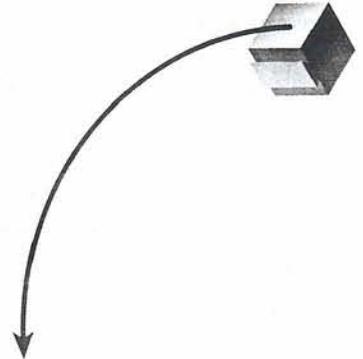
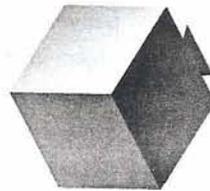
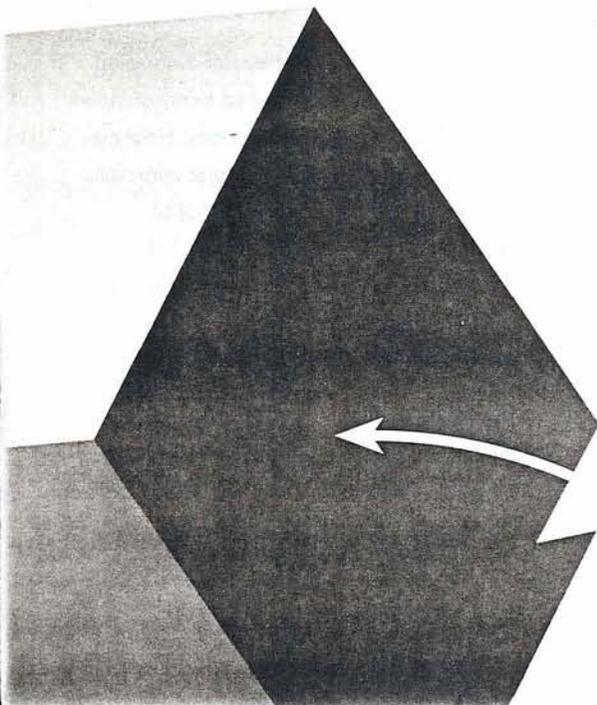
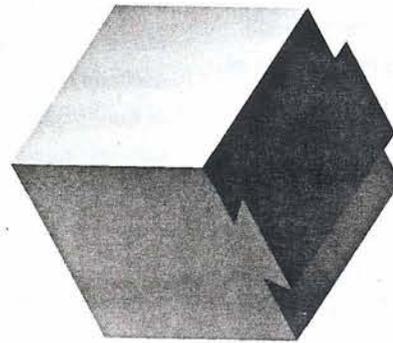




ILLUSTRATION



Illustra **Information Asset Management**





Illustra Object-Relational Database Management System

ILLUSTRATM: OBJECT-RELATIONAL DBMS

The Illustra Server is the industry's first DBMS that efficiently handles alpha numeric, character, text, video, images, and documents within a single repository. Built from the ground up to deliver high-performance relational and object database management, Illustra embeds Object-Oriented (OO) capabilities in a relational model, providing the first breakthrough in the 25-year history of the relational DBMS. The resulting synergy delivers capabilities that neither an Object DBMS (ODMS) nor Relational DBMS (RDBMS) can provide.

Although relational DBMS has solved the problems of managing commercial data consisting of numbers and character strings, it has difficulty handling the growing predominance of more complex data. Leading application architects are seeking to expand the definition of data to include: diagrams, maps, images, sound, documents, time series, multi-dimensional data, etc.

The two predominant modern DBMS architectures, RDBMS and ODBMS, each provide a partial solution to the problem of managing rich data. Unfortunately, both suffer from serious limitations.

RDBMS: No Rich Data Types

Repeated attempts to manage rich multi-media data using an RDBMS such as Oracle, Sybase, and Informix have failed. Because the RDBMS can store complex data only as

uninterpreted BLOBs (Binary Large Objects), a relational DBMS is just not suited to manage such information.

Many RDBMS vendors striving to capture the benefits of OO are attempting to graft an object layer on top of the old relational product. But this technique is fatally flawed as well. Because the basic engine is unable to understand how to optimize storage and access to object data, these layered products are very inefficient.

ODBMS: No Query Language

In the 1980's, the technology that promised to manage rich multi-media data was Object Orientation (OO), which offered a new way to view and model the relationship between data and applications. OO brought the hope that applications would become easier to develop, more robust and more maintainable. The merger of the existing client/server database model with Object Orientation led to the development of Object-Oriented Database Management Systems (ODBMS) that could store objects created by an OO application like C++. However, the ODBMS model suffered from a fatal flaw: it had no common query language. Much of the appeal of the RDBMS stemmed from its widely adopted query language, SQL. Lacking a query language, the ODBMSs failed to deliver the flexibility that made the RDBMS architecture so successful. In addition ODBMS systems lacked many of the high level features required by corporations; including scalability, security, server-side functions, concurrence, etc.

OBJECT-RELATIONAL: THE BEST OF BOTH WORLDS

In the past, application architects were faced with an unpalatable choice: they could use either a DBMS that modeled the rich data effectively or one that provided a well-known query language, but not both.

What is required is a data management system powerful enough to store and manipulate richly structured data, enforce the complex business rules that define its integrity, and is flexible enough to handle novel data structures effectively.

The Illustra Server is the world's first Object-Relational DBMS (ORDBMS). It supports Object-Oriented management of rich data types, but at the same time provides an efficient query language based on extensions to industry-standard SQL. Its support for inheritance speeds application development and enhances quality. Maintenance costs are reduced because Illustra acts as a single object repository.

The essence of the problem of managing rich data types is there are so many complex and rich kinds of data to model. How can a single product hope to manage information as diverse as video images, spatial information and time-series data? Illustra does this by extending the relational database model to support new data types. In other words, the key is extensibility.

The Illustra ServerTM provides a high-performance extensible platform for storage and retrieval of objects. Object extensions, called DataBladeTM modules, plug intelligence into



Illustra for specific kinds of data, extending the SQL language with tailor-made functions and allowing Illustra to effectively manage the data required by a specific application. DataBlade modules can even include new access methods, for speedy access to data not well served by the B-trees of the RDBMS vendors. For example, a D-Tree is provided for text support and an R-Tree for rapid access to spatial data. DataBlades may also contain display methods to aid in the visualization of complex data.

A DataBlade embeds data intelligence into the Illustra Server, making it an intelligent repository of rich data.

Illustra Server is a Relational DBMS

It supports the key relational technologies that have proven so successful including:

- Flexible data access via standard SQL
- Standard security controls
- Full server-enforced data integrity
- Transactions and recovery
- Performance and scalability

Illustra Server is an Object DBMS

Illustra also gives relational developers access to the key OO technologies:

- Ability to create any data type
- Optimized access to rich data types
- Rapid high-quality development and low maintenance through encapsulation, inheritance, polymorphism
- Direct data access through Object IDs

Rules and Alerters

Illustra also supports a rich rule system that enables a developer to specify an action to be taken before, after, or instead of the user-requested action. It supports alerters, a mechanism for informing external programs about events within the database.

DATABLADES: WHAT THEY ARE AND HOW THEY WORK

DataBlades Make BLOBs Obsolete

Effectively managing advanced data means going beyond the limited capabilities of traditional database systems. DataBlades, a unique feature available only with Illustra, enable you to plug intelligence into your DBMS for your specific kinds of data. When fitted with a DataBlade, the Illustra system "understands" your data types, so that it can deliver fully optimized query and storage for non-traditional data.

Current RDBMS have great expertise in a limited number of data types: integers, floating point numbers, dates and character strings. Designed into the core of these traditional DBMS is a key set of capabilities for each data type:

- Content-based query capability
- Comparison operators
- Intelligent query optimization
- Efficient storage capability
- High performance
- Storage methodology (access method) appropriate to the data

In order to handle more than these simple pre-defined data types, Relational DBMS relegate rich data types to second class status, storing them as Binary Large Objects (BLOBs). Because BLOBs are uninterpreted bit patterns, the RDBMS does not know how to perform content-based queries on them. It has no sensible comparison operators, so it cannot intelligently build an optimal query plan and it cannot provide high performance storage and retrieval. In fact, the RDBMS cannot provide for BLOBs any of the features that make the RDBMS so useful for traditional data, making the database management system incapable of managing the more complex data. The hard work is left up to the individual application developer – the work of understanding the contents, format, and methodologies required of each data type – and this work needs to be re-invented and re-embedded in each application. Worse, because the RDBMS cannot understand BLOB contents, BLOBs have to be shipped across the network to the client for processing, placing a heavy burden on scarce network bandwidth.



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DataBlades represent a completely new approach to supporting rich data, passing well beyond simple BLOB support. A DataBlade is a snap-in module that adds expertise and intelligence to the DBMS system, extending the system with the key functionality required for native support of specific data types. Just as a general purpose utility knife can be extended to perform different cutting jobs by inserting special-purpose blades, so the Illustra Server can be extended to manage new data types by snapping in the required DataBlade.

An Illustra DataBlade™ moves object orientation beyond a programming methodology to a data management strategy. DataBlades include new data types and functions, and may also include display methods, and new access methods to allow intelligent query support for the new data types.

Relational Supercharged with Objects

The Illustra Server combined with DataBlade modules supercharges the relational model, extending the SQL query language to efficiently process rich data. It provides content-based queries, optimized query plans and high performance storage and retrieval tailored to the individual data type. Illustra:

- Is the first DBMS that enables integration, movement, and management of multiple data types
- Provides the power of objects, the flexibility of relational
- Features server-enforced integrity for complex data
- Uses DataBlades that make BLOBs obsolete

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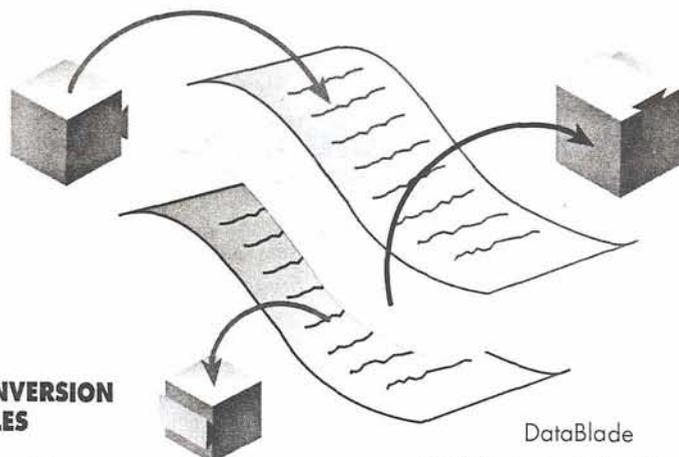
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Illustra™ Text DataBlade



FEATURES AND BENEFITS

■ **Full RDBMS capabilities** - Documents can either be stored as external files, or large objects. Large objects get the full set of RDBMS management facilities expected from a relational database: security, concurrency control, transaction management, recovery from failure.

■ **Fast application development** -

Through the use of object-oriented capabilities, applications get smaller and simpler. Knowledge of how to manage documents is in a single place - within the database. In addition, through the use of hierarchical data definition (inheritance) and function overloading, the user can define new types based on the doc type, and take advantage of the functionality of the document data type.

■ **High performance** - Using D-TREES, an access method custom designed for text/document data.

■ **Extensibility** - The doc data type can be further extended by the user for specific needs. In addition, the doc data type can be combined with other data types, whether user-defined, or supplied by Illustra™, to create entirely new constructs.

TEXT AND TEXT CONVERSION DATABLADE MODULES

The Text DataBlade® module is a user installed extension of the Illustra ORDBMS. It greatly expands the functionality of the database, by adding new data types and functions that manage text and document libraries. The Text Conversion DataBlade module adds capabilities to the Text DataBlade module by supporting many of the popular word processor file formats and converting documents between them.

Text DataBlade module

Documents can be stored within the database as large objects, and receive full concurrency, recovery, and transaction control. They can also be stored as external files, remaining in their original system file.

The document data type includes the implementation of an advanced indexing method to speed performance. As documents are added to the database, they are automatically indexed through a method of "stemming" each word in the document. The process of stemming reduces multiple versions of a word to a common stem, to make searches of the document contents easier for users to specify. For example, the words helped, helping, helps, helper are all reduced to the common stem "help", and this is what is indexed. The stemming dictionary is extensible, to allow the user to specify exceptions to the standard stemming process for industry specific words.

Performance is further increased by using a D-TREE, an access method. The Text

DataBlade module extends the database by adding the D-TREE access method, resulting in the ability to conduct a high performance search of all of the words and phrases in a large text library. As new documents are added, they are also automatically indexed, and custom key-words can be added that are not included in the text of a document.

Text Conversion DataBlade module

The Illustra Text Conversion DataBlade module performs conversions between many popular word-processing, publishing, and text processing formats (for example, Microsoft Word, WordPerfect, and FrameMaker). Documents are converted to ASCII on input, which is used for indexing by the Text DataBlade module. Documents are stored in the database in their native format, with all markup information preserved. Documents can be output in their original format, or converted to a number of supported output formats.

The conversion process is based on a powerful filter engine, which is superior to the format conversions supplied as part of many word processor or publishing applications. Conversions among fully featured applications are very complete, including tables, raster and vector images, grouping, fill patterns, headers and footers, autonumbers, index tokens, font types and styles, and footnotes.

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Illustra Text DataBlade



ILLUSTR A

ILLUSTR A SOLUTIONS

The Illustra Text DataBlade module offers a sophisticated set of core facilities for text management and inquiry. As such, it is usable in a wide variety of situations. Some typical applications are:

On-line Research

A medical database of over 30,000 articles is indexed at a university. Using the document functions, articles that most closely deal with similar medical conditions are found and retrieved. Because the articles are stored in their original format, they can be displayed with original formatting and graphics intact.

Multimedia Source Library

A major multimedia company keeps a digitized library of photos. Each photo has, in addition to the digitized image, a set of keywords, describing the date, time, and other information about the photograph. In addition, an unstructured text field of arbitrary length is included as descriptive material.

Through the functions within the Text DataBlade module, a list of candidate photos for a particular application can be found. In addition, by using facilities for image manipulation and analysis within the Image DataBlade module, only photos that have the appropriate qualities (such as contrast, brightness, overall color) can be selected. The Text DataBlade module allows display of the text field, and the Image DataBlade module allows display of the image, both on the client system.

Government Agency

A major government agency keeps a large library of policies, procedures, orders, and forms online. When a new policy manual is created, the Text DataBlade module allows a comparison of which other documents are most like the new document. It is not necessary for a person to generate a list of keywords, as the entire new document can be the search argument for similarity. By finding the related documents, a list of the policies and procedures which need to be changed is generated.

Insurance Claims Adjustment

An insurance company has a large database of claims information, along with information about the insured individuals. With each claim is a transcription of the physician's notes about the case, which are supplied under an agreement of confidentiality. An investigator is looking for potential abuse or fraud, and knows that certain combinations of factors are most subject to having a problem. By using the security facilities available in a relational database, the investigator can be allowed to include information from the doctors' dictation in his search, without being allowed to see the actual text. Information on which diagnosis codes, ages, income levels, etc. can be combined with information from the doctor. In this way, the most accurate search of potential cases to investigate can be generated.

Licensing

The Illustra Text DataBlade module is licensed separately, on a per concurrent user basis.

Illustra™ Spatial DataBlades

FEATURES AND BENEFITS

■ **RDBMS capabilities** - Spatial information now gets the full set of RDBMS facilities expected from a relational database management system: security, concurrency control, transaction management, and recovery from application or system failure.

■ **Fast application development** - Knowledge of how to manage spatial data is in a single place - within the database. Through the use of object-oriented capabilities, applications get smaller and simpler, and as a result, cost less to develop and are of higher quality. In addition, because of inheritance, function overloading, new data type definitions, and new user defined data types can take full advantage of the facilities made available by the 2D Spatial DataBlade® module.

■ **High performance** - The combination of a high performance relational database manager, the performance increases for complex objects inherent in object-oriented technology, a specialized indexing method, and the ability to develop applications in a high level, non-procedural language SQL, result in the rapid development of high performance spatial and geographic applications.

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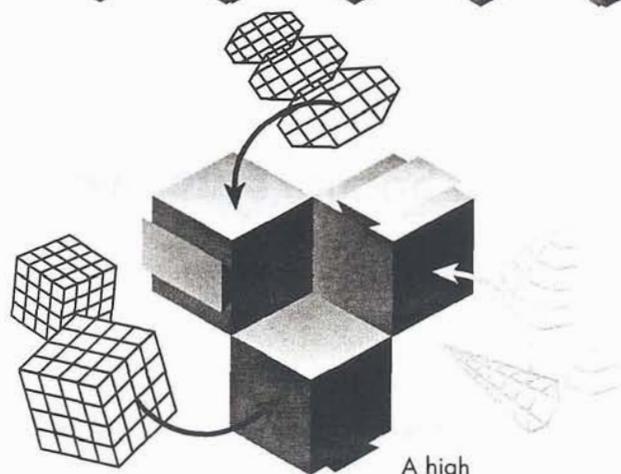
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2D & 3D SPATIAL DATABLADES

The 2D Spatial DataBlade® module is a user-installable extension to the Illustra™ Server that adds support for data in 2-dimensional space. The 2D Spatial DataBlade module adds 10 data types that describe common planar geometric shapes and polygons of arbitrary complexity. Over 200 functions are defined to allow *object creation, comparison, manipulation and query.*

The 3D Spatial DataBlade module is also a user-installable extension to the Illustra Server that adds server support for data in three dimensional space. The 3D DataBlade module adds 18 3D data types - circles, 3D-boxes, lines, in addition to polygon mesh and surfaces of arbitrary complexity. Over 1,000 functions are added that allow spatial queries and manipulation. These functions are combined into a small set by overloading the names, to make *programming easy.*

The key operations used with position information - location, distance, overlap, among others - are incorporated into the database and are accessible through SQL, both as SQL queries and from within C programs using the supplied libraries. Because of Illustra™'s object-relational design, these new functions become an integral part of SQL, and are used like any other SQL capability. As a result of extending the intelligence of the database in this way, application programs are easier to develop and quicker to write.



A high performance R-TREE access method is supplied with the 2D and 3D Spatial DataBlade modules. R-TREES support spatial indexing - rapid, high performance access to spatial information and relationships without the need to examine each object. Box and polygon types can be indexed in the 2D and 3D Spatial DataBlade modules.

The 2D and 3D Spatial DataBlade modules also support smart objects, an intelligent storage mechanism. Spatial objects can have a very wide variation in size - for example, a polygon representing a geographic feature may have a few points, or thousands. Small data items are best stored with the row, in the same table. But larger objects are most efficiently stored separately, which Illustra supports as a "large_object" data type. For spatial data, the system automatically chooses whether an object is stored as large or small, on an object by object basis. This maximizes performance while allowing the system to manage a real world mix of large and small objects. This capability is invisible to SQL users.

ILLUSTRATION SOLUTIONS

The Illustra 2D and 3D Spatial DataBlade modules offer a sophisticated set of core facilities for spatial management. As such, they are usable in a wide variety of situations. Some typical applications are:

Geographic Information System

A GIS supplier has implemented their current



Illustra Spatial DataBlades



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application with several non-extensible systems. The system is designed to show a satellite image of a portion of the earth and then overlay map information. A user can highlight a point, and see text information about the political entity at that point. The geographic information requires a unique file layout and a specialized access mechanism for acceptable performance and is stored in a custom designed file system. Text information is stored in a relational database management system. Image data is in a third custom file system. Application development in a non-extensible system of this type has been very complex, since each application needs knowledge of how to access and manage the data in all three file systems.

By using the Illustra 2D Spatial and Image DataBlade modules, all of this information is stored in a single way, with a single software tool. The availability of the R-TREE access method enables the Illustra Server to meet the performance requirements for spatial data that were beyond the capabilities of a conventional RDBMS. Because of the object facilities in Illustra, software development is easier and changes are easier to make – the knowledge required to manage all three different data types is in a central place, instead of in each application. In addition, the new application now has security and concurrency control that was only true for the relational portion of the old system, which stored text information.

Aircraft Design and Maintenance

An aircraft manufacturer uses the 3D Spatial DataBlade module to store component placement information within an airframe during initial aircraft design, and over the life of the product. By storing information in three dimensional space, alternate designs can be analyzed or visualized, and engineers can determine how movement or change in a part's dimensions might affect surrounding components. The Illustra object-relational database and the 3D Spatial DataBlade module allow both the component placement information and maintenance records to be stored in the same database, which the prior proprietary file system couldn't do. In addition, the use of the R-TREE indexing system results in performance many times faster than the in-house designed system.

Oil Field Visualization and Management

A tremendous quantity of information is developed over time concerning resources within an oil field as wells are drilled, samples are taken, and various seismic maps are constructed. Storing and accessing this information becomes difficult overtime, since proprietary systems are used. But they lack the extensibility, performance, and generality of an Object-Relational DBMS.

With the Illustra 3D Spatial DataBlade module, the limitations of a proprietary format can be bypassed. The spatial relationships of oil field geology can be stored, and in turn made available for high performance visualization systems. In addition, by also using the Text and Image

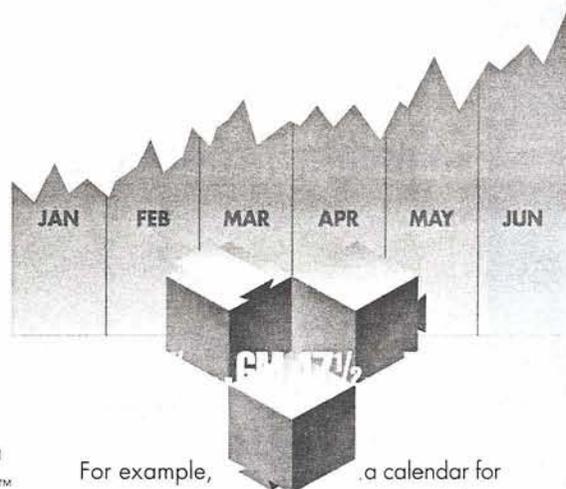
DataBlade modules, seismic test observations stored as raster images and geologists' notes about field conditions can be stored in the same database and accessed in the same application, through a common SQL interface.

Using data in such varied ways is impossible without the extensibility and performance capabilities of the Illustra Object-Relational DBMS, supercharged with the additional functionality added by an appropriate set of DataBlade modules. The value of data is dramatically enhanced in ways that separate proprietary solutions cannot approach.

Licensing

The Illustra 2D and 3D Spatial DataBlade modules are licensed separately, on a per concurrent user basis.

Illustra™ TimeSeries DataBlade



FEATURES AND BENEFITS

- The first relational DBMS that understands time series data – fully supports time series as a data type.
- Extends the relational model to support repeating time-based data - financial, scientific, or other.
- Supports efficient high performance, storage, access, and modeling of time series data.
- Provides a rich set of functions for storing, manipulating, and analyzing time series information.
- Reduces application complexity, development and maintenance time, and cost - allows rapid adoption of improvements in analytical technologies.
- Time series modeling and methodology for one instrument can be used for other similar instruments through code reuse.

THE TIMESERIES DATABLADE

The TimeSeries DataBlade® module is a user-installable extension of the Illustra™ ORDBMS. It greatly expands the functionality of the database by adding sophisticated support for the management of time series and temporal data. The DataBlade module supports a regularly repeating time-stamped series of any type or assortment of data - integer, floating point numbers, currency, text fields, spatial information or any other information that can be represented in digital form, or any structure or combination of these. For example, a set of open, high, low and close currency values can be used to record a time-based series of stock prices. The granularity of time recording can be in a variety of units - seconds, minutes, days, weeks, as required by the application.

The DataBlade module includes support for two new data types, time series, and calendars, and over 40 functions to manage them. The time series type stores sequences of timestamped information, and a related calendar allows rapid access to specific portions of the time series for update, analysis, display or other uses.

Calendars

An instance of a time series is the combination of a time series vector, and an associated calendar. The time series manipulation functions use the associated calendar to define the granularity and layout of the time series information and to enable high-performance searches, finding requested portions or single entries from the entire time series.

For example, a calendar for a stock trading time series might define the regular days that trading is done in the U.S. (Monday through Friday), and the positive or negative exceptions to this rule (e.g., the market is closed on Thanksgiving day, or business occurred on one holiday, one time). This information allows Illustra to quickly find information in the time series - for example: find the records for IBM stocks for the 30 valid trading days preceding Jan 15, 1994.

Calendars can be defined at many levels of granularity and can cover any number of years or time periods. A standard set of calendars (for example, U.S. business days) is included with the TimeSeries DataBlade module, and users may also define their own.

Each calendar consists of a starting and an optional ending time point, a pattern, a starting timestamp for the pattern, and a list of exceptions to the pattern. A pattern might be "workdays, {1 off, 5 on, 1 off}, day", indicating that valid business days to record in the time series are Monday through Friday. The exception list would include days that were legal holidays and no trading occurred - for example the list of U.S. legal holidays. Calendars can be unbounded with no ending point.

Time series

Time series are stored as "smart objects". Depending on their size, they are either stored with the rest of the data in the table row (tuple) or as a separate file. The storage

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Illustra TimeSeries DataBlade



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mechanism is invisible to the developer: it is used only by the system to optimize performance and storage. No matter how the objects are stored they are under full database transaction and security control.

TIME SERIES IN A RELATIONAL CONTEXT - A FIRST

By extending the object-relational model with time series support, Illustra delivers:

Extensibility

Any combination of data types can be modeled within a time series. And as new analysis methodologies are incorporated into the database, they are available to applications immediately, without program recompilations. The time series data type and analysis functions can all be extended by the user to meet specific requirements.

High Performance

Time series is a "first class" type and is fully managed by the DBMS, not an uninterpreted BLOB that requires client programs to analyze it. The use of the calendar allows rapid, indexed access to time series data.

The Illustra client/server architecture allows search and analysis to be done at the location most appropriate to the problem. Server-based functions can search for appropriate data avoiding network overhead. For some analysis functions, using the power of the individual client workstation is the appropriate solution. Execution of database functions can be transparently moved between the client and server to best match the problem and available hardware.

Fast Application Development

Through the use of object-oriented capabilities, applications get smaller and simpler. Knowledge of how to manage and manipulate time series is in a single place - within the database. In addition, through the use of inheritance capabilities, users can re-use software defining new time series data types based on existing, working models.

Illustra delivers the capabilities you expect in a relational DBMS - the key relational technologies that have been proven successful and accepted across a wide market -

- Compliance with industry standard SQL
- A well understood, and widely used programming interface
- Full relational capabilities for security and integrity control
- Enhanced server-enforced integrity
- A transaction model that guarantees system integrity in the event of an unexpected failure

Illustra supercharges relational - giving relational developers access to the key advances in object-oriented technology -

- Intelligent support for advanced, complex data types
- High quality development environment
- Software reuse
- Faster development cycle
- Insulation from changing requirements, and new types of data

Typical Applications

A major fund manager tracks a portfolio of 3,000 equity securities, recording 65 variables each that are updated daily. Over

24 years of data are kept on line and are used in portfolio modeling.

When using a standard relational database management system for their portfolio modeling system, an initial design to store this information resulted in over 720,000 records. Queries to analyze this data were difficult to write, and suffered from poor performance due to the lack of specific time series management capabilities in the database.

As a first alternative, they examined specialty products designed for time series that incorporated a proprietary database. These were unable to integrate with their existing portfolio management and trading systems which was based on a standard RDBMS. In addition, these were limited to numeric portfolio factors only, allowing no convenient way of extending the modeling strategy with new information sources such as news feeds or published reports.

Using the Illustra TimeSeries DataBlade module, they found that recording time series information on 3,000 securities required only 3,000 records. Storage representation is more intuitive, and performance was greatly improved. By using the Rules system and Alerters coupled to proprietary models and algorithms, they were able to automatically generate purchase and sale recommendations for risk management and portfolio performance optimization.

Licensing

The Illustra TimeSeries DataBlade module is licensed separately, on a per concurrent user basis.

Illustra™ Web DataBlade

FEATURES AND BENEFITS

- Allows all of the break-through features (including Versioning, Rules, Multimedia Data Support) of the Illustra™ "Database for Cyberspace™" to be used on the World Wide Web.
- Allows the use of industry standard Hypertext Markup Language (HTML) as a database-enhanced application development tool (4th generation language) and provides interfaces to market leading web (HTTP) server software.
- Improves information accuracy and saves time and money by providing "remote authoring" capabilities. Push the work to the "client-side" and let the owners of the information be the ones who actually submit it to your website.
- Included application templates show you how to get your information up on the network in short-order. Using a familiar "catalog" metaphor users can browse and do full text searching on data ranging from consumer goods to your company's standard operating procedures.

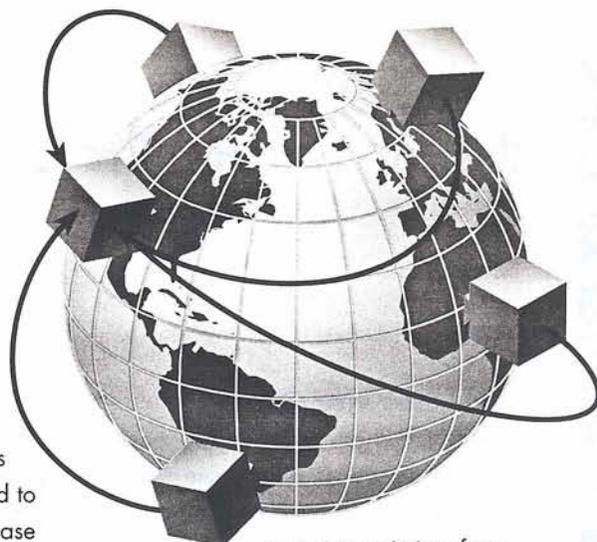
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WEB DATABLADE

The Illustra Web DataBlade® module is the first in a suite of products designed to empower a whole new class of database supported Web-aware applications. It is a collection of tools, functions and examples designed to facilitate the linking of the Illustra Server to any of the industry standard Web (Hypertext Transfer Protocol) servers and to ease application development. Once developed, such applications can either be accessed throughout the world via the Internet or within the confines of an enterprise or even a single department utilizing the network infrastructure already in place. The Web DataBlade module supports most of the leading Web servers including Netscape™, NCSA, and CERN. No changes to HTTP server software or browsers are required. One can even take applications already developed in Illustra™ (or other database management systems) and make part or all of it accessible to anyone on "the net." The features of the Web DataBlade module are explained below as well as on our home page. If you have Internet access, sit down in front of your browser while you read our first interactive datasheet.

Beyond CGI

The current volume standard in the database-web server integration marketplace is CGI implementations using the Perl scripting language. The Web DataBlade module is Illustra's implementation of Perl support (Mi-Perl) as well as a programmatic interface to the database and to the Web Server via CGI. With the flexibility of a



programmatic interface through Perl, queries can be issued and their results processed and dynamically formatted using the Illustra Web DataBlade module. The Web DataBlade module has an HTML anchor as a defined type, extending Illustra to intelligently deal with HTML anchors. Resulting data sets from SQL queries can be rendered as hot links to any network resource.

Examples/Demonstrations

By way of an example, in the Illustra catalog application template, queries by product type result in data sets of products. Illustra shows the individual product name as a hot link to another database record that contains picture, price, paragraph, and current inventory of the item selected (see the catalog template at <http://www.illustra.com/demos/catalogs.html>).

There is no requirement for your data to actually be stored in Illustra or even at your site to take advantage of the Web DataBlade module and Illustra's capabilities. For an example, go to the graffiti wall demonstration and enter an http command (i.e., ` Let's Go To Sun's Home Page `). In this example, what you posted to Illustra, when rendered back to you, came back "hot." When you click on "Let's Go To Sun's Home Page", you're off (the graffiti wall demonstration can be found at <http://www.illustra.com/demos/graf.html>).



Illustra Web DataBlade



ILLUSTR A

Support for Web Server APIs

Illustra believes that programmatic interfaces (APIs) to Web servers will become more common place. As a result, the Web DataBlade module supports this more efficient direct access to Netscape's line of servers and will support other market leading servers as they become available. Efficient modeling and understanding of internal Web server data structures and functions are natural extensions to Illustra. The immediate benefit is improved Web server performance.

HTML-Based Utilities and Sample Code Included

Included with the Web DataBlade module are utilities that allow the browsing of any Illustra table using a standard browser. All information about a table's columns, indices and rules are dynamically generated and rendered in HTML (including Illustra system tables). Also included as examples is the source code to many of the demos on Illustra's home page to facilitate rapid development of your own applications.

SOLUTIONS:

Some typical applications of the Web DataBlade module and Illustra Object-Relational Database management system include:

Integrated Catalog Enterprise Management

Manage credit limits, inventory levels, reorder points, account transaction histories, and the actual catalog with the Illustra database system. The catalog is automatically updated whenever the product line changes. There is no more need for manual updating of a catalog when a

product is added or dropped. The database not only provides automated catalog generation and ad-hoc access to all aspects of the enterprise, but it uses rules and alerters to notify administrators via email when the system requires attention (for example see Illustra's catalogs at <http://www.illustra.com/demos/catalogs.html>).

Third Party Vendors Directory

Resellers, distributors and partners can "remotely author" their own information about the products and services they offer via electronic HTML "forms" directly to the Illustra database. The Illustra Web DataBlade module can be used to dynamically generate a web-based "Third Party Vendors Directory." Directory publishers save on printing costs and avoid the need to "chase down" information. At the same time they can be confident of "up-to-the-minute" accuracy of content.

Stock photo library

By using Illustra's Visual Intelligence™ technology in conjunction with the Web DataBlade module anyone anywhere can search for images by the content of those images (try our Visual Intelligence demo at <http://www.illustra.com/demos/vir.html>).

Website management

Using Illustra's integrated system of Rules and Alerters in conjunction with TimeTravel™ versioning technology, Webmasters can efficiently manage their website. Rules can be designed to control the workflow process from page authoring (e.g. writing, proofing, approving content), updating (e.g. automatically notifying visitors of "what's new"),

user tracking, and row-level data security (try the "Graffiti Wall" demo at <http://www.illustra.com/demos/graf.html>).

Internal Corporate Document Distribution

Many organizations have large catalogs of internal reference materials and no efficient way to provide access to them on an enterprise-wide basis. Using any industry standard HTTP server in conjunction with Illustra and almost any Web-browser an organization can quickly develop a method for internal document distribution. By adding the Illustra Text DataBlade module those documents can be searched via keywords.

Illustra™ Image DataBlade

FEATURES AND BENEFITS

- **Extends the relational DBMS model -**
Provides support for image conversion, storage, manipulation, enhancement, and management. Image applications now get all of the benefits of relational database systems.
- **Supports images combined with other data types -** Combines images with other data types for greater flexibility. Images can now be integrated with other data types such as video and OMF content multiplying the value of the database.
- **Accepts over 50 image formats -**
Performs automatic conversion of images on input, optional conversion between types.
- **Supplies large set of image functions -**
Built-in functions simplify image manipulation and management. Fully extensible for user supplied functions. Complex image applications are shorter and easier to develop.

ILLUSTRATION IMAGE DATABLADE

Technology changes have greatly increased both the volume and value of digitized images. However, harnessing the value of these new types is a complex process, and combining this information with traditional relational data usually requires a custom designed system, with separate subsystems designed for each kind of data.

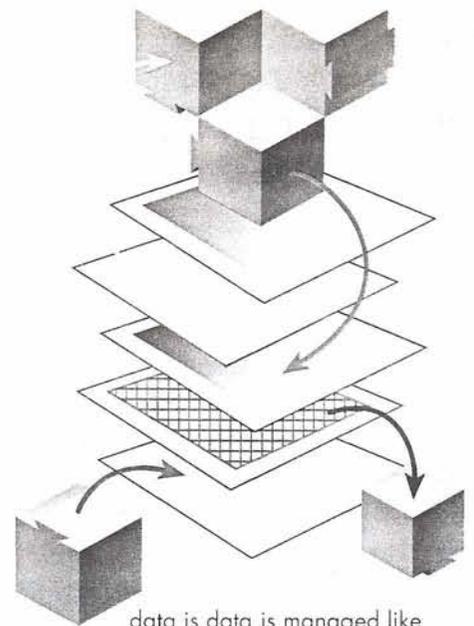
The Illustra Image DataBlade® module extends the relational model to include support for image conversion, storage, manipulation, enhancement, and management. Image applications now get all of the benefits of the Illustra object-relational database system. Photographs, computer generated images, drawings, scanned photographs, and other image types can now be combined with other data types to build high performance software solutions.

Building on Object-Relational Technology

Some relational database systems have attempted to accommodate the flood of image data by implementing support for Binary Large Objects (BLOBs). But this leaves the complete responsibility for image management, conversion, and display to the application developer, and results in much longer and more complex programs.

In contrast, the Image DataBlade module is a user-installable extension to the powerful Illustra object-relational DBMS and builds on Illustra's ability to handle both object and relational data equally well.

Developers can use SQL, a high level non-procedural language to input, display, manipulate, and convert images. Image



data is data is managed like conventional numeric or textual data, and the task of developing a complex application is greatly eased.

Image DataBlade Functionality

The Image DataBlade module creates a new "image" data type with 4 internal storage levels. The DataBlade module will import over 30 raster image formats which are converted to the appropriate internal format for easier manipulation. Different images stored in a single column in a database table do not need to be in the same format.

Images are stored as internal large objects, and are subject to full concurrency, recovery, and transaction control. Stored images may be displayed, manipulated, modified, enhanced, or analyzed by a large number of methods. A complete list of available functions is listed in the product specification.

Image Display

Images that are stored can be displayed on the client workstation using any user-supplied X11 viewer (such as XVIEW, XV, or others). On output to the viewer, the image may be automatically converted to any compatible image format. The "ImgDisplay" function is made a part of Illustra's extended SQL by the installation

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Illustra Image DataBlade



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of the Image DataBlade module (as are all of the functions). If a developer or user runs a SELECT query using SQL, traditional data from the result set can be printed, while the image can be displayed on the client workstation.

File Output

Images can be output from the database, and stored in an external file. As part of this process, images may be automatically converted to a different format.

Image Manipulation

Images may be manipulated in a large variety of ways, either prior to display, or prior to being written to an external file. Some examples of manipulation include:

Scaling: Images may be rotated, scaled, sheared, truncated.

Enhancement: Various image enhancement techniques are supplied, such as Gamma, dithering and edge enhancement.

Multiple images: Several images can be manipulated allowing images to be pasted together, combined with a variety of mathematical operators or color mapped.

Image management: Functions are supplied to support edge detection, or image analysis.

Extensibility

The Image DataBlade module can be further extended by including new functions and data types. The included functions can be combined with user-supplied functions to enhance the capability of the DataBlade module. In addition, images can be

combined with other data types, whether user-defined or supplied by Illustra, to create entirely new constructs.

TYPICAL APPLICATIONS

The Illustra Image DataBlade module offers a sophisticated set of core facilities for image management. As such, it is usable in a wide variety of situations. Some typical applications include medical/patient record systems, multimedia source libraries, image recognition and scene analysis and geographic information systems.

Licensing

The Illustra Image DataBlade module is licensed separately, on a per concurrent user basis.

Illustra™ VIR DataBlade

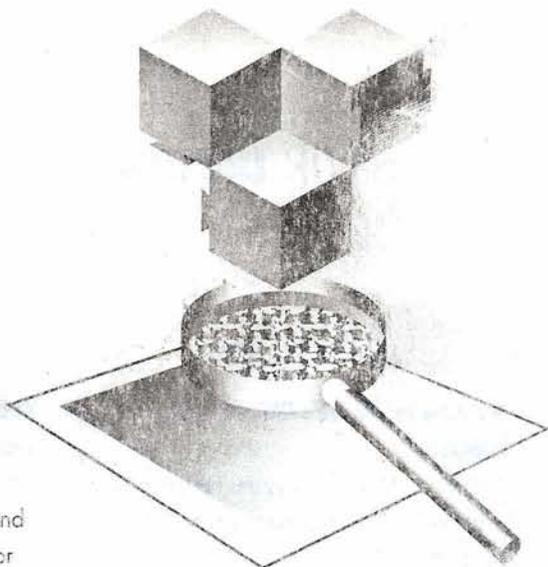
KEY FEATURES

- Searches and retrieves images and video based on unique attributes
- Optimized for Illustra's Object-Relational Database
- Customizable for specific asset management needs

ILLUSTRATE™ VISUAL INTELLIGENCE™ MULTIMEDIA ASSET RETRIEVAL SYSTEM

The explosion of digital images, video and graphics has created an urgent need for software that makes it easy for content creators to retrieve and manage their media assets. Illustra Visual Intelligence is a powerful, content-based image retrieval system for retrieving images and video from complex multimedia databases. Based on breakthrough Visual Information Retrieval (VIR) technology from Virage, Inc., Visual Intelligence represents a new concept in image retrieval and management that delivers significant productivity gains to users while making the multimedia database management task much easier and more intuitive.

Visual Intelligence is the ideal tool for managing valuable multimedia assets used in digital studios, multimedia production, desktop publishing, prepress and service bureaus, commercial printing and corporate publishing. The Visual Intelligence system includes the VIR DataBlade® module and the Visual Intelligence graphical user interface (GUI). The system gives users the ability to perform searches on any kind of image, including video, based on the actual content of the image. Visual Intelligence enables users to launch a search by simply clicking a mouse on a sample image, sketching the rough outlines of a desired image or scanning an image directly from print or a camera.



Search and Retrieval on Image Attributes

With images, the important qualities are color, shape, texture and composition. Illustra's Visual Intelligence system lets users quickly search and retrieve images based on these attributes. Visual Intelligence ranks an entire image collection against the image being searched and helps the user make intelligent decisions about which images are most like the selected image. The system actually "looks" at the image and understands its features, so users can ask the system to "find other images that look like this one".

Visual Intelligence takes image and video retrieval far beyond the 30-year old keyword technology that was designed for alphanumeric data. All other existing image browsers and management systems use keyword-only search routines as the means to find and retrieve images. Keywords are useful but are cumbersome, limiting and inefficient when addressing multi-dimensional data such as images and video. Full keyword indexing of images and video is so arduous that it is impractical. In addition, keyword retrieval supports only pre-planned access to the data - there is no way to ask a new question, except for typing in new words on a hit or miss basis. For many subject areas, such as texture maps, there are no suitable keywords.

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Illustra VIR DataBlade



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Optimized for Illustra's Object-Relational Database

The Visual Intelligence system is optimized to deliver high-performance with Illustra, the leading Object-Relational Database Management System (ORDBMS). The Illustra database architecture is designed specifically to solve the major data management problems encountered in developing, managing and distributing multimedia content and products. Illustra can store and retrieve complex multimedia assets as easily as text and numbers. It provides a standardized, yet extensible query language and flexible and controllable security. Illustra is designed for extremely fast access to terabytes of multimedia content by tens to hundreds of simultaneous users.

Illustra combines the power of object orientation with the flexibility of relational databases to create an entirely new class of multimedia database. Because multimedia data is intrinsically highly varied, only an extensible DBMS can manage it. Illustra is the only truly extensible DBMS system. Its unique architecture is designed to easily handle new data types - such as audio, video and still images - through the use of DataBlade modules, "snap in" software modules that fully understand new data types and apply all the advantages of a relational database to them.

Customizable for specific asset management needs

The combination of Visual Intelligence and the Illustra ORDBMS provides the foundation for building customized asset management solutions tailored to the unique needs of each organization. Illustra's extensibility enables programmers to store data of any structure at all together with its "methods", the intelligence that makes data behave the way they want it to. For instance, the system can be "trained" to allocate royalties as video clips are repurposed into part of a CD-ROM game or to provide an automatic version archive that enables users to see a multimedia project as it was at any point in its development cycle.

A solid foundation for the future

With its flexible user interface and advanced Visual Image Recognition features, Illustra's Visual Intelligence system provides a solid foundation for solving multimedia management problems today and tomorrow. The Visual Intelligence system and the Illustra database can easily be extended to quickly store and retrieve every element that goes into multimedia production including audio, video, art, animation, code, images, documents and schedules. In combination, these leading-edge technologies provide a simple and cost-effective way to manage multimedia assets to maximum advantage.

Illustra™ OMF DataBlade

A WORK IN PROGRESS

KEY FEATURES

- Basis for next generation intelligent asset management systems
- Supports Open Media Framework composition as native data type
- Enables queries against OMF content

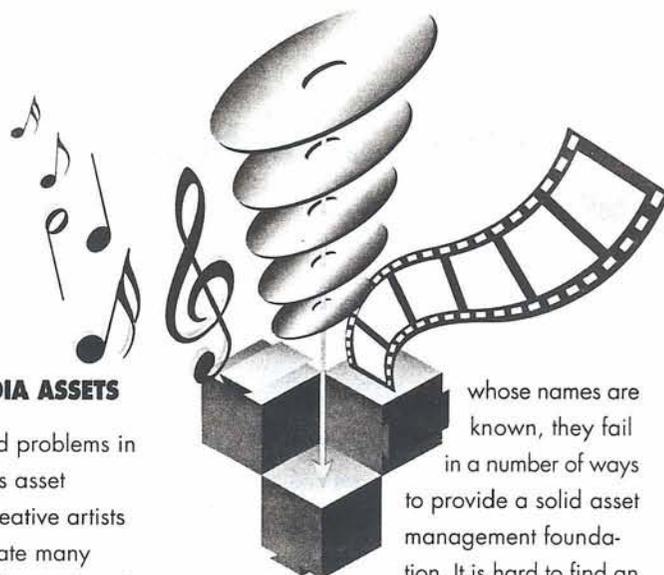
MANAGING MULTIMEDIA ASSETS

One of the major unsolved problems in multimedia development is asset management. Teams of creative artists working on a product create many thousands of objects which are shared, used and re-used in different ways to form the final product. The objects may be images, geometric shapes, animations, video, sound, or compositions made up of numbers of simpler objects. This collection of objects becomes an extremely valuable asset which needs to be copyrighted, protected from loss and theft, and made readily available for authorized use.

The requirements for managing these asset stores are daunting. To speed the development process, it is important that creative artists are able to easily and quickly locate objects they need without knowing anything about how and where the data is stored. Because development rarely progresses in a linear way, the asset manager must carefully protect version trees of objects, enabling authors to retrace their steps to earlier versions and branch out with new developments. For maximum return on investment, the objects must remain available so that they can be remastered into other products. But as they are repurposed, information such as ownership and royalty must travel with them.

COMPLEX DATA STORE

Current authoring, pre-production and post-production tools all store multimedia data in file systems. While files provide simple storage and rapid retrieval for objects



whose names are known, they fail in a number of ways to provide a solid asset management foundation. It is hard to find an

object in a file system unless you know its name, and a complex multimedia product typically consists of tens of thousands of named objects. Clearly, no one can remember all the names, and so objects have to be laboriously tagged with keywords to give searchers hints about their contents. However, a keyword system is very labor-intensive to manage. It is also incapable of answering even quite simple questions, such as which compositions would be affected by a change in a given object, or which objects are similar to others.

Some companies are experimenting with the use of a Relational DBMS (RDBMS) as a data store for multimedia objects. While an RDBMS can help in managing shared access to data, an RDBMS is intrinsically limited because it natively manages only alphanumeric data: numbers, character strings, date and time. All other kinds of data, including multimedia objects, are stored as Binary Large Objects (BLOBs). A BLOB is effectively a file that is stored either within or alongside the relational database. Because an RDBMS has no understanding of the internal structure of a BLOB, it cannot interrogate their contents. Hence, objects still have to be keyword tagged, just as in a file system.



Illustra OMF DataBlade



ILLUSTRATION

THE OMF DATABLADE TODAY

The OMF DataBlade® module under development at Illustra includes a new data type, "OMF_value", for storing OMF compositions. This data type can be used to define a column in a table. This column can then be used to store entire compositions in such a way that their content is visible to the DBMS. Application developers can write functions that reside within the database and extend the SQL language to support manipulation of compositions. While SQL is the query language, it will rarely, if ever, be exposed to end-users. Instead it acts as a non-procedural, high-level language that helps application developers create intuitive and dynamic interfaces to their asset database.

The Illustra™ OMF DataBlade module makes it easier to answer questions like these:

- find all compositions that include a given music clip
- find video tracks that don't have an audio track
- calculate the total length of sound files for a given composition
- find all compositions including work by a given author

THE OMF DATABLADE TOMORROW

The next generation of asset managers will build on these facilities and add content recognition algorithms to provide a sophisticated retrieval environment that goes far beyond keyword tagging.

Commercially available software is now able to perform similarity searches on line art and photographs of landscapes, faces and medical images. Soon it will be possible for creative professionals to ask the asset management system to find images that use a texture similar to this one, or all scenes containing this object, or all sounds similar to this one. For example, in a few years the system should be able to find all scenes containing a given actor or prop. As content recognition matures, Illustra DataBlade modules provide a ready means for incorporating either third party code or in-house algorithms into the kinds of asset management systems that creatives are looking for.

OMF WORK IN PROGRESS

Illustra is actively seeking development partners who are prepared to help define the requirements for the next generation of asset managers. Work is already in progress to incorporate content recognition algorithms into Illustra for the asset management system of the future. Illustra is also interested in forming partnerships with asset developers, asset managers, and production tools vendors who wish to present a more productive environment to their creative artists.



Illustra Application Development Tools



ILLUSTRA

Basic application as events. They are available when the developer places the VBX control on a form and double clicks on the controls.

ILLUSTRA QUERY (IQ)

Ad hoc queries are often used during the development of an Illustra Server application and IQ provides a comprehensive environment for creating, editing, and debugging SQL queries.

IQ is a graphical query interface to the Illustra Server. It enables you to connect to an Illustra Server, issue Illustra SQL commands, and view the results. IQ features include:

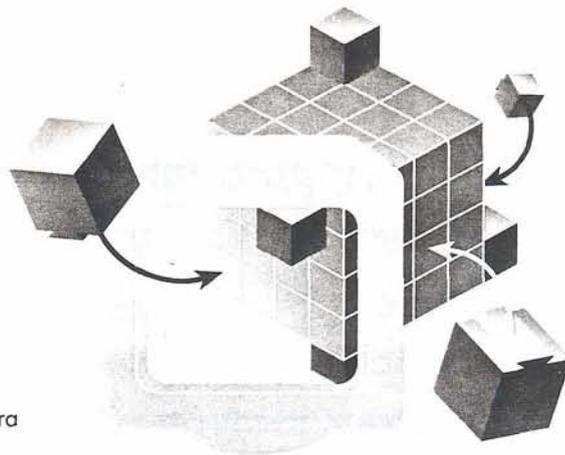
- **Multiple Database Connections** - Up to 32 different database connections managed simultaneously!
- **SQL Batch Processing** - Develop, debug, and optimize SQL statements prior to using them in your applications.
- **Query History** - Queries results are stored in memory so you can refer to previous queries without having to execute them again.
- **Result Set Output** - Query results can be saved to disk in comma delimited format for use with other tools like Microsoft Excel or Access.
- **DBA Tools** - Manage users and databases with the built in DBA utilities.

ILLUSTRA ODBC DRIVER

Open DataBase Connectivity (ODBC) is an interface designed by Microsoft to connect heterogeneous databases to a single application. For an application to access a database through ODBC there must be an ODBC driver supplied by the database vendor (or a third party). Illustra has developed an ODBC driver for the Illustra Server so applications that support ODBC can access Illustra databases. Products like Microsoft Visual Basic or Access can now take advantage of the power in the Illustra Server.

- **Performance** - The ODBC driver is optimized to provide performance close to that of using the native client interface for Illustra (LIBMI) so queries will execute faster.
- **Illustra data types** - Support for Illustra's extended type system is built into the driver so applications that use data types defined by DataBlade® modules or by the user can use the ODBC driver.
- **Support for Access, Power Builder, and Visual Basic** - The ODBC has been certified with industry standard applications to guarantee it is an industrial strength driver.

Illustra™ Application Development Tools



INDUSTRY STANDARD INTERFACES

Illustra is committed to providing access to the Illustra™ Server from all the most popular development environments. As a developer, you don't have to worry about learning a new language or development process. You can continue to use the tools you're accustomed to, so you're instantly productive when you begin application development.

Illustra supports the use of both 3GL and 4GL environments. Illustra supports C, C++, and industry standard SQL interfaces. Within the Windows and Windows NT environments Illustra has full support for Microsoft Visual C++, Microsoft Visual Basic, and ODBC. Illustra also offers a collection of tools and functions developed by Illustra specifically for Illustra users.

LIBMI

LIBMI is the client interface for developing client/server applications. This interface is available for Sun OS, Solaris, SGI Irix, Dec Alpha OSF1, HP-UX, Windows NT, and Windows 3.1. It is offered at no additional charge to developers. LIBMI is a collection of C functions and uses TCP/IP to communicate with the Illustra Server. LIBMI manages connections with the server, executes SQL queries, gets rows from result sets, and passes large objects to and from

the client. It is the interface to the Illustra Server, no matter which development environment you're using because it is the underlying mechanism for communicating with the server.

LIBMI includes an alerter function which is a database object whose purpose is to notify applications of interesting events that occur in the database. What is of interest to one application may be of no interest to another, so an application must declare its interest in an alerter by "listening" for it.

An alerter requires a mechanism for communicating with the application. The mechanism must either "poll" or "callback". If the mechanism is poll, alerters are saved until the application issues an Illustra SQL poll statement. If the mechanism is callback, notification is sent as soon as the alerter is fired. In Visual C++, the application is notified with a Windows callback function.

VISUAL C++

The interface to Visual C++ is provided with the LIBMI Dynamic Linked Library (DLL) that is included when you purchase the Illustra Server. With Visual C++, developers can write C or C++ code to access the server. Writing directly to the LIBMI interface is the lowest level interface to the server.

The Visual C++ interface includes all the libraries, include files, sample applications, and documentation needed to begin developing an Illustra Server application. It also includes the Illustra Query™ (IQ) tool to help developers debug the SQL portion of their application.

VISUAL BASIC

Probably the most exciting product for database developers is Visual Basic. It insulates developers from the low-level complexities of writing a Windows application in C or C++ and lets them focus on solving the business problem at hand. Illustra has abstracted the LIBMI interface into Visual Basic and provides VBX controls to respond to server alerters (a more generalized implementation of triggers).

VBLIBMI and its VBX Control

When developers receive the Visual Basic interface to the Illustra Server they get everything they need to begin developing Illustra Server applications. In addition to the LIBMI DLL, they receive the VBLIBMI interface and its associated VBX control, sample applications, and full documentation of the Visual Basic interface.

VBLIBMI

The interface between LIBMI and the Visual Basic application is the VBLIBMI DLL. It abstracts the low-level C function calls in LIBMI into functions and data types that are usable in Visual Basic.

Alerters in Visual Basic

With Visual Basic the alerter mechanism is handled differently than with Visual C++. The Visual Basic interface includes the Illustra VBX control that receives alerters from LIBMI and transfers them to the Visual