Enterprise Portal Engineering

By Alan Perkins
Chief Solutions Architect
ASG Federal

The business-driven, information-centric, architecture-enabled Enterprise Portal Engineering methodology described in this paper provides an effective, productive, common sense approach to developing, implementing and managing Enterprise (Information) Portals

Table of Contents

Introduction ...............................................................................................................................................1
What Is an Enterprise Portal? ...................................................................................................................1
Enterprise Portal Structure and Components ...........................................................................................2
Strategic Enterprise Portal Engineering ....................................................................................................3
A Case Study – National Guard Counterdrug ............................................................................................10
  The Problem: .........................................................................................................................................10
  The Solution: .........................................................................................................................................10
  Results: ..................................................................................................................................................11
Summary ...................................................................................................................................................11
Introduction

The latest "silver bullet" for IT is the Enterprise Portal. It has many names: Enterprise Portal, Enterprise Information Portal, Corporate Portal, Web Portal, and just plain Portal. Whatever it's called, portals promise to provide necessary information from any source to anyone who needs it. This has the potential for significant productivity and competitive gains. While Enterprise Portals may have this potential, it is not easy to deliver -- even with new tools and technologies and single point access to heterogeneous information, in multiple formats, from multiple sources. In order to be truly effective, Enterprise Portals cannot just happen -- they must be "engineered." This paper provides a simple definition for Enterprise Portals, describes their benefits, and outlines a method and tools for easily and efficiently engineering them.

What Is an Enterprise Portal?

Simply stated, an Enterprise Portal is a extension of an enterprise data warehouse that delivers, via Internet, Intranet, and/or Extranet, not only structured internal data, but unstructured data from both internal and external sources.

The term "Enterprise Information Portal" was first published in a report by Merrill Lynch, November 16, 1998. The report states,

"Enterprise Information Portals are applications that enable companies to unlock internally and externally stored information needed to make informed business decisions. Enterprise Information Portals (EIP) are an emerging market opportunity; an amalgamation of software applications that consolidate, manage, analyze, and distribute information across and outside of an enterprise (including Business Intelligence, Content Management, Data Warehouse and Data Mart, and Data Management applications).

1. **EIP systems provide companies with a competitive advantage**: Corporate management is just realizing the competitive potential lying dormant in the information stored in its enterprise systems. … EIP Applications combine, standardize, index, analyze and distribute targeted, relevant information that end users need to do their day-to-day jobs more efficiently and productively. The benefits include lowered costs, increased sales and better deployment of resources.

2. **EIP systems provide companies with a high return on investment (ROI)**:… EIP products help companies cut costs and generate revenues.

3. **EIP systems provide access to all**: The Internet provides the crucial inexpensive and reliable distribution channel that enables companies to make the power of information systems available to all users (employees, customers, suppliers). Distribution channels include the Internet, Intranet and Broadcasting."

Both the full report and a summary can be downloaded from the SageMaker web site [www.sagemaker.com/company/lunch.htm].

An Enterprise Portal is typically a blending of technologies, including:

- Relational and multidimensional databases
- Client/server architecture
- Extraction/transformation programs
- Graphical user interfaces
- Content-management servers
- Search tools
- Automated classification engines
- Content catalogs
- Extensible Markup Language tools
- Directories

One of the principal reasons for developing an Enterprise Portal is to integrate internal data with external information from various sources into a single and consistent architecture that supports analysis and decision-making within the enterprise. Enterprise Portals are one of the hottest industry trends — for
good reason. A well-defined and properly implemented Enterprise Portal can be a valuable competitive tool.

Enterprise Portal Structure and Components

In their book, Building Corporate Portals with XML, McGraw Hill, 1999, Clive Finkelstein and Peter Aiken describe Enterprise Portals in terms of their evolution from Data Warehouses. “An Enterprise Portal extends the concept of a data warehouse to intranets and the Internet.”

This means that it is necessary to understand Data Warehouses in order to Enterprise Portals. A Data Warehouse is a subject-oriented repository designed with enterprise-wide access in mind. It provides tools to satisfy the information needs of enterprise managers at all organizational levels — not just for complex data queries, but as a general facility for getting quick, accurate, and often insightful information. A Data Warehouse is designed so that its users can recognize the information they want and access that information using simple tools. A more complete definition of Data Warehouses is available in other white papers by the author.

The components and structure of a typical Enterprise Portal are illustrated in Figure 1. This diagram is adapted from the Decision Processing Blueprint found on the DataBase Associates Decision Processing [www.decisionprocessing.com] web site.

![Figure 1. Enterprise Portal Components and Structure](image-url)

Finkelstein & Aiken describe the Data Warehouse to Enterprise Portal evolution as follows:
1. **Transaction data** is extracted and transformed from structured data sources such as operational databases and transactions from batch and online systems. **Business Knowledge** resources may be extracted and transformed from unstructured data sources on the corporate intranet. **External Information** may be source data from the Internet or extranets.

2. ETL (extract, transform, and load) Tools use meta data defined in the *Meta Data Interchange Hub* (repository) as well as *ETL Templates* as guides. The meta data is defined in an *Enterprise Architecture* model (more about that later) plus *Business Area and Data Model Templates*.

3. The central role of the **Enterprise Data Warehouse** is as an information clearinghouse used to manage all of the acquired data and information.

4. The Enterprise Data Warehouse is used by **Analytic Applications** (e.g., OLAP --Online Analytical Processing) and **BI Tools** (e.g., EIS -- Executive Information System, DSS -- Decision Support System, DEW -- Decision Early Warning) to Analyze, Model, and Distribute the information based upon the **Business Information Directory**.

5. Distribution of **Information and Analyses** is via **Web Interface** and **Enterprise Portal**.

6. Business Information is distributed for many uses. These include Business Performance Management, Customer Relationship Management (CRM), Supply Chain Management (SCM), Financial Management, and Human Resource Management.

7. Based upon **Business Decisions** (and actions), changes may result in **Performance Measures & Metrics**, **Business Knowledge**, **Transaction Data**, or **External Information** and the business information value chain begins again.

---

**Strategic Enterprise Portal Engineering**

The methodology described in this paper, coupled with appropriate computer-based tools, provides flexibility and capability to easily develop and manage Enterprise Portals. **Enterprise Portal Engineering** is the process of designing, developing, and deploying data warehouses and enterprise portals that provide homogeneous access to vast amounts of facts using meta data, XML, Internet and Intranet technologies. By applying engineering concepts to design, development, and deployment of Enterprise Portals, organizations can achieve *information alignment* -- identify the information needed by all stakeholders and portal users to achieve enterprise goals and objectives. They can also achieve *information leveraging* -- accurately and effectively manage large amounts of information through automated meta data management.

"Enterprise Portal" and "Data Warehouse" are relatively new terms that describe the methods and concepts that have been used for almost twenty years to develop and implement Executive Information Systems (EIS), Decision Support Systems (DSS), and Management Information Systems (MIS). These years of practical experience have been distilled as best practices in **Strategic Enterprise Portal Engineering** (illustrated in the figure below).

Strategic Enterprise Portal Engineering is an iterative, disciplined approach that integrates proven best practices with state-of-the-art tools and includes active participation of potential users.

Like any other large information systems project, Enterprise Portal development can get bogged down if the scope is too broad, and the number of people involved is too large. A clear purpose and scope are necessary to manage the application of information systems resources, as well as the expectations of potential users. The scope of development can be limited by building an Enterprise Portal one subject area at a time. Each subject area supports a single organizational element, enterprise function or business object (e.g., customer, product, account, etc.), and the scope of development is limited by the subject area requirements.

For the initial subject area, which usually provides the Enterprise Portal proof-of-concept, the scope must be sufficient to provide real, immediate, and high profile benefits. After the first subject area is developed and implemented, additional subject areas can be developed and integrated over time as enterprise needs dictate and as resources are available.
Figure 2. Strategic Enterprise Portal Engineering
Designing and developing an Enterprise Portal or a Data Warehouse using this approach involves five key activities:

1. Establish sponsorship;
2. Identify and document enterprise needs;
3. Design architecture;
4. Apply appropriate technology; and
5. Implement.

1. Establish Sponsorship

The first step is to establish sponsorship, if it does not already exist. Establishing the right sponsorship chain will help ensure successful development and implementation. The sponsorship chain should include an Enterprise Portal manager and two other key individuals. At the top of the chain is an executive sponsor with resources to invest in information infrastructure improvement. A project “driver” between the executive sponsor and the Enterprise Portal manager keeps the project moving and on schedule. Everyone of these individuals must have authority to act independently to manage the project and make decisions.

An important aspect of establishing sponsorship is ensuring everyone in the enterprise understands the purpose of the Enterprise Portal, its potential benefits, and the enterprise’s plan for implementation. An Enterprise Portal Engineering plan should be developed early in the cycle and should address all of the necessary activities.

2. Identify Enterprise Needs

Identifying enterprise needs is a major component in the engineering life cycle for any information system, and it is crucial when engineering an Enterprise Portal or a Data Warehouse. When developing operational systems, there is often one single enterprise sponsor or one group of users with a clear view of what they need, what the system should look like, and how it should function. When developing an Enterprise Portal, there are always multiple potential users, each with a different idea of what an Enterprise Portal is and what it should provide. Because of this lack of a single focused direction, identifying precise enterprise needs is critical to the success of an Enterprise Portal project.

Enterprise needs can best be expressed in terms of enterprise goals, objectives, measures and critical success factors. An enterprise’s business plans typically provide the basis for defining enterprise strategic information needs. Interviews with key enterprise managers and analysis of other pertinent documentation are other techniques used to determine these needs.

Determine Measurement Cycles

Completely defining an enterprise measure includes describing the cycles or time periods used for the measure. Are quarters, months, or hours appropriate for capturing useful measurement data? How much historical data will be needed? These vary greatly by enterprise. The United States Federal Reserve Bank views enterprise measures in monthly, quarterly and annual increments and uses years of historical data to determine trends in the economy. An insurance company requires decades of actuarial data for meaningful measures. A telephone sales operation, on the other hand, uses hourly enterprise measures and may only keep a few weeks of information.
Validate Measures

After identifying and defining enterprise needs, it is absolutely necessary to communicate them throughout the enterprise. One of the best justifications for undertaking an Enterprise Portal project is the synergy achieved through the process of defining and then communicating its critical success factors and measures. Everyone becomes aware of precisely what defines success and how it is measured. In addition, the measures undergo a “reality check” by people who were not involved in their development, but who may be measured by them and who will be involved in creating the raw data from which the measures will be derived. Their feedback is used for refining the measures.

Resolve Data Conflicts

As enterprise portals are developed, businesses frequently discover that very similar data entities and processes exist in various departments under different names. If not corrected, homonyms, synonyms, and other data conflicts may be integrated into a corporate data warehouse as duplicative, inefficient data elements or processes that generate unnecessary and erroneous complexity. One of the most commonly misused terms is “customer.”

To the Accounting Department, “customer” could mean the organization (or individual) that receives a bill. “Customer” could also mean an individual receiving service or buying a product. To the Sales Department, “customer” could mean the organizations on which the salesperson calls. Providing any one of these interpretations as the enterprise definition of “customer” would not meet the needs of the enterprise and would doom its Data Warehouse effort to failure. Additionally, each department could use different names to describe the same data entity (Customer vs. Client vs. Prospect vs. Account…).

It is advisable to take great pains to resolve all data conflicts in the Enterprise Portal information model before continuing with the next phase of the development cycle.

Build an Enterprise Portal Model

Enterprise needs should be documented in an Enterprise Portal Model that links enterprise needs with Enterprise Portal data entities and enterprise rules, becomes both requirements documentation and a source for communicating the contents of the Enterprise Portal (its meta data) to its users. Measures, critical success factors, and business rules are documented as business-language statements. Supporting Enterprise Portal data entities are documented in a corresponding data models. Providing a clear and unambiguous definition of every data entity, describing the way each is used, as well as defining derivation formulas, aggregation categories and time periods, are activities critical to capturing a clear understanding of an enterprise’s measures.

3. Design Enterprise Portal Architecture

After defining and thoroughly documenting enterprise needs (measures and critical success factors), the organization can begin actual Enterprise Portal architecture (meta data) design. Like the process for identifying and documenting enterprise information needs, this activity also involves active user participation in facilitated sessions. There are two types of Enterprise Portal meta data that needs to be designed: structural and access.

Structural meta data is used for creation and maintenance of the Enterprise Portal and its supporting Data Warehouse. It fully describes both structure and content. The basic building block of structural meta data is a model that describes its data entities, their characteristics, and how they are related to one another. The way potential users currently use, or intend to use, enterprise measures provides insight into how to best serve them from the Enterprise Portal, i.e., what data entities to include and how to aggregate detailed data entities. An Enterprise Portal data model provides a means of documenting and identifying both strategic and operational uses of enterprise
measures. It also provides the capability to document multi-dimensional summarization of detail data.

Naturally, the number and specificity of data aggregation categories in an Enterprise Portal will depend directly on the types of individuals who participate in design sessions.

Strategic thinkers tend to look for “big picture” answers, and therefore need very few aggregation categories. The “roll-ups” for each strategic aggregation of data, however, can be quite complex.

Operational thinkers have a tendency to want to dissect and review every measure by every category used in their part of the enterprise, and thus tend to require large numbers of less complex aggregation categories.

Structural meta data identifies the system of record for all Data Warehouse data entities. It also fully describes the integration and transformation logic for moving each Data Warehouse entity from its system of record to the Data Warehouse. In addition, structural meta data defines the refreshment schedule and archive requirements for every data entity.

When the Data Warehouse or Enterprise Portal structure changes, its meta data is changed accordingly. Old versions of the structural meta data are kept to document the changing nature of the Data Warehouse and allow access to archive data. This will ensure that decision support activities, such as trend analysis and data mining, continue to provide quality results.

Structural meta data also includes performance metrics for programs and queries so that users and developers know how long programs and queries should run. Enterprise Portal and Data Warehouse performance tuning also uses these metrics.

Access meta data is the dynamic link between the Enterprise Portal and end-user applications. It generally contains the enterprise measures supported by the Enterprise Portal and a dictionary of standard terms including user-defined custom names and aliases. Access meta data also includes the location and description of Enterprise Portal and Data Warehouse servers, databases, tables, detailed data, and summaries along with descriptions of original data sources and transformations.

Access meta data provides rules for drill up, drill down and views across enterprise dimensions and subject hierarchies like products, markets, and customers. Access meta data also allows rules for user-defined custom calculations and queries. In addition, access meta data contains individual, work group, and enterprise security for viewing, changing, and distributing custom calculations, summaries, or other analyses.

A critical part of designing the Enterprise Portal architecture is reverse engineering existing operational systems and external data sources as physical design models in the architecture repository. Every data element in every physical design model must be associated with its logical counterpart in the logical strategic information model. This provides the basis for gap analysis and defining transformation requirements.

Identify Systems of Record

Clearly defining Enterprise Portal and Data Warehouse architecture also involves identifying the correct source of raw operational data to populate the Data Warehouse as well as internal and external sources of unstructured data. This effort also addresses possible integration and transformation logic. Identifying the sources of Enterprise Portal data entities is one means of validating the Enterprise Portal Model and Architecture Design.

Apply the Correct Technology Solution

Only after fully defining enterprise requirements and designing the architecture should an enterprise begin to select the technology for an Enterprise Portal. Key technology issues, in addition to determining the hardware/software platform, include developing programs for loading information into the Data Warehouse, implementing access control (security) mechanisms and selecting one or more Enterprise Portal user interface tool sets. It is important for Enterprise Portal engineers to realized
that choosing a technology before fully understanding the requirements for the technology is a sure recipe for failure.

**Design User Interfaces**

Enterprise Portal users get useful information through user interfaces, which are always browser-based, offering a ubiquitous, easy-to-use interface via secure Intranet, Extranet, or the Internet. It is the quality of these user interfaces that has the most impact on how users will perceive the Enterprise Portal. User interfaces should be designed to the following criteria.

- Two criteria for an effective user interface are ease of use and performance. For ease of use, most enterprises establish a user-friendly graphical user interface that reflects the corporate culture. For performance, developers must ensure that the corporate browser, which should be hardware/software platform independent, fully supports and is optimized for every chosen user interface paradigm.
- Another important selection criteria for user interfaces are the information needs and the level of computer literacy of potential users. A general rule is that users of highly summarized data need simple, extremely graphical interfaces, and detail data users need more complex, but less graphical tools.
- One more critical user interface criterion is that the interface supports the access meta data designed for the Enterprise Portal.

If a user interface is easy to use, allows all potential users to get the information they need in the format they need, and does it in an acceptable amount of time, it is the right interface. It is generally easier to design the correct user interface if the users are involved in every step of the development/deployment life cycle.

**Determine Hardware/Software Platforms**

Because an Enterprise Portal is only accessed via a browser, the principal hardware consideration will be to ensure that all potential users of the Enterprise Portal have devices that allow them sufficient access and reasonable response time. Because an Enterprise Portal typically is integrated with an Enterprise Data Warehouse, the following are some important hardware platform considerations:

- How much data will be in the Data Warehouse and how much can the platform accommodate economically? How scaleable is the platform? Is it optimized for Data Warehouse performance? Will the platform support the software selected for the Data Warehouse?

Concurrent with hardware selection is the selection of system software to support the Enterprise Portal browser and the Data Warehouse. Among the choices are operating systems, development software, and database management systems. The structure and size of the Data Warehouse will determine system software requirements. For example, an Enterprise Portal, by its very nature, will require not only relational technology, but also multidimensional access and a client/server architecture.

**Develop Integration and Transformation Programs**

Integration and transformation programs are necessary to extract information from operational systems and databases for both initial load and subsequent updates of the Data Warehouse. Sometimes, it is possible to develop a single program for both initial load and periodic updates of the Data Warehouse, but often circumstances make this an unacceptable development option.

- A separate initial load program is necessary when the volume of initial data is so large that it cannot be transferred without adversely impacting other users of the operational systems. This is particularly true when initial load and update volumes are significantly different.
• Separate programs also should be considered for capturing historical data from the operational systems for loading into the Data Warehouse, because this is usually a one-time process.

• An additional reason for separate initial warehouse loading programs involves historical data maintained separately from the operational systems (many operational systems only maintain the most recent values for data). This situation usually requires retrieval of historical data from archive and backup files.

Usually one set of integration and transformation programs initially loads the Data Warehouse, and a second set periodically updates the Data Warehouse. Update programs are generally smaller and simpler than programs developed to load the Data Warehouse. Update programs often are built into operational systems to trap new occurrences of data as they are added. This works best for well-documented, in-house operational systems. Update programs that extract data from commercial off-the-shelf software or from older, poorly documented, legacy systems typically capture and transform just the changes made since the last update. Over time, update programs will be changed to reflect changes in both operational systems and other data sources.

Develop security policy and procedures.

A Data Warehouse is a read-only source of enterprise information, therefore developers need not be concerned unduly with controlling create, update and delete capabilities for structured internal data in the Enterprise Data Warehouse. Enterprise Portals can similarly provide read-only access as a Decision Processing Portal. But as an Operational Portal, an Enterprise Portal can also allow secure access to operational databases and - based on change authorization - can create, read, update or delete any data. Thus developers must analyze and implement sufficient security to ensure data integrity.

For both the Enterprise Data Warehouse and Enterprise Portal, developers will need to address the trade off between protecting a valuable corporate asset against unauthorized access and making the data accessible to anyone within the enterprise who can put it to good use. The best solution is to allow everyone in the enterprise to have access to the enterprise measure definitions and derivations, but only allow access to the underlying detailed data only on an approved, need-to-know basis.

In addition to access security, an enterprise must be concerned with physical security for its internal Data Warehouse. Because its contents are an extremely valuable corporate resource, they must be protected against loss and damage. This protection is available in many forms ranging from simple backup and off-site storage strategies to installation of no-break power and redundant disk storage and computer systems.

4. Implement the Data Warehouse and Enterprise Portal

Data Warehouse implementation includes loading the preliminary data, implementing transformation programs, designing a user interface “look and feel,” developing standard queries and reports, and thoroughly training Data Warehouse users.

Implementation begins with integration and transformation programs for ensuring data quality. Effective loading and maintaining of data in the data warehouse is critical for decision support activities and also for providing information to all users and stakeholders. Also, in order to allow users to properly compare data based on different periods of time, it is important that the data warehouse databases allow for the building of history, and not just provide snapshots that are valid only at one point in time.

At the same time the Data Warehouse is being loaded, external data sources should be identified and arrangements made to acquire the data when appropriate. Some external data elements, particularly those from trusted, structured sources will be loaded into the Data Warehouse with the internal data. Other data elements will be acquired periodically and stored in segregated data stores where they cannot impact internal data. Still other data elements will only be acquired upon demand and will be
extremely transient. These data elements usually have no lasting value and therefore are not stored but are used once and replaced as needed.

A Case Study – National Guard Counterdrug

The author has participated in several Enterprise Portal Engineering projects. One of the most interesting, and challenging involved developing a strategic enterprise information portal for the National Guard Counterdrug Office. The National Guard is responsible for supporting Federal, State and Local Law Enforcement Agencies in their drug interdiction, eradication and drug demand reduction (education) missions. The National Guard Counterdrug Office, which is part of the National Guard Bureau headquartered in the Washington, DC metro area, is responsible for managing the program. The actual counterdrug missions are conducted by independent Counterdrug Offices in 50 States and 4 U.S. Territories.

The Problem:

When the author was first asked to help with their strategic information management problem, each state-level counterdrug office was reporting their monthly activities differently. It took weeks to consolidate, analyze and take action on this data. Not only did the counterdrug program need strategic information, they needed consistent operational data as well.

Before their portal could be engineered, a nationwide Counterdrug Management Information System needed to be engineered. That system needed to provide multi-dimensional mission planning, execution and evaluation functions as well as ongoing resource and system management capabilities. This day-to-day automated support for the counterdrug activities (missions) in the National Guard offices in fifty-four states and territories was the key purpose for the system.

The Solution:

Although the enterprise information portal was concurrently designed, it was only after the state-level operational management systems were deployed, that the enterprise information portal could be completed.

Data captured while conducting counterdrug mission support activities at the state level was periodically summarized as performance measures for ongoing evaluation of mission and program effectiveness. The measures were reviewed and then automatically and electronically reported to the central National Guard Bureau, in the Washington, DC area, where they were used to populate a data warehouse at the heart of the Enterprise Information Portal.

The National Guard Counterdrug portal provided the basis for both an Executive Information System (EIS) and a Decision Support System (DSS). An example of the EIS user interface is in the figure below. The graphic interface to the EIS changed colors depending upon the content of the underlying data. This provided executives with an "at a glance" view of program effectiveness (green = effective; yellow = less than effective; red = poor performance; gray = no report this period). The thresholds for the measures could be set and easily changed by the National Guard Counterdrug staff.

In addition to managing the counterdrug program, the National Guard used their portal as the source for answering ad hoc queries from state governors, the Defense Department, and the US Congress.
Results:

Both Air Force and Army personnel from National Guard counterdrug offices in multiple states and territories and from all levels of the National Guard Bureau participated in requirements definition and analysis, business modeling, and application design sessions. Active end-user involvement was a keystone that ensured that the National Guard counterdrug systems exactly met requirements. Using a state-of-the-art technology infrastructure and a quality rapid application development (Q-RAD) approach, a fully functional, quality information system was delivered ahead of schedule and under budget.

Summary

Information is a valuable resource. A well-defined Enterprise Portal and Enterprise Data Warehouse, properly implemented, can be a valuable tool for managing and using that resource. It translates the vast volumes of detailed, unorganized data an enterprise captures via its operational systems into useful feedback, predictors, and warnings that help users at every organizational level make informed decisions.

Strategic Enterprise Portal Engineering will help you deliver effective strategic information that exactly meets the needs of your enterprise -- public or private, large or small -- to the right people, in the right place, at the right time, in the right format.

For more information please contact:

Visible Systems Corporation
201 Spring Street
Lexington, MA
info@visible.com
Alan Perkins has been a Systems Analyst on the White House staff, Director of the US Army Data Processing School in Germany, Vice President of R&D for a virtual corporation, Vice President of Consulting for a software engineering tools company, and General Manager of a high-tech consulting firm. He has provided information and enterprise management consulting to numerous companies, associations and government agencies.

Mr. Perkins specializes in Enterprise Architecture Engineering. He helps clients quickly engineer enterprise architectures that are actionable and adaptable. His approach results in architectures that enable and facilitate enterprise initiatives such as Corporate Portals, Enterprise Data Warehouses, Enterprise Application Integration, Software Component Engineering, etc.

The following are papers are available at www.visible.com:

"Enterprise Architecture Engineering"
"Enterprise Architecture Engineering Critical Success Factors"
"High-Performance Enterprise Architecture Engineering – Implementing the Zachman Framework for Enterprise Architecture"
"Enterprise Change Management – An Architected Approach"
"Getting Your Acts Together – An Architected Solution for Government Transformation"
"A Strategic Approach to Data Warehouse Engineering"
"Data Warehouse Architecture – A Blueprint For Success"
"Critical Success Factors for Data Warehouse Engineering"
"How to Succeed in the 21st Century – Critical Information Management Success Factors"
"XML Metadata Management – Controlling XML Chaos"
"Business Rules Are Meta-Data"
"Enterprise Application Modernization – Solving IT’s Biggest Problem”
"Strategic Enterprise Application Integration”
"e-Engineering – A Unified Method"
"Enterprise Portal Engineering"
"Quality Software [Component] Engineering"
"Software Engineering Process Improvement"