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RIO: A Standards-based Approach for Reusable Information Objects

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Overview

Introduction

Cisco Systems recognizes a need to move from creating and delivering large inflexible training courses toward creating database driven objects that can be reused, searched, and modified independent of their delivery media. This is the driving force behind Cisco's Reusable Information Object (RIO) Strategy.

Reusable content in the form of objects stored in a database has become the Holy Grail in the e-learning and knowledge management communities. Training departments were among the first groups to understand how reusable *chunks* of content could increase efficiency in course development and delivery, thereby reducing costs. However, this concept has until recently been little more than conjecture and theory.

Perhaps the greatest obstacle to widespread adoption of object-based content development has been the lack of a unified standard for what constitutes a single unit of content. Past attempts at standardizing reusable content failed to approach the problem holistically, focusing instead on one or two component rules. Cisco realized that a successful standard must unify four key components:

- ◆ Instructional design methodology
- ◆ Content structure
- ◆ Metadata
- ◆ Data format

Eliminating any of these components leaves the standard open to interpretation, and reuse becomes impractical.

Cisco Systems, Inc., the world's largest provider of internetworking technologies, took on the challenge of establishing a unified standard for reusable content in December of 1998. Less than one year later, Cisco completed a successful pilot of their Reusable Information Object (RIO) standard, using software developed by a third-party vendor. RIO combines Component Display Theory and Performance-based instructional design methodology, modified Information Mapping content structure, Information Management System (IMS) metadata, and the eXtensible Markup Language (XML) data format.

Importance

The RIO standard offers a solution to systemic problems facing training and information developers. At the core of the solution is the ability to effectively manage knowledge.

The RIO standard:

- Provides an efficient development process that keeps pace with shortening production cycles
- Enables information to be shared across functional areas, the supply chain, and customer communities
- Reduces redundancy of information
- Ensures consistency and quality of content

Objectives

This white paper describes the rationale for the development of the RIO standard and offers RIO as a possible solution for achieving true reusability of content across companies, industries, and institutions.

The original context for this document is a white paper to be presented at TechLearn '99. By developing the document according to RIO specifications, the information contained herein may be reused in multiple contexts including training.

Prerequisites

This document assumes the reader has experience in course development, training or instructional design; or, the reader is responsible for creating content and information that will be used to build Reusable Information Objects.

Scenario

The information contained in this white paper applies directly to content developers in the Cisco e-learning supply chain. Specifically, Cisco's Worldwide Training organization and its partners will use this information to support the development of new content and conversion of legacy content to the RIO standard.

This document may also serve as a starting point for communication regarding the RIO standard among e-learning and knowledge management professionals in the standards community at large.

Outline

In this white paper, the components of the RIO standard are examined, as are the risk factors critical to successful implementation: workflow, culture, and technology.

- Overview
- Background of RIO Initiative [Fact]
- Performance-Based Instructional Design Methodology [Concept]
- The Instructional Design Process [Process]
- Information Mapping Content Structure [Fact]
- Standardized Metadata [Fact]
- XML Data Format [Fact]
- Confronting Cultural Issues [Process]
- Pilot Implementation [Fact]
- Summary

Goals of RIO at Cisco [Fact]

Introduction

In the face of ever shortening product cycles and an increasing demand for training, Cisco recognized the need to streamline its development processes. The goal was to migrate to a database platform that supports rapid development, publishing to multiple formats, and data sharing across functional areas within Cisco and among partners.

Faster Development

The most critical requirement for the RIO initiative was to support a training development process that could keep pace with Cisco product development cycles.

The following requirements were identified:

- It must be collaborative. A team of collaborators including instructional designers, subject matter experts, reviewers, editors, production staff could work on the same project at the same time.
- It must be easy to make incremental changes for product updates. If there is only a ten percent change to the content of a course, then it should only require a ten percent effort to make the change.
- The tools must be simple to use. Subject matter experts should not be expected to learn new tools. For collaborative content development to be successful, existing workflow must be maintained where possible.
- It must be easy to reuse existing assets within the organization. If valid materials exist in other departments or among Cisco partners, they should be easy to locate and reuse.

Publish to Multiple Formats

Cisco recognized the inefficiency of its internal process for developing derivative instructional materials from the same source content. The new solution must be able to easily output this training content to multiple formats. For example, one source document should be able to generate the following derivative materials:

- Instructor guides
- Student guides
- Instructor-led slide presentations
- Web courses

- CD-ROM products
- Integrated web/leader-led delivery

Sharing With the E-Learning Supply Chain

Cisco wanted to make it possible for all content providers, be they third party developers, suppliers, channel partners, Cisco sales engineers, or other experts within Cisco, to create and share consistent content.

This ability to share reusable training content along its entire e-learning supply chain is highly valued at Cisco. Examples of the e-learning supply chain include:

- Customers
- Prospects
- Suppliers
- Contractors
- Partners
- Regulators
- Employees

Sharing With Corporate Divisions

Cisco also recognized the great need to share information across divisions within the organization. Ideally, content developed by technical publications, engineering, or marketing should be accessible to training and other groups within Cisco. For example, a hardware specification developed by engineering should be available to technical publications, or a procedure written by technical publications should be available for use in a training program without modification.

The Enabler: A Unified Standard

Cisco believes that the goals articulated here can only be achieved through a unified standard for instructional design, content structure, metadata, and data format. The RIO standard provides rules and guidelines to achieve these goals.

Performance-Based Instructional Design Methodology [Concept]

Introduction

Cisco recognized that without guidelines for instructional design, content objects are created in haphazard ways that diminish their relevance outside the original context.

The RIO strategy derives its instructional design guidelines from the work of Dr. Ruth Clark. In the 1980's, Dr. Clark fused performance-based instructional design with Dr. David Merrill's Component Display Theory and a modification of information mapping. The approach provides a uniform methodology in the development process and consistent content that is modular and reusable.

What is Performance-Based Instructional Design?

Dr. Ruth Clark is a proponent of performance-based instructional design - a methodology that is job-based and learner-centric.

It is *job-based* in that it views all training as a means to enable a worker to successfully complete a job task. The process follows these basic steps:

- Identify the job task
- Identify the skills and knowledge required to successfully complete the task.
- Develop training in small modular chunks that are organized to support the task.

Training developed from a performance-based perspective is *learner-centric* in the following ways:

- Engages the student with exercises and practices
- Draws examples from the student's experience

Example: New Product Training

The following example illustrates a performance-based instructional design perspective.

Cisco introduces a new product. Sales engineers are expected to identify customer requirements and recommend the new product when it is appropriate. The job task in this scenario is:

- Assess customer requirements and match them with product capabilities

New product training is designed from the beginning to meet this requirement. The requisite skills and knowledge needed to achieve this goal are identified. Then, training is developed to meet this objective. The student is successful when they can demonstrate the ability to correctly recommend the new product.

Non-example: New Product Training

The following non-example illustrates a development process that is not performance-based.

Cisco introduces a new product. The training department is asked to develop a course on the new features of the product. The course is developed around the features list. Then, learners are tested on their recall of the new features.

This method of training does not match a job task. If training is developed from this perspective, the learners may not be able to apply the training to their jobs and the training itself may not be focused on the desired outcome.

The Instructional Design Process [Process]

Introduction

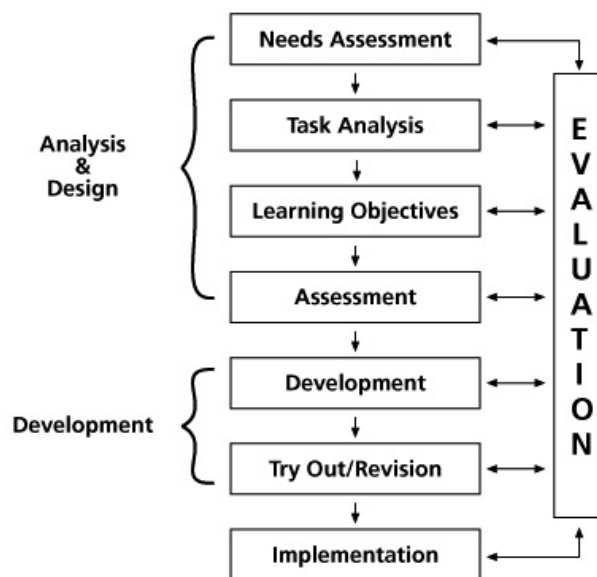
Cisco has adopted a proven instructional design model. This model, approached from a performance-based perspective and implemented using information-mapping rules produces consistent, modular, and relevant instructional content.

Cisco Approach

To ensure consistency across projects and developers, Cisco has developed templates, processes, and guidelines that step developers through the instructional design process from needs assessment through implementation.

Instructional Design Phases

The process of instructional design at Cisco is described in these consecutive phases. In practice however, these phases frequently overlap.



Needs Assessment	Looks at the organization and finds problems that can be addressed via training.
Task Analysis	Analyzes job function and breaks it up into the component tasks. For each task, the skills and

	knowledge required to complete the task are identified.
Learning Objectives	Identifies the learning objectives for each task.
Development	Selects an appropriate delivery format and develops the training material.
Try out / Revision	Training is piloted on a sample group. Feedback is gathered and training is modified.
Implementation	Training is implemented on a large scale.
Evaluation	Feedback is gathered and integrated into the training updates.

Information Mapping Content Structure [Fact]

Introduction

Information Mapping (tm) is a methodology for developing structured content that is consistent and modular, and written in a manner that fosters reuse.

Information Mapping can be applied to any type of information. At Cisco there is a desire to standardize information structure across the functional areas of training, technical publications, engineering, marketing, and sales. The goal is to be able to share and reuse content across functional areas without modification. For example, a procedure developed for technical publications should be useful without editing within a training context.

History of Information Mapping

Information Mapping is based on the research of Robert Horn, a professor at Harvard and Columbia Universities who studied how readers deal with large amounts of information. He devised a standard approach for communicating information based on learning theory, human factors engineering, and cognitive science.

Information Mapping provides guidelines for authors to break complex information into elements optimal for readers. Information is categorized into seven types:

- Concept
- Process
- Principle
- Procedure
- Fact
- Structure
- Classification

Each type has its own structure optimized to communicate the information. Information types are comprised of component *blocks*.

Benefits of Information Mapping

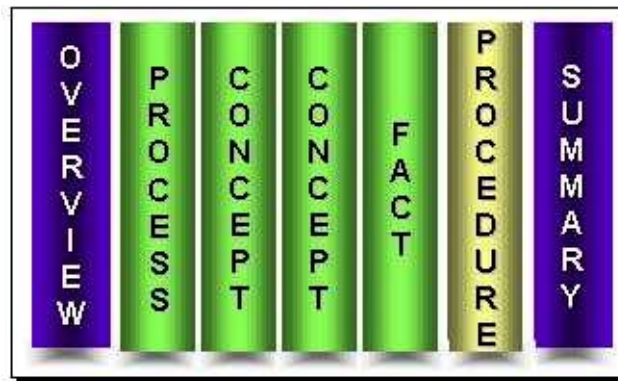
Information Mapping has proven to be cost effective method. Research has shown significant benefits:

- 20%- 50% increase in writing productivity
- 10%-50% decrease in reading time
- 13%-83% increase in retention
- 10%-50% decrease in training time

Source: *Information Mapping Inc.* <http://www.infomap.com/method/method.htm>

Cisco's Reusable Learning Objects

Cisco has adapted Information Mapping for its RIO standard. The RIO standard is a two-level hierarchy. Reusable Learning Objects (RLOs) are containers for Reusable Information Objects, which are modified Information Mapping information types. The RLO has an overview and summary that provides context for the aggregation of component information types. The goal is to be able to mine the organization for existing assets that map to the desired educational goal.



Reusable Learning Objects (RLOs)

- Focused on a single job task
- Similar to a short *Lesson*
- Contains (7 plus or minus 2) RIOs

Reusable Information Objects (RIOs)

- Supports the job task with knowledge needed
- Built upon standardized templates
- Contains 7 (plus or minus 2) items or *building blocks*

For more on RIO please see

http://www.coursenet.com/html/prodserv/white_paper.htm

What is Metadata? [Concept]

Introduction

If information in a database is to be reused and shared across the supply chain, it must be catalogued in a consistent manner.

Metadata Definition

Metadata is data about the data. It enables users to precisely locate and retrieve knowledge assets based on known attributes such as keywords, ownership, dates, and usage.

IMS Metadata Standard

The Information Management System (IMS) is a standards body that has implemented a metadata standard to describe educational assets. It divides the metadata into the following categories:

- Metametadata
- General
- Life Cycle
- Technical
- Educational
- Rights
- Relation
- Annotation
- Classification

A goal of the IMS is to enable interoperability of educational assets drawn from repositories of educational assets on the Internet. The content in the repositories is easily found, used, and in some cases purchased. Using a common meta-language to describe educational assets is the first step toward creating interoperable content.

By adopting the IMS metadata standard, Cisco hopes to foster sharing of educational content with its customers and partners.

Cisco's IMS Metadata Implementation

The Cisco RIO standards committee has adopted a subset of the IMS (Information Management System) metadata standard. It is implemented with a controlled vocabulary for keywords and user roles. One of the features of the IMS standard is its extensibility. Cisco is leveraging this extensibility to support its internal processes and procedures.

Educational Metadata Example

RIO's have information about the educational content such as the intended audience, how long it will take to complete, and any prerequisite knowledge.

Production Tracking Metadata Example

RIOs contain information on the production status of the object for use by its developers. A RIO holds information such as who the object is assigned to, when it is due to be published, and its status. This information is used by the production system to track and facilitate workflow.

Metadata Analogy

Metadata is like a label on a can. The label tells you about the contents inside the can. Metadata standards are like nutritional information standards on food labels. They provide a standard means of comparison for size of serving, calories, grams of fat, etc..



XML Data Format [Fact]

Introduction

XML (eXtensible Markup Language) is the structured data format that Cisco selected for its RIO standard because it met the following technical requirements:

- Dynamic data exchange
- Publish to multiple formats
- Supports structured data such as Information Mapping

Data Exchange

To integrate content from dispersed databases requires a common set of rules for exchanging that data. A recent Forrester survey report found the following:

- 48% of respondents indicated that complex connectivity was the biggest stumbling block to implementing database driven Web applications.
- Like many of companies in this survey, Cisco is specifying XML (eXtensible Markup Language) as the standard format for enterprise data exchange.

Selecting XML as a data format allows Cisco to easily exchange data across departments, the supply chain, partners, and customers.

Publish to Multiple Formats

XML separates structure from presentation. In this way, the same content can be rendered differently depending on the target audience, and the delivery platform. RIO/RIOs are being published into the following formats:

- Static HTML (CD-ROM or Web)
- Adaptive Dynamic Delivery
- Printed Student Guides
- Instructor Presentation (HTML)



Structured Data Format

XML is hierarchical in nature. The structures are defined by a Document Type Definition (DTD) which enforces and validates that the data conforms to the rules. The rules of Information Mapping are optimally expressed in a DTD.

Confronting Cultural Issues [Process]

Introduction

Detractors of a structured approach to content development argue that any unified standard may be too restrictive and that rules may limit creativity. The RIO standard acknowledges that content authors will be required to follow conventions and that this may be a change in their development process. However, the success of RIO depends on consistency of information in terms of instructional design, content structure, metadata, and data format. Creating content for reuse requires discipline, but these costs are outweighed by gains in productivity.

Perhaps the biggest challenge facing Cisco and the members of their supply chain is in the area of change management. Human nature is resistant to change, while success of the RIO standard is dependent on both technical and cultural innovation.

Cisco is facilitating the transition to RIO in the following ways:

- Easy to use tools
- Training
- Incentives

Managing Change

Tools	The tools used by designers and subject matter experts to create RIO-compliant content are easy-to-use and guide them through the development process.
Training	One method for fostering cultural change is to provide comprehensive training and support for developers working with the RIO methodology and tools. Cisco conducted their first RIO training class in late September of 1999. Additional classes are planned in the United States and in Europe.
Incentives	Rewards and incentives for locating and reusing RIO content (rather than creating redundant content) are also part of the implementation strategy at Cisco. Details of these incentive programs have not been released as of this publication date.

Pilot Implementation [Fact]

Introduction

The RIO standard was tested in a pilot class conducted in September 1999. The four-day class included twenty students from various departments within Cisco including various training groups, Human Resources, technical documentation, lines of business, and electronic media production.

Pilot Goals

The goal of the pilot was to solicit feedback from a focused audience on the following issues:

- RIO standard
- RIO training
- RIO Bravo, the authoring solution

Curriculum

The content for the course was a modified version of the Clark Training course *How to Plan, Develop and Evaluate Training*.

During the first three days, students learned the performance-based instructional design model and how to apply the Information Mapping methodology. On days three and four, the students used the RIO Bravo tool to create RIO-compliant training objects.

Tools

Cisco selected CourseNet Systems of San Francisco as the vendor to provide an authoring solution for the RIO pilot. In six weeks, CourseNet developed a customized version of their CourseAdvantage learning object system called RIO Bravo.

Technical Solutions

The CourseAdvantage system was selected because it met Cisco's baseline technical requirements:

Used a centralized	At the core of the system is a centralized database that is
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database	accessible via distributed Web interfaces. The CourseAdvantage distributed authoring solution supported Cisco's need for a collaborative workflow among instructional designers, subject matter experts (SMEs), media artists, and reviewers.
Leveraged familiar tools and technologies	To facilitate the adoption of the RIO standard, it was important that SMEs use familiar tools and be able to work off-line. RIO Bravo supports off-line content creation using MS Word templates. MS Word files are downloaded with RIO-specific programming. From there they can be e-mailed to subject matter experts who work with these MS Word files off-line. Custom programming in the Word files: enforce RIO rules, upload media to the database, convert the MS Word documents into XML, and upload the XML content to the RIO Bravo server.
Met IMS standards for metadata	RIO Bravo supports IMS metadata standards. Cisco crafted their specific metadata requirements. RIO Bravo automates the entry of many of these metadata values.
Uses XML as the data format	The system met the technical requirements of using XML as its native data format. XML separates content structure from its presentation, therefore allowing different types of output. RIO Bravo outputs to static HTML, printed student and instructor guides, an instructor's presentation format, the Cisco Online Testing (COLT) format, and dynamic Web preview directly from the database.
Integrates with IT systems	RIO Bravo could only be deployed on Cisco's intranet if it met IT standards. These requirements included Solaris, Oracle database, thin clients, and minimal client installations.

Survey Results

After the pilot class was concluded, the participants were surveyed. One hundred percent of students surveyed after the pilot course responded yes to the question:

"Do you believe there are benefits to using the RIO Bravo tool and the RIO standard to develop courses?"

Their comments included:

"Great idea!"

"Can't wait to implement and develop with it."

"Excited about the potential; looking forward to using the next version."

Based on pilot user feedback, Cisco found that the RIO standard did not require any modifications and the RIO Bravo tool exceeded expectations.

Survey feedback also suggested greater focus in the classroom training on the use of RIO in workflow. Feedback concerning the training and the tool drove the revision cycle.

Summary

Review

This paper described the need for a unified standard to enable reusable content. It identified four required components:

- Instructional design methodology
- Content structure
- Metadata
- Data format

Cisco Systems combined proven methodologies and processes of performance-based instructional design, Information Mapping content structures, IMS metadata standards, and the XML data format to produce the RIO standard.

The RIO standard addresses the following business goals:

- Faster development
- Publish to multiple formats
- Share information with the e-learning supply chain
- Share information with corporate divisions

The RIO strategy also addresses cultural and technical issues surrounding a change in workflow. RIO addresses these concerns with:

- Easy to use tools
- Training
- Incentives

Next Steps

The RIO standard is being presented for the first time to a large audience at the TechLearn '99 Conference in Orlando, Florida. Cisco submits this proposed unified standard for consideration by its partners and affiliates with the goal of creating truly open and interoperable content. Cisco will continue to solicit feedback on the proposed standard from its internal and external stakeholders to evolve RIO.

Additional Resources

For a pdf versions of this document and the *Cisco Systems Reusable Information Object Strategy and Standards* please see

http://www.coursenet.com/html/prodserv/white_paper.htm

For more information regarding Cisco Systems please see: <http://www.cisco.com>

For more information regarding Dr Ruth Clark please see:

<http://www.clarktraining.com>

For more information regarding Dr. David Merrill please see:

<http://www.coe.usu.edu/it/id2/>

For more information regarding Information Mapping please see:

<http://www.infomap.com>

For more information regarding CourseNet Systems please see:

<http://www.coursenet.com>

For more information regarding educational metadata please see:

<http://www.imsproject.org>

For more information regarding XML please see: <http://www.oasis.org>, and

<http://www.xml.org>