that makes extensive use of shared capabilities, an LOB capability method will be primarily the activities that engage shared capabilities.

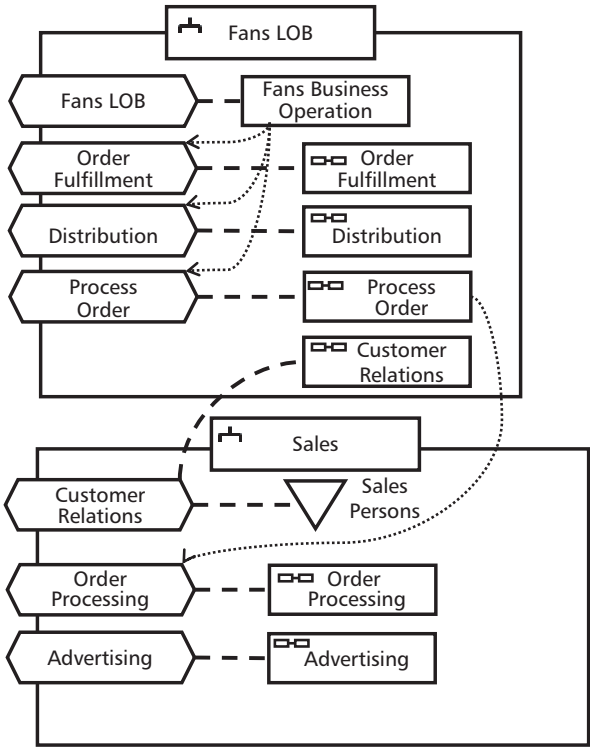

Figure 7 — A capability management diagram.

Typically, a collaboration that fills a role of an activity is an organization unit that manages the capability required by that activity. If that role performs multiple activities in the parent collaboration, then the organization unit must have the capabilities required by each of the activities. For each offered capability that has defined roles and activities, the organization unit will use a capability method to define the delivery of that specific capability. The capability method will use the resources and facilities of the organization unit and may further delegate some of its work to other units and their capability methods.

Figure 7 illustrates a VDML capability management display. The large boxes represent the organization units named in the small rectangles at the top of each large box (i.e., Fans LOB and Sales). The stretched hexagons represent capability offers (e.g., Order Fulfillment). A capability offer indicates that the associated organization unit can provide the capability. Multiple organization units can offer the same capability, and each will show a capability offer. A heavy dashed line connects a capability offer to the capability method used by the organization unit to provide the capability. The dotted arrows lead from a capability method to a capability offer used by the capability method through delegation from one or more of its activities.

An organization unit can offer and provide a capability but need not own the capability method. For instance, the bottom of Figure 7 shows that Sales offers Customer Relations but the Fans LOB owns the capability method. This means that the Fans LOB defines the method but Sales receives the requests and assigns the resources to provide the capability.

Measurements and Scenarios

VDML provides the ability to represent the same business model under different circumstances. The structure may be the same, but the measurements differ. We describe these different circumstances as scenarios. So a VDML model might represent measurements of different product mixes with different scenarios. In addition, a capability defined by a capability method might be engaged more than once within a value stream. The measurements of the capability method will likely be different in the different contexts. VDML manages the measurements separately for each occurrence.

For a management dashboard, the current state of the business would be one scenario. However, through

VDML, business analysts can capture the state of the business at different times, or for different product mixes, as separate scenarios for comparison or future reference. If business analysts are exploring potential changes or hypothetical circumstances, they should do so in separate models in order to maintain the integrity of the dashboard.

For a dashboard, expected measurements should be expressed as upper and lower bounds. As a default, variances within six standard deviations might be considered normal, while measurements outside six standard deviations could be flagged as deviations.

LINKING THE MODEL TO REALITY

Elements of a VDML model represent the operational structure and associated measurements of an enterprise. For the model-based dashboard, these measurements must come from the actual operation of the enterprise. In order for the measurements to be timely, it is necessary to implement an automated linkage between the model and the operational business systems. If only one or a few executives have dashboards, they may only need a limited number of monitored measurements, so a business analyst can design the dashboard to specifically query several databases to retrieve those various measurements. However, the goal of the model-based dashboard is to provide not only the measurements of immediate concern, but also to meet the needs of all business leaders as their needs evolve as well as to provide supporting detail for a deeper understanding of problems and potential consequences of corrective actions.

The model-driven dashboard should be available to all managers, and probably business analysts and architects throughout the enterprise as well. The dashboard should provide current information about the user's area of responsibility. A user's area of concern is expressed by the KPIs selected for his or her dashboard and by the target scenario selected for evaluation of variances. The user should be able to use other VDML modeling facilities to understand consequences and explore ideas. Each user will have different interests, different KPIs, and different ways of monitoring those measurements of interest. The benefits of timely and consistent access to data and business models by all managers will justify the investment in a model-based system.

Figure 8 depicts the components of a model-based dashboard and business modeling system. The following sections discuss each component.

Dashboard User Interface

The dashboard user interface is primarily a graphical display. The simplest graphical element would be a number with a caption, or a table with a column of captions and a column of measurements. Upper and lower limits can be displayed in additional columns. The graphical elements in Figure 9 represent those typical in dashboard systems:

- Graphic A is essentially a meter indicating a current value within a range and with the current value displayed in a box.
- Graphic B shows variation in the value of a measurement over time. The X-axis is time over which values

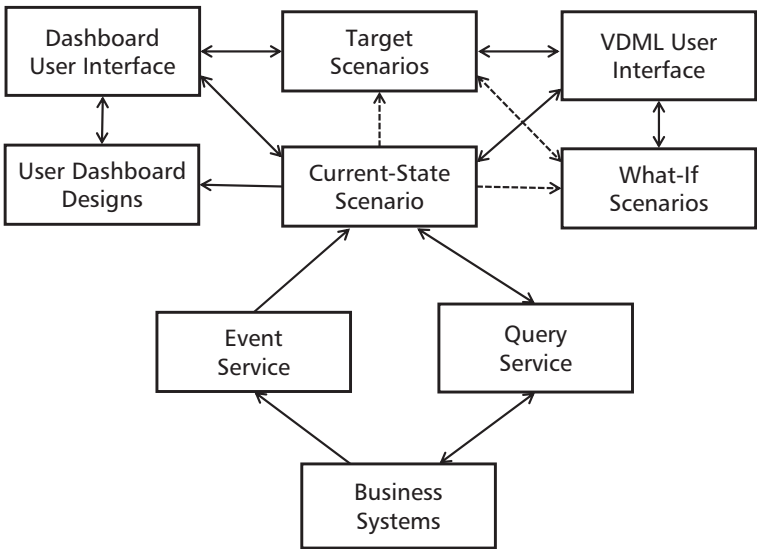

Figure 8 — Model-based dashboard system components.

have been collected (possibly hours since capturing the most recent measurement), and the Y-axis is the measurement value. Horizontal lines above and below represent the upper and lower limits of expected values. The most recent measurement is on the right, so the graph rolls to the left, showing measurements retained for a specified time period.

- Graphic C shows a bar graph comparing multiple measurements. Each bar would be identified for the measurement it represents, and the measurements along the bottom would be scaled to contain the longest bar. This might, for example, represent the contributions to a particular value by a number of different activities in a collaboration or value stream, with the longest bar representing the greatest impact and potentially the activity/capability with the greatest opportunity for improvement.
- Graphic D provides another form of comparison of measurements. A pie chart would have an associated legend for each pie segment.
- Graphic E shows another bar graph, where the bar represents the expected range of each measurement and the pointer identifies the value of the most recent measurement for each.

This is not a comprehensive set of graphics but illustrates some potential diversity. Each graphic should have a pop-up display for additional detail. Each graphic may also specify an action to perform when a measurement exceeds limits, such as flashing, sounding an audible alarm, or sending an email or text message to the user. This illustrates the types of displays that measurements must support.

VDML User Interface

The current-state scenario, the target scenarios, and the what-if scenarios are all developed and managed in the VDML modeling environment. In addition to the concepts and some proposed displays described earlier, a VDML implementation will include various tabular displays of attributes and measurements to support analysis and data entry, including tables for comparisons of equivalent measures over multiple scenarios. We expect that implementers of VDML will define additional user-interface displays based on market demand and implementer innovation.

Business Systems

Operational business systems, at the bottom of Figure 8, are the source of operating data to support the dashboard and detail of the VDML model. The measurements that appear in a manager's dashboard as well as the measurements that support the related VDML models will originate from heterogeneous data stores across the enterprise. This may include relational databases, object-oriented databases, hierarchical databases, more fundamental file structures, and enterprise applications. These sources will have different data structures and data element specifications and names. Some will be batch processing systems that update their data stores periodically. Others may be updated as messages are received and activities are recorded. Operating activities may not be completed on a regular schedule. A dashboard must be supported by these diverse sources.

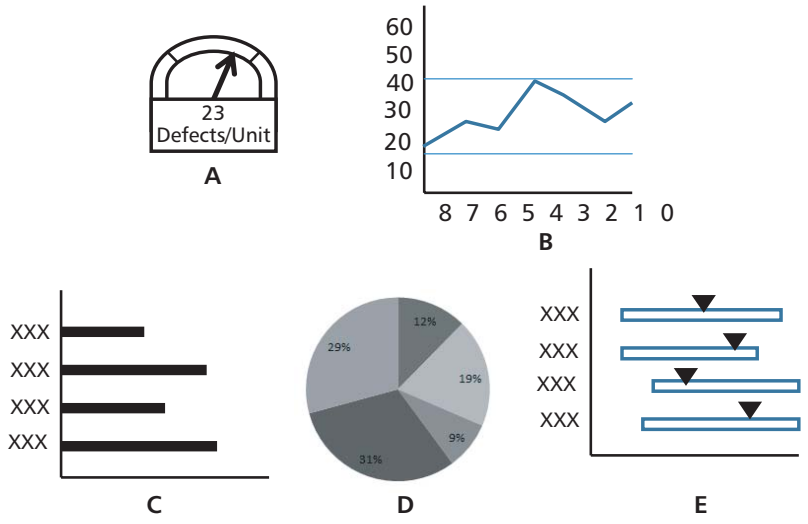

Figure 9 — Examples of dashboard graphical elements.

Query Service

The query service retrieves operational data from various sources as required to update the dashboard. Queries may be issued on a periodic basis to update the dashboard, or they may be issued on demand when the user expresses an interest.

One approach to query support is to use an enterprise information integration (EII) system. EII products have been available for the last 10 years.[11] We will use the EII approach to illustrate the dashboard system requirements. Other system integration products may provide other mechanisms to access the heterogeneous sources.

An EII product provides a virtual database interface through which data from heterogeneous sources can be accessed. The virtual database is a representation of enterprise data that supports a consistent expression of queries to heterogeneous data sources. The data sources are modeled by the query service respecting their particular technology. The virtual database schema is modeled as a relational schema. The transformations between the virtual database and the data stores are modeled. The Common Warehouse Metamodel (CWM) from OMG provides the modeling standard for this transformation.

When a user submits a query against the virtual database, it is translated into queries for relevant elements in one or more of the data source(s). The responses to these queries are then integrated to conform to the virtual database schema and the original query specification. The use of standard modeling technology simplifies the implementation and maintenance of these EII services.

The links from the VDML model to the query service should not only provide the appropriate measurements, but they should also provide access to business metadata. Business metadata should include properties of each data element such as source, date/time of origin, and possibly a confidence-level indication. Different sources may be more or less reliable, they may be updated more or less frequently, and there may be inconsistencies in the basis of measurements from different sources. For example, measurements may be based on inconsistent units of production. When a measurement is computed, the metadata available to the business user should include the computation and business metadata for each element of the computation.

Event Service

The event service (sometimes called an event broker) conveys event notices to the current-state scenario to update its measurements. Events may originate from business transactions or updates of business systems. These events are typically communicated as messages specified with the XML Schema language. Event services have been available for a number of years as a component of enterprise application integration (EAI) and may exist in various forms in commercially available application integration products.

An event service receives notices of actions or data updates and delivers those notices to subscribers. For the dashboard system, there is seldom a need to receive updates for data that is not currently of interest, so subscriptions may only be posted for data of current interest in at least one dashboard. If some events seldom occur, then they should be accepted so that when they become of interest, the associated measurements have a current value without waiting for the next event to occur. Furthermore, only some data element updates will be available as events, and only some data elements are sufficiently significant to require real-time updates, particularly for top management. So use of the event service should be selective. Finally, business metadata associated with events should be available within the event notices forwarded by the event service.

Current-State Scenario

The VDML current-state scenario, representing the current state of the business, is the central component of the model-based dashboard. It determines the measurements that are monitored. For data from the query service, it defines the query expressions and frequency of queries. For data updated by events, it initiates event notification by the event service. It holds the latest value (or sequence of values for a defined time period) for each monitored measurement.

All users share the current-state scenario so redundant updates are not required. Rather than constantly querying for every measurement, the requirements of currently active dashboards and the dynamic nature of each measurement should drive the queries. Furthermore, the current-state scenario should track measurements for which there is current interest — at least one active dashboard design. Certain other measurements may be identified for continuing updates while the remaining measurements may be retrieved on demand to support situation analysis. If a measurement is infrequently updated by an event, then it may be updated even though it is not currently of interest. When a user requires additional data to support analysis, or upon activation of a new dashboard design, then queries and event service subscriptions should be issued for the additional data.

It is also desirable to trace the value of a measurement over time. The need for such historical data is primarily a function of user interest, so it may be appropriate for the dashboard to maintain a history or initiate capture only for selected measurements being observed. However, there may be some measurements where a history is important even though the measurement has not been recently of interest. Consequently, it may be desirable for the current-state scenario always to retain a history for selected measurements.

For efficiency, individual queries may be used to retrieve multiple, related measurements. For batch processing systems, this should include data from business transactions that have occurred since the previous batch processing cycle. Depending on the volume, data for all transactions may be held in the current-state scenario, or if the volume is high, then a sampling of the values over the period may be sufficient.

In general, it is preferable for measurements to be retrieved at an elementary level with computations for aggregation of measurements from more detailed activities performed in the VDML model. This has the following benefits: (1) detailed data will be available for investigation of the root cause of a problem; and (2) the structure of elementary capabilities tends to be stable even though higher-level capabilities, and thus the current-state model, may be reconfigured. However, in the early stages of development, the detail of more elementary methods may not be available, so the dashboard can observe measurements reported for the higher-level, delegating activities.

Target Scenarios

A major challenge for dashboard designers is to present consistent data. A business does not deliver a product (including the result of a service) by simultaneous operation of all the activities in the value stream. Upon delivery of a product, the value stream consists of activities that contributed to that product perhaps days, weeks, or months in the past, depending on the nature of the business. Consequently, measurements associated with current product delivery may be the result of contributions that do not reflect current operation of those long-completed activities.

Furthermore, the data available from heterogeneous sources may be captured at different times and reported for different periods or units of production. Some measurements may be reported as they happen. Some will be reported as the result of an important event or at the end of a shift or other time period. What should appear on the dashboard?

The dashboard should focus on current operations and exceptions. Variances should be based on limits developed from statistical measurements of each operational variable during a typical time period. Exceptions are then defined as statistically significant variations. Upper and lower limits may be generated from the statistical measurements used in a typical VDML model, or the user may set them, particularly for KPIs with targets that differ from actual experience.

In the model-based dashboard system, target scenarios are user-defined scenarios associated with the current-state model. A dashboard user can create a target scenario to define targets for those measurements of interest to that user. The scope is typically one value stream, or a segment of the value stream of interest to that user. The targets become input to a dashboard design to define the expected limits on measurements. The VDML user interface allows users to view and modify target scenarios.

Comparison of current measurements against target measurements has several advantages:

- The user can compare current operating measurements (in the current-state scenario) to limits defined in alternative target scenarios if the current circumstances change.
- Measurements are evaluated independent of the time basis of other measurements that may reflect earlier or later stages in a production process.
- Measurements are independent of different units of production that may occur in different branches of a value stream.
- If there is significant variance, then the associated operation is a concern even though the end product may not be delivered until long into the future.
- Measurements will persist even though processes and organizational responsibilities change.

In order to measure variances against an appropriate target, different scenarios can represent the expected measurements for different classes of product. Thus, the current measurements of an activity can be compared to a target measurement appropriate to the target product of that activity.

In order to support analysis of exceptions that occur later in the value stream, it may be desirable to capture a history of exceptions earlier in the value stream. A target scenario could enable a user to specify those measurements for which exceptions may later be of interest, even though they may not be actively displayed on the dashboard.

What-If Scenarios

What-if scenarios are scenarios that represent alternative circumstances. These may be historical scenarios but more often they will be scenarios used to explore business changes or consequences of variances. Users should define these scenarios in VDML models that are separate from the model that supports the current-state and target scenarios. The current-state scenario and the target scenarios should not be altered to explore ideas. The user interface to these scenarios is the VDML user interface provided by a VDML modeling system provider.

The VDML user interface should support the creation of what-if models from the current-state scenario or one or more target scenarios. For example, a business analyst can create a what-if model and scenario as a copy of the current-state scenario for analysis and exploration of a current problem. Or, a business analyst can create a what-if model and scenario from a target scenario to analyze statistical measurements for a value stream.

A business analyst can also create a broader what-if model by combining the current-state scenario with target scenarios for different value streams. For a shared capability method, the what-if scenario will contain a set of measurements for each use of the capability method. Tabular displays should support comparison of the corresponding measurements for each use of the capability method. Similarly, each value stream will have its own value proposition(s) within a combined what-if scenario.

Not all what-if scenarios should be implemented in the same VDML modeling environment. It should be expected that users may have personal VDML models and associated scenarios, independent of the dashboard system, to support their efforts.

Later, in the "Evolving Reality" section, we will consider some of the implications of using the VDML model beyond the scope of dashboard support.

User Dashboard Designs

The dashboard provides a display capability, discussed earlier, that can be tailored to the specific requirements of each manager. A manager should be able to configure his or her dashboard similar to a diagram in a PowerPoint slide with the addition of some data specifications. A manager may have a number of dashboard designs in his or her library that may be useful under different business conditions.

A dashboard design will include the specifications for each monitored measurement by reference to the current-state model, along with the graphical form of the measurement as well as the placement of the graphical element on the dashboard canvas. The dashboard design will incorporate one or more target scenarios to define the upper and lower limits for measurements. It might also specify email or text messages to be generated for certain events or exceptions. The dashboard will trigger queries to the query service and subscriptions to the event service through the current-state scenario.

Implementing a Dashboard System

A complete dashboard system that covers the enterprise for all LOBs, business leaders, and capabilities is a major undertaking. The process should move forward in beneficial increments.

The first step toward implementation of a model-based dashboard is the development of a VDML model for a selected value stream with manually entered measurements. The implementation should focus on measurements of the most important values. This provides a basis for understanding the modeling concepts and should provide benefit for the analysis of value delivery and the evaluation of potential improvements to specific capabilities. The granularity of the model will be a factor in both the time to develop the model and the benefit derived from it. In the long term, enterprises should model activities and supporting capabilities at a level of detail where the most detailed capabilities are relatively generic and useful as sharable value stream building blocks. Users can then aggregate measurements from these capabilities to the more abstract levels.

However, in the short term, it may be more practical to limit detail and use aggregated measurements observed for higher-level, delegating activities. Enterprises can then expand this foundation over time to model additional detail and additional value streams, providing support for consideration of consolidation and management of shared capabilities. This is all within the expected scope of a VDML model.

The next step involves implementation of the query service, the dashboard user interface with the dashboard designs, and the target scenarios. This should begin with one value stream as well. The value stream model will identify the required measurements and provide a basis for specification of accesses to the business systems by the query service. Once the pilot value stream is stable, additional value streams should be added for an expanded user community.

Implementation of the event service may be deferred depending on the nature of data sources and the need for immediate updates. Generally, managers closer to actual business operations will need more timely data in order to react in a timely manner. If executives are the initial users, it may be practical to defer implementation of event-driven updates. However, coordination of updates with batch processes may still require that some updates be event-driven.

THE EVOLVING REALITY

The use of VDML should not be limited to supporting a management dashboard, but rather should provide a modeling environment for ongoing analysis, design, and transformation of the enterprise. VDML can provide a better understanding of business relationships by modeling relationships that often do not appear on organization charts. Many existing enterprises operate in LOB silos with business processes optimized for delivery of current products. VDML is particularly suited to the development and management of shared capabilities, and optimization from an enterprise perspective. The modeling capabilities of VDML along with other changes in technology, markets, and the business ecosystem will shape the evolution of the business.[12] In this section, we present several aspects of such business transformation.

Capability Consolidation

Consolidation of capabilities as shared services will drive separation of the management of shared services from LOB management. Shared services will support multiple lines of business. Management of those shared capabilities must be unbiased in their support for the different LOBs and must focus on meeting customer requirements and achieving economies of scale.

Consolidation of shared capabilities may also lead to outsourcing. For non-mission-critical capabilities, an outsourcing provider can achieve greater economies of scale (across multiple clients) and will likely provide greater scalability to accept new clients and enable those clients to adapt to changes in market demand. VDML models will assist in defining the scope of outsourcing and in managing the relationship.

A shared capability may be used to provide multiple services to multiple internal customers. The manager of a shared capability should have well-defined capability interfaces and service-level requirements (i.e., value propositions). Users of the shared capability should not be concerned about how the service is performed, except as it impacts the product of their value stream and the cost, timeliness, and quality of their product.

Thus, the dashboard should be a primary tool for monitoring both LOB performance and performance of shared services — both internal and outsourced. Each has a value stream, and their value propositions should reflect the multiple measurements of their performance.

Accountability and Empowerment

The dashboard provides every manager with knowledge about the current state of the business, the performance of subordinates, and the consequences of variances. Based on the VDML model, top management can trace problems with customer values back to sources of those problems and the responsible organization units. As such, accountability for problems as well as improvements will be more apparent. This accountability also clarifies the scope of authority of individual managers and their impact on the end products and services.

Consequently, a shared service manager has a well-defined domain in which to innovate along with a well-defined group of consumers for collaboration on changes that might affect the value propositions of his or her service. Based on VDML and his or her dashboard, the capability manager also has insight on the affect of the capability on end customers and thus can identify justification for investment in improvements. This should enable managers at all levels to explore innovative ideas.

The same principles apply to outsourced capabilities. The outsource provider must have well-defined interfaces and value propositions. However, the outsource consumer does not have control over the implementation of the service or investments in improvements. The consumer must monitor and enforce the interface and value proposition requirements and negotiate any changes to requirements.

In either case, the consumers of shared services have primary responsibility for enforcing the service agreements and thus must devote some resource to that effort.

Finally, the clarity of responsibilities and the impact on the enterprise motivate and empower individual managers to improve their own operations, and they help clarify where work with other managers is needed to resolve broader issues.

Risk Management

Consolidation creates single points of failure. Service disruption or failure of a consolidated capability affects each LOB that relies on that service. On the other hand,

those factors that may affect a capability are no longer scattered across multiple LOBs, but instead can be mitigated in one place. This is particularly true for regulatory compliance as well as management of critical resources.

The primary method of mitigation is to provide redundancy. Enterprises can achieve redundancy through multiple capabilities, or within a consolidated capability with redundant facilities, cross-training, operations in multiple locations, reserves of critical materials, and other such means. Yet these measures will increase costs. If the cost exceeds the benefit of economies of scale, there must be other factors managers can consider. For instance, a former, fragmented capability may have carried unrecognized risks, or there may be overlooked diseconomies of scale, such as consolidation resulting in increased transportation costs.

VDML can assist in risk analysis through consideration of the impact of each capability on the value streams. Managers can use deliverable flows and value contributions to understand the propagation of effect of a capability disruption. Some capabilities may only affect certain products or services, while others may have mitigated risks. Similarly, the manager dashboard can reflect the impact of a disruption or failure when it occurs.

The development of shared services and value propositions for services and LOBs clarifies responsibilities for risk awareness and mitigation. Managers should consider the risks to their operations and assess the impact they could have on each LOB their capability supports. They should also, in many cases, be the first to know of an adverse event or impending problem and take action to alert their management and mitigate the effects. A disruption-alert value measurement could be propagated down all affected value streams.

Furthermore, the VDML model can predict when a variance of an early activity will impact the end product or a critical later activity. Assuming that activities have a duration measurement, the durations of activities between the early variance and end product delivery provide an estimate of when the effect will be realized. Furthermore, if the activity is a shared service, then the consequences can be identified for the multiple value streams.

Enterprises can use their understanding of delayed impact on subsequent activities for risk mitigation. If an activity fails or a key resource is unavailable, then that activity and subsequent activities will stop unless there are inventories (VDML stores) in the value stream that enable subsequent activities to continue. Activities, such as transportation of materials, may be interrupted frequently, so enterprises can maintain stores of shipped resources to allow for late or failed deliveries. Enterprises may maintain redundant capabilities to absorb the lost production capacity of a failed capability, but then the redundant capability must have adequate capacity. A loss of capacity of a shared capability may call for consideration of priorities among LOBs considering differences in profitability and customer dissatisfaction.

Capacity Management

While economies of scale can save money by reducing excess capacity, consolidation can also create a risk where increased demand from multiple LOBs will exceed the capacities of shared services. Such competition for shared resources may not be obvious when the LOBs are organizationally quite separate from the management of shared services. When these capabilities are within the individual LOB organizations, management may be more aware of the limitations and may be in a better position to reallocate resources or fund expansion than the manager of a shared service that has a smaller and more restricted budget.

VDML can assist in tracking capacity and demand. Changes in demand can be reflected in VDML scenarios for future time periods, and the effects from multiple LOBs can be identified for shared services. Managers can trace the implications of changes in demand through the value streams to identify capabilities that may be challenged to meet the needs of demand aggregated from multiple LOBs.

VDML can also help identify opportunities for sharing resources across organization units. Where managers can identify similar resources (e.g., skilled personnel or specialized equipment) in different organizations, pooling of resources may reduce the risk that the aggregated need for resources will exceed the total available resources for the participating organization units. To facilitate such sharing, enterprises may bring together organization units with similar resources under a parent organization unit that can optimize workload balance.

Cost Recovery

Enterprises must allocate the cost of shared services to the LOBs supported by those services to ensure that the lines of business are accountable for their full cost and to provide appropriate incentives and accountability to control the costs incurred by the shared services. The cost of shared services should not simply be allocated as enterprise overhead. Some LOBs will make greater use

of a shared capability than others. Not charging an LOB for the cost of services invites "cost shifting," and top management will be unable to accurately evaluate the performance of each LOB, or the shared services.

This does not necessarily mean that each rendering of a service should be precisely billed for resources consumed. In some cases, the cost of each service rendered should be billed because the costs vary significantly. For example, warehousing may be a shared service, but some LOB may make considerable use of the warehousing of parts or finished product, while others that build to order may have minimal warehousing requirements. VDML and the manager dashboard should reflect these cost differences as part of the value stream monitoring and analysis for each line of business. The VDML model should help define appropriate cost allocations.

Costing is an art. Multiple value streams may realize the benefits of some costs but reasonable allocations may depend on the nature of the activities and/or the work products. For example, a premium product feature has an installation cost but the addition of that feature reduces the cost of a related premium feature, so the cost of both premium features is less than the sum of the individual premium features. Or the cost of producing a base product may depend on how many premium products (possibly a different value stream) are being produced at the same time. Nevertheless, objective cost analysis will be increasingly important for management of an enterprise with shared capabilities and outsourcing.

Extended Applications of VDML

The dashboard focus and the VDML discussion in this report have focused on the value streams that produce products and services for end customers. As the enterprise realizes the benefits from models developed for LOB value streams, they will soon recognize the potential benefits of application to other areas of the enterprise.

Close to mainstream business are support services that sustain operational capabilities. For example, production engineering, machine maintenance, and materials management are essential to a manufacturing operation, but they do not contribute directly to the value stream. Enterprises can model these activities and thus monitor and evaluate their value contributions.

Traditional business support services, such as accounting, purchasing, HR, and IT, can have value streams and value propositions as well, reflecting the value of their services to internal consumers. Modeling can clarify the impact these services have on mainstream business and can help identify opportunities for improvement. This can help in the consideration of outsourcing such services, providing the basis for interface specifications and SLAs even though the implementation of the service provider may not be visible to the client.

Enterprises can also define value streams for internal activities to manage or transform itself. A project is a collaboration — more specifically, a capability method. Managers can plan projects, incorporating existing capabilities and services, and then monitor them in dashboards in the same manner as high-volume production processes. Such projects may involve changes to production facilities, strategic change initiatives to business methods, introduction of new products, or IT application development projects. VDML can tie these undertakings into related aspects of the business and clarify the needs and accomplishments for additional collaborations.

CONCLUSION

A model-driven dashboard can provide a current and consistent view of the state of the enterprise for managers across the enterprise. This will improve understanding and the ability to reach consensus on business decisions. It will also empower individual managers to improve their operations with a greater understanding of the impact on the LOB they serve or are responsible for. Clarity in the way the business operates will expose opportunities for improvement and foster innovation, ultimately making ongoing business change a competitive necessity.

This operational visibility, along with visibility of business design, will improve accountability, capacity management. and risk management, and will enable restructuring of the business, particularly in consolidations of capabilities and possibly in outsourcing to improve efficiency and agility. Clarity of value streams and associated values may reveal opportunities from restructuring, such as concurrent or batch operations.

Enterprises should undertake the implementation of a model-based dashboard in stages, but with an understanding of the end solution. The first stage should focus on one value stream and top-management dashboards based on query access to priority data. As this becomes stable, the scope should be increased to include more value streams and more data access. Managers should first be exposed to VDML modeling and then implementation of their dashboards. As more managers become involved, particularly those closest to day-to-day operations, an event service should be implemented to provide more timely updates to the more volatile and time-critical data.

In the long term, a model-based dashboard helps managers throughout the enterprise become more engaged in innovation and collaboration in order to improve operations for the benefit of the enterprise. Thus, the enterprise will operate more efficiently and be able to more quickly adapt to challenges and opportunities.

ENDNOTES

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ABOUT THE AUTHOR

Fred Cummins is a former EDS and HP Fellow with a long career in IS development and consulting. Throughout his career, he has worked with leading-edge technologies and their impact on business, including distributed systems architecture and integration, object-oriented systems, knowledge-based systems, computer-based modeling, and technology strategy. Mr. Cummins has developed systems and functioned as a technical advisor across multiple industries, including manufacturing and distribution, financial services, transportation, insurance, healthcare, and government. He has been an active participant in the OMG for 18 years and cochair of the OMG Business Modeling and Integration Task Force for the last 13. Mr. Cummins is currently a leader in the development of specifications for Value Delivery Modeling Language and Case Management Model and Notation. He has authored numerous papers and three books, most recently *Building the Agile Enterprise with SOA, BPM, and MBM*. He can be reached at fred.a.cummins@gmail.com.

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DIGITAL INNOVATION & TRANSFORMATION
Karim Lakhani, Fellow, Cutter Consortium
Keynote followed by Panel

GE & THE INDUSTRIAL INTERNET
Karim Lakhani, Fellow, Cutter Consortium
Case Study

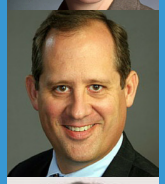
THE CLOUD BUYER'S PLAYBOOK
Dr. James Mitchell, Senior Consultant, Cutter Consortium
Keynote

MANAGING CHANGE FOR BUSINESS TRANSFORMATION
Sheila Cox, Senior Consultant, Cutter Consortium
Hands-on Exercise

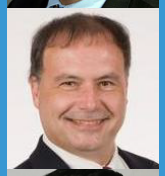
LIGHTNING TALKS
Moderated by Lou Mazzucchelli, Fellow, Cutter Consortium

TUESDAY, NOVEMBER 15

BUSINESS ARCHITECTURE
Whynde Kuehn, Senior Consultant, Cutter Consortium
Deep Dive/Workshop



CIO/CTO ROUNDTABLE
Vince Kellen, Fellow, Cutter Consortium
Forum



SCALING AGILE
Tom Grant, Director, Cutter Consortium Agile Practice
Deep Dive

CREATING NEW PRODUCTS & SERVICES FROM LARGE DATA SETS
Vinay Venkatraman, Senior Consultant, Cutter Consortium
Keynote, followed by Panel Discussion

THE ROBOTS ARE COMING TO DIGITALLY TRANSFORM US; THE CLOUD IS LOOKING FOGGY...THE END OF THE WORLD AS WE KNOW IT?
Robert D. Austin, Fellow, Cutter Consortium
Keynote

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