Generic AEC/FM Model: ISO 10303 AP241
at ISO TC184/SC4

19th October 2008

Inhan Kim
KyungHee University
Background

To-Be

CONSTRUCTION MANAGEMENT
- Configuration Management
- Document Management
- Workflow Management
- Process Management

SERVICE SYSTEM
- Piping
- HVAC
- Structure

APPLICATION SYSTEM
- Facilities Maintenance
- As-Maintained Status Report
- Maintenance Scheduling
- 3D virtual reality
- 2D Representation

BUILDING AND CONSTRUCTION
- Building
- Civil
- Plant
Aims of Research

◆ In this paper:
  ▪ proposes a new model structure which can represent AEC facilities and their maintenance history based on an AP241 core model
  ▪ introduces an overall structure and data integration method of the AP241 data model

◆ The data model has high-level definition of facility information using facility product classification and their relationship.

◆ It would be of great interest to represent historical information of facilities based on AEC approach time variation.
Background

Evidence of Industry Need for Generic Model

- Information about the AEC facilities are created and used by many different organizations throughout a lifecycle of facility.

- Concurrent engineering requires coordination of work of other disciplines such as planning, purchasing and logistical activities.

- Currently design, construction and maintenance of AEC facilities are performed using a great variety of software programs.

- However there exists no underlying common data model.

- Such an underlying common data model would enable high quality data exchange and data sharing during the complete life cycle of a facility.
Background

As-Is

Lifecycle of AEC Facility

Design → Procurement → Installation/Construction → Operation & maintenance → Improvement → Disposal/Reuse

AEC Industry

- Data Exchange & Feedback
- Need Solution

Commercial CAD system

- Data Exchange & Feedback
- Need Solution

O&M Lifecycle: 10~50 Years

- PMIS
- ERP
- FMIs

Lifecycle: 5~6 Years

Lab for Information Technology in AEC

織部情報研究所
Background

Problems & Solutions

◆ data interoperability
  ➔ using Neutral Data Format
  ➔ using Reference Data Library as a Standard Reference Library

◆ long-term data archiving
  ➔ using Open Standard. STEP
  ➔ not only file based system but also STEP based Model Server

◆ represent facilities historical data
  ➔ using AEC Generic model, Temporal relationship, and Standard Reference Library
Background

AP241 Strategy

Lifecycle of AEC Facility

Design → Procurement → Installation/Construction → Operation & maintenance → Improvement → Disposal/Reuse

Data Exchange
Data Integration
Lifecycle Support

Common Data Model
(STEP data model & Reference Data Library)

Horizontal Data Integration through the Life Cycle

*Ref: JBIM2008 Spring. Page 30
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ITalab
Lab for Information Technology in AEC
AP241 Introduction

Overview

◆ AP241 - Generic model for Lifecycle support of AEC facilities
◆ Project Leader: Inhan Kim(Kyunghee Univ.)
◆ Scope
  ▪ Spatial structure of the AEC facility;
  ▪ Location of the elements that constitute an AEC facility;
  ▪ Make use of shape representation including two dimensional and three dimensional shape;
  ▪ Make use of drafting information that presents the AEC facility;
  ▪ General representation of properties;
  ▪ Classification of the elements and properties;
  ▪ Change Management;
  ▪ Association of approvals;
  ▪ Association of constraints;
  ▪ Maintenance and feedback of operational information concerning the AEC facility.
What is STEP

STandard for the Exchange of Product model data
- a series of ISO Standards, ISO 10303
- The overall objective of STEP is to provide a mechanism that describes a complete and unambiguous product definition throughout the life cycle of a product, independent of any computer system.
AP241 Introduction

A 241 Generic model for lifecycle support of AEC facilities
## AP241 Introduction

### STEP Part No. of AP241 Core Modules

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<th>Title</th>
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AP241 Introduction

Schedule for the Standardization

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<th>Stages</th>
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<th>Actions</th>
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<td>CD Committee Draft</td>
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<td>FDIS Final Draft for International Standard</td>
<td>2009-00-00</td>
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<tr>
<td>IS International Standard</td>
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</table>
AP241 Introduction

Aims of Development

◆ Assess in detail the information requirements of AEC facilities, resources, processes and controls.
◆ AP241 can be used for data exchange and sharing of combined 3D CAD product data at all stages of the lifecycle.
◆ From this Aims, AP241 will provide;
  ▪ the overall definition of the foundation entities and their relationships
  ▪ different participants and different applications software to use the definitions as a common basis for the exchange of project data and knowledge
AP241 Introduction

AP241 provides environmental data & PLCS capability

Facility life cycle

Design → Procurement → Installation/Construction → Operation & maintenance → Improvement → Disposal/Reuse

AP241 gathers environmental information of AEC area. (Building, Plant, Bridge, Transportation, Tunnel, Dam) support management of lifecycle data.

AP241 includes:
- AP203e2 shape representation
- AP221 functional data & symbolization
- PLCS modules

Use & accumulate Reference Data
- ISO 15926 part 4
- Gellish
Related standard data model

- AP239
  - Product Identification
  - Activity recording
  - Product status recording
  - Etc.

- AP221
  - External item identification
  - Assignment capabilities
  - Class classification capabilities

- AP241
  - AEC Product definition
  - AEC Process definition
  - AEC Resource definition
  - AEC Control definition
  - Relationship between AEC object
    (every object is defined as abstract level)

- AP225 modules
  - Building item
  - Building component
  - Building structure

- Shape representation capabilities

- AP203 edition 2

- Reference Data
  - RDL for the PLANT area
  - Gellish for the civil & the Construction area
  - Products
  - Process
  - Assets
  - Organization
  - Property
  - Architecture
  - HVAC/Piping
  - Transport
  - Electrical
  - Structure
Real world objects

AEC Objects

Products
- Building
- Road
- PLANT
- Assembly
- Document
- etc
- Functional breakdown
- Physical breakdown
- Service system
- Individual product
- Individual part

Resources
- Construction aid
- Material
- Equipment
- Code & standard
- Document
- etc
- Human
- Money
- Time
- Information
- Software

Process
- Plan
- Design
- Construction
- Handover
- O&M
- Demolition
- e.g. Architectural design process
  - Draw up brief
  - Draw up programme
  - Make global design
  - Make detail design

Control
- Client brief
- Contract
- Construction plan
- Bill of material
- Schedule
- Project
- Action
- Condition
- Event
- Performance
- Work

Produce

Use

Control
AP241 Basic Concepts

**CO matrix table**

- **Two-Dimensional Conformance Options.**
  - Vertical structure is associated with a type of AEC facility
  - Horizontal structure is associated with view definitions for a certain type of AEC facility

<table>
<thead>
<tr>
<th>Domain</th>
<th>View Definition</th>
<th>Spatial/Architecture</th>
<th>HVAC/Piping /Transport</th>
<th>Electrical</th>
<th>Structural</th>
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<td>CO7</td>
<td>CO8</td>
<td>CO9</td>
<td>CO10</td>
</tr>
</tbody>
</table>
AP241 Data Integration Method

Establishment of AP241 for the environment

- Environment-conscious information
  - Realization by information model
    (environment-conscious information model)
  - Realization by reference data
    (environment-conscious reference data)

AP241
- PLCS DEX
  (Information model)
- Discipline extension module
  (Domain specific information model)
  - Building: AP225, IFC
  - Road ➔ Create Road module (based on JHDM)
  - Bridge ➔ Create Bridge module
    based on IFCBridge

Reference Data Library (RDL)
- Plant ➔ ISO 15926 part 4, AP221
- Civil ➔ ISO 15926 part 4, Gellish
- Dam ➔ ...

**AP241 Data Model**

- **Aec_thing** is a super class of everything within the AEC industry. Root concept exists only for the AEC specific object definition. STEP data model do not have a root concept in general.
- **Aec_object** is an abstraction of any semantically treated things that exists in space and time including material objects, non-material objects and actions.
- **Aec_relationship** is an abstract generalization of all objectified relationships. This concept allows keeping the relationship specific properties to later handle relationship specific methods.
The Eiffel Tower lifecycle data representation

Lightning striking the Eiffel Tower

- Eiffel Tower was struck by lightning on 3 June 1902, at 9:20 P.M.

- The damaged middle lighting illuminating the tower had to be replaced.

- This maintenance activity and individual objects can be described by AP241

*Ref: NOAA’s National Weather Service (NWS) Collection .
http://www.photolib.noaa.gov/htmls/wea00602.htm
The Eiffel Tower lifecycle data representation

Assumptions of maintenance history

- ‘#LF-11’: serial number of the broken middle lighting
- ‘#LF-22’: serial number of the new lighting

Middle Lighting
Aec_object_individual

#LF-11

Successor: Beginning of #LF-11

Predecessor: End of #LF-11

Eiffel Tower
Aec_object_individual

#LF-22

Serial number

Construction date
31st Mar. 1889

Maintenance date
3rd June 1902

Event
Beginning of the Eiffel tower
Beginning of #LF-11

Event
End of #LF-11
Beginning of #LF-22

Lifecycle
Time

Functional location

Part
Whole

Part
Whole

Serial number

The Eiffel Tower lifecycle data representation

Description of Required Entities

[Aec_object_individual] : The ‘Eiffel Tower’ which is located in Paris since its construction in 1889. The ‘middle lighting’ known by the serial number ‘#LF-11’ which is installed in the tower.

[Aec_type_definition_relationship] : The Aec_object_type that indicates the ‘#LF-11’ is a member of the ‘middle lighting’ type.


[Temporal_instance] : The relationship that indicates that the ‘Eiffel Tower at the UTC 1902-06-03T21:20’ is an instant of the ‘Eiffel Tower since 1889’.
The Eiffel Tower lifecycle data representation

Description of Required Entities

[Temporal_whole_part] : The relation that indicates that the service period of ‘#LF-11’ and ‘#LF-22’ are temporal part of whole lifecycle of the ‘Eiffel Tower’. The ‘#LF-11’ was where the middle lighting is also part of the tower.

[Temporal_bounding] : The relation that indicates that a Calendar_date known as ‘31 March, 1889’ marks the service start of the ‘#LF-11’ is an instance of the Beginning. The relation that indicates that the Calendar_date known as ‘3 June, 1902’ marks the service stopped of the ‘#LF-11’ is an instance of the Ending.
Conclusions and Future Work

- This paper presents AEC industry specific requirements for data interoperability to represent historical data of facilities property.

- AP241 data model can represent geometrical shape and non-geometrical attributes.

- AP241 will be used for data exchange and sharing of combined 3D CAD product data at all stages of the lifecycle.

- AP241 is allowed to represent complex time variation.

- Model extension methods allow the AP241 data model more flexible and extensible.

- AP241 can be utilized by various domain actors as a basis of their extended data model development.

- Future work is required to develop a discipline extension module for the road and other relevant domains.
Thank You!

Q&A

iTALab at Kyunghee University [http://italab.khu.ac.kr](http://italab.khu.ac.kr)

Contact

Name: Inhan Kim
E-mail: ihkim@khu.ac.kr
Tel: +82-31-201-2926
AP241 Data Integration Method

AP241 defines;

- **Context Independent Information**
  - means independent within the domain of construction but not necessarily outside the domain of construction.
  - includes for references within an ARM to external data models

- **Information of Common Interest**
  - is that context independent information which may need to be exchanged or shared on a common basis
  - It will not be all of the context independent information, some of which may be used in a context dependant manner.
AP241 Data Integration Method

AP241 defines;

◆ Semantic level facility product data
  ▪ An exchange between different software within different disciplines which makes available only that information which is necessary.
  ▪ For example, an exchange between a building services application and a structural application would incorporate dimensional and weight information; other information being unnecessary.

◆ Interfacing to the Reference Data/Extension Module
  ▪ For instance, the AP241 might establish a foundation set of information for a beam
  ▪ However, to progress the structural application from design to fabrication would require a more detailed definition.
  ▪ The objective is that the detailed definition would use the AP241 definition and then extend it using Reference Data or discipline extension module.
AP241 Browser prototype

EDMinterface™ = SDAI + DB Functions + Queries

OpenCASCADE

EDMserver™

EDMdatabase™ (Express Store)

HTML Output
Express Schema
STEP Physical File
Express X Schema
JAVA Classes
C++ Classes

Database Management
Express Compiler
Express-G Modeling/Viewing
STEP Read & Write
EDMexpress Debugger
Express-X Model Conversion
Model Checker

Model Conversion
Model Checker

TCP/IP

EDM

GUI Framework (JAD, QAD, MFC)
OGAF: Open CASCADE Application Framework
Development Tools (WxK, Wizards, Draw)
Native Plugin Interface
Native Interface
Foundation Classes (handles, portability)

Open
Components
Services

ssp*: Surfaces from Scattered Points
AP241 Browser prototype

Create Graphical Data (Microstation) → Add Product & Assembly Data (SolidWorks) → Export stp file & manually editing → AP241 stp File → Graphical Representation module → Property Management module → AP241 Browser

Gellish Data (Civil & Construction) → Non-graphical data
AP241 Browser prototype
AP241 based Data Exchange Scenario

CAD Sys. A

-Design

System B

-Management Sys.
-CAD Sys.

Deliverables
-AP241 p21 format
-AP241 OWL format

Local Repository
Or Part Library

AP241 Plug-in
for CAD Sys. A

Transaction

Data

Mapping

Export

AP241 format

AP241 RDL Server
Or Somewhere

Import

Mapping

Transaction

Query (ID)

Respond (angle valve)

AP241 Plug-in for Sys. B

Local Repository
Or Part Library

Query (angle valve)

Respond (ID)

Mapping

React