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Integrated Bridge Project Delivery & Life Cycle Management

FHWA Project: DTFH61-06-D-00037

Krishna K. Verma, P.E.

Principal Bridge Engineer

Contract Officer's Technical Representative

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FHWA Advisory Panel

Fred Beckmann Consultant	**Kenneth Hurst** Kansas DOT	**Sena Kumarsena** HNTB
Shri Bhide Bentley System, Inc	**Roy Eriksson** Eriksson Technologies, Inc.	**David McQuaid** Consultant
Joan Bowser New Mexico DOT	**Luke Faulkner** AISC, Inc.	**Tom Siewert** NIST
George Christian New York State DOT	**Asif Habibullah** Computers and Structures, Inc.	**Bill Wright** FHWA (HRDI-06)

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Presented By

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What Is It?

- Leveraging of automation and communication technologies for managing bridges through their lifecycle

- Fluid and seamless electronic data exchange, management and access

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For What?

- Improved communication of information to efficiently manage bridge related data between stakeholders in
  - bridge design
  - construction
  - operations
  - life cycle management

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What Is Current Practice?

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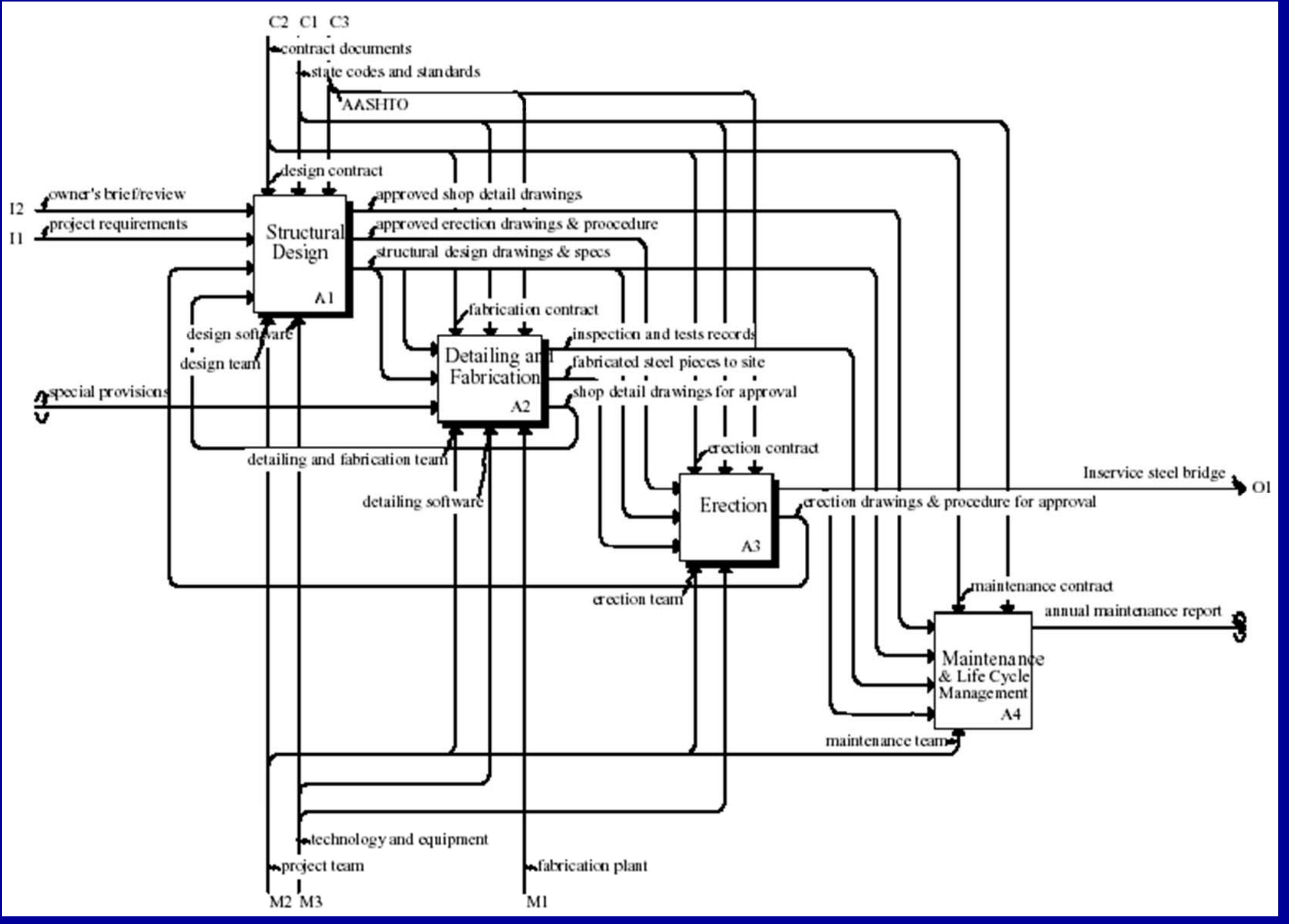
A View of the Life Cycle Process



On-Going Efforts To Improve Current Practice

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Project Background

Focus of Current Efforts

- Speed up bridge construction activities
- Simultaneously enhance the quality and durability of bridges being constructed

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Project Background

Emphasis of Current Efforts

- Cost-effective use of prefabrication techniques for bridge components
- Advanced materials technologies, such as self consolidated concrete
- Construction methods, e.g. stage construction, use of SPMTs and incremental launching for bridge superstructures

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How Do Other Industries Deliver Projects?

Project Background

Other Industry Initiatives

- Building and other industries (Auto, Aerospace and Marine) have documented reduced costs, faster delivery and improved quality resulting from 3D-based integrated design and manufacturing processes.

- Recent examples:
  GM Plants, Denver Museum, Queen Mary 2

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THE CONSTRUCTION WEEKLY
October 10, 2005 • enr.com
The McGraw-Hill Companies
ENR
Engineering News-Record
Visions
No easy path for post-Katrina planning
Energized
Devastation opens door for new power grid
Next Wave
U.S. awards $2.5 billion in new embassy contracts
Virtual Building
General Motors' design-build team perfects a digital design, then locks it and builds without changes. The result? Faster, better, cheaper, safer–and smiles all around.
McGraw_Hill CONSTRUCTION

Benefits Cited – General Motors Plant (200,000 SF):

- Completed in 14 months instead of 20 months
- Digital design, built without changes, potential field construction conflicts resolved ahead of time
- Components precisely prefabricated and delivered for assembly at site, no waste bins at the construction site
- Faster, better, cheaper, safer and smiles all around

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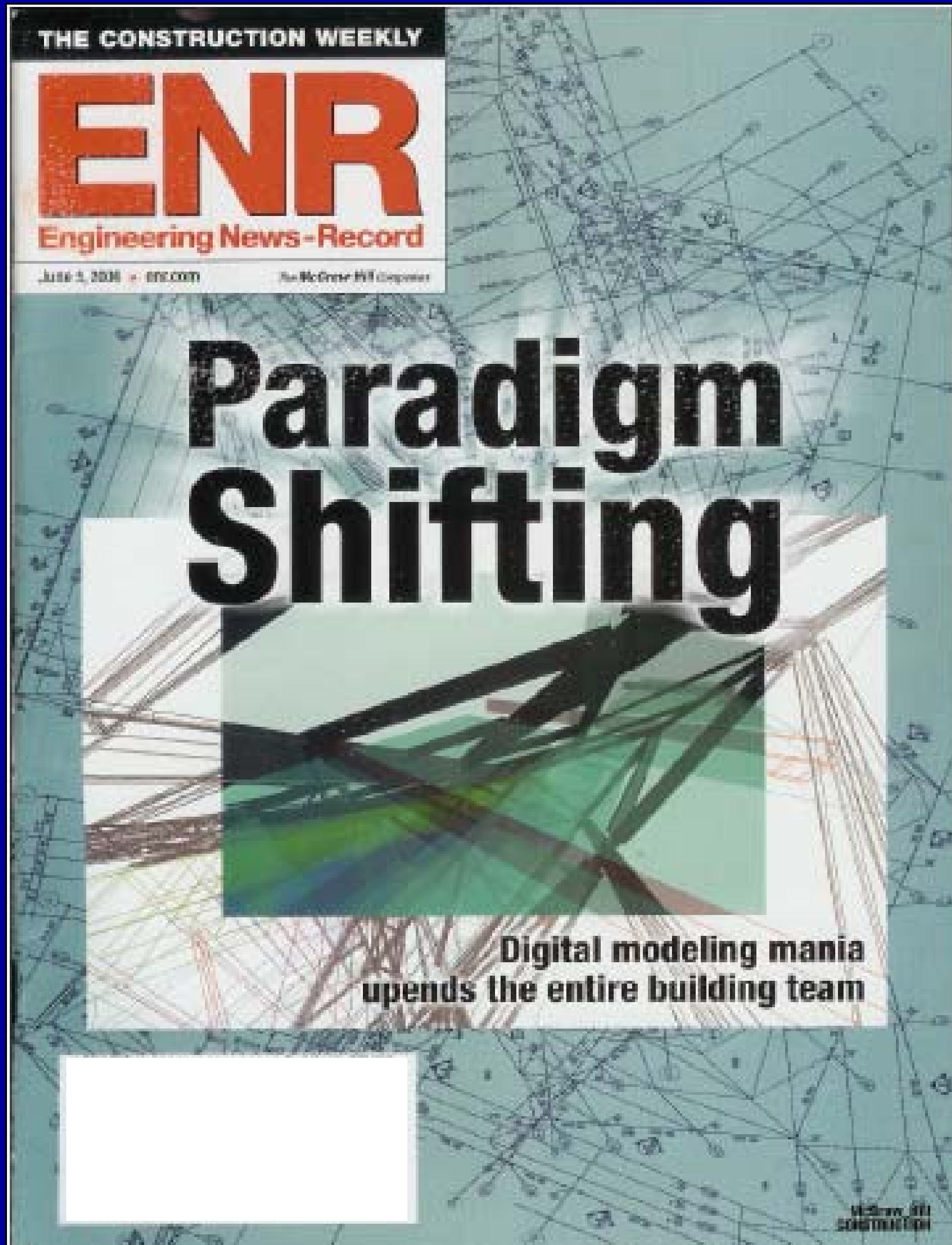
THE CONSTRUCTION WEEKLY
ENR
Engineering News-Record
enr.com
Paradigm Shifting
Digital modeling mania upends the entire building team

Queen Mary 2

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Benefits Cited – Queen Mary 2 Ship:

- Completely built and in the ocean in two years – years saved
- Built in three parts and then assembled together
- Most complex construction and yet construction conflicts avoided

Types of Benefits cited by Other Industries

- Tangible Benefits:
  - Faster project delivery
  - cost savings
- Intangible Benefits:
  - Process and work-flow re-engineering
  - supply-chain integration
  - risk management and claims mitigation

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Types of Benefits cited by Other Industries (cont'd)

- Quasi-tangible Benefits:
  - Improved data availability
  - complete audit trail
  - reduced data entry and improved information management
  - reduced rework
  - improved timely design and construction decision making
  - improved quality of construction

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American Institute of Architects (AIA) Two new model agreements for integrated project delivery (IPD)

- Require use of Building Information Models (BIM) and a division of projects into phases
- Provide two (2) levels of Design and Construction integration:
    1. Transitional for those unaccustomed to IPD
    2. Single purpose entity, offering a fully integrated way to deliver a building

* Excerpts from “AIA Issues New Docs For Integrated Delivery”, by Nadine M. Post, ENR.com

BIM Graphic of Station Platform

* Excerpts from “Doing Business with MTA NYCT” special supplement to May 2008 *NY Construction* Magazine

- MTA NYCT Design Managers each selected 1 project in 2008 for use of BIM
- Implementing BIM on all MTA NYCT projects by 2009
- BIM used to determine that the massive Fulton Street Transit Center project in New York City could proceed with construction while the station remains open to trains and passengers

Genesis of this Project

Project Background

Piecemeal Progress in the Industry

- Parametric design tools and TransXML omit detailing for fabrication and construction
- 3D pre-cast concrete modeling tools are not (yet) bridge-oriented
- Bridge inspection or design/rating (e.g.) apps each require their own data (re)entry
- 3D geometry created (e.g.) for visualization is not also leveraged for fabrication & construction

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Project Background

Piecemeal Progress in the Industry

- 3D for structural analysis is also not leveraged for other asset management purposes needing such 3D geometry data
- Even when electronic data exchange is pursued, only small pieces of the overall workflow involved in bridge delivery are addressed

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Project Background

- FHWA International Review Tour 1999

  - Prevalent CAD/CAM in Europe, Japan

- FHWA Workshop 2001: "*Computer Integrated Steel Bridge Design and Construction: Expanding Automation*"

  Established a roadmap for integrating steel bridge design-through-construction processes and for advancing the state-of-the-art practice in steel bridge manufacturing automation and productivity

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Project Background

"*Theme Areas*" Progress:

- 3D Modeling & Electronic Info. Transfer:
  NCHRP 20-07 Task 149 Project (Completed Nov. 2003)
- Standardized Specs and Approval Processes:
  NSBA/AASHTO Collaboration
- Standardized Design Details:
  NSBA/ AASHTO Collaboration
- <u>Showcase of Benefits of Automation:</u>
  AASHTO Subcommittee on Bridges and Structures Resolution (2005)
  FHWA Project: DTFH61-06-D-00037

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2D vs. 3D

2D CAD provides an electronic "drawing board"	3D CAD enables a parametric model
2D drawings contain the information	3D model contains the info; drawings are only reports
2D drawings human-readable; separate manual data entry is required for analysis	3D model is computer-readable, such that direct analyses are possible
Coordination is difficult; information is scattered among different drawings and specifications clauses	Coordination is automatic: 3D model is the single source for all product information
Manual checking	Automated checking
No support for production	Potentially full support for production (via CNC codes etc.)

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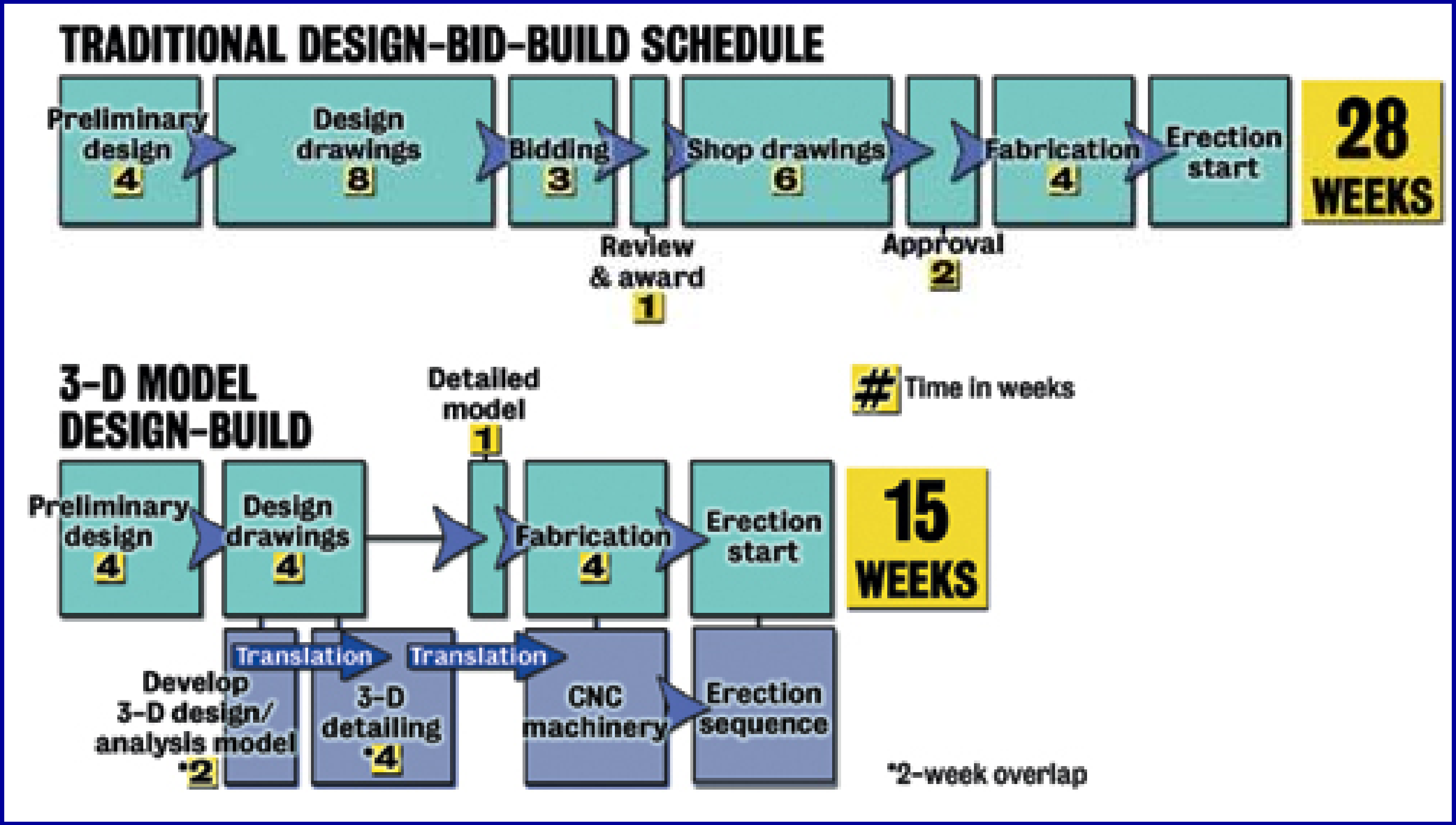
What This Is About



Project Vision

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Overview of Project Vision

- Develop a prototype integrated system illustrating data exchanges and applications
- Address entire bridge life cycle
- Utilize 3-D bridge information modeling (BrIM) as a technology to accelerate bridge project delivery and enhance life cycle management

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Overview of Project Vision

- Demonstrate the viability, efficiencies and benefits of the integrated bridge project delivery and life cycle management concept through one-half-day and two-day presentations of the prototype integrated system to stakeholders around the country

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Project Scope

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Project Scope

- A large and complex project
- Relates many data exchanges and stakeholders
- Involves development of a prototype - not production - software linking appropriate existing commercial software that demonstrates a viable integrated system for bridge project delivery and life cycle management

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Project Scope

- Implementation will require initial stakeholder input, mechanics for maintenance, and will illustrate economic benefits and improved quality
- Presentations, seminars, and other information exchanges address the "*Stakeholder Engagement and Buy In*"

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Project Objectives

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Project Objectives

- Develop integration and linking software
- Demonstrate utility of an integrated approach
- Promote benefits and efficiencies of this approach
- Develop and conduct one-half and two day workshops
- Make presentations to illustrate use of the system for concrete and steel bridges

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Project Approach

Project Approach

- Generate a 3D architectural blueprint for appropriate use, and to facilitate leveraging of data

- Significantly improved 2D design drawings, as well as construction drawings

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Project Approach

- Data ownership issues will be addressed with the philosophy espoused by the AISC Code of Standard Practice:

    The quality of the contract documents is the responsibility of the entities that produce those documents

- Related key issue:

    View / Approve / Edit control and tracking

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Project Approach

- Highlight the benefits of automation and communication technologies to achieve rapid coordinated bridge design, construction and subsequent life cycle management
- Approach will be implemented by performing an integrated set of overlapping tasks

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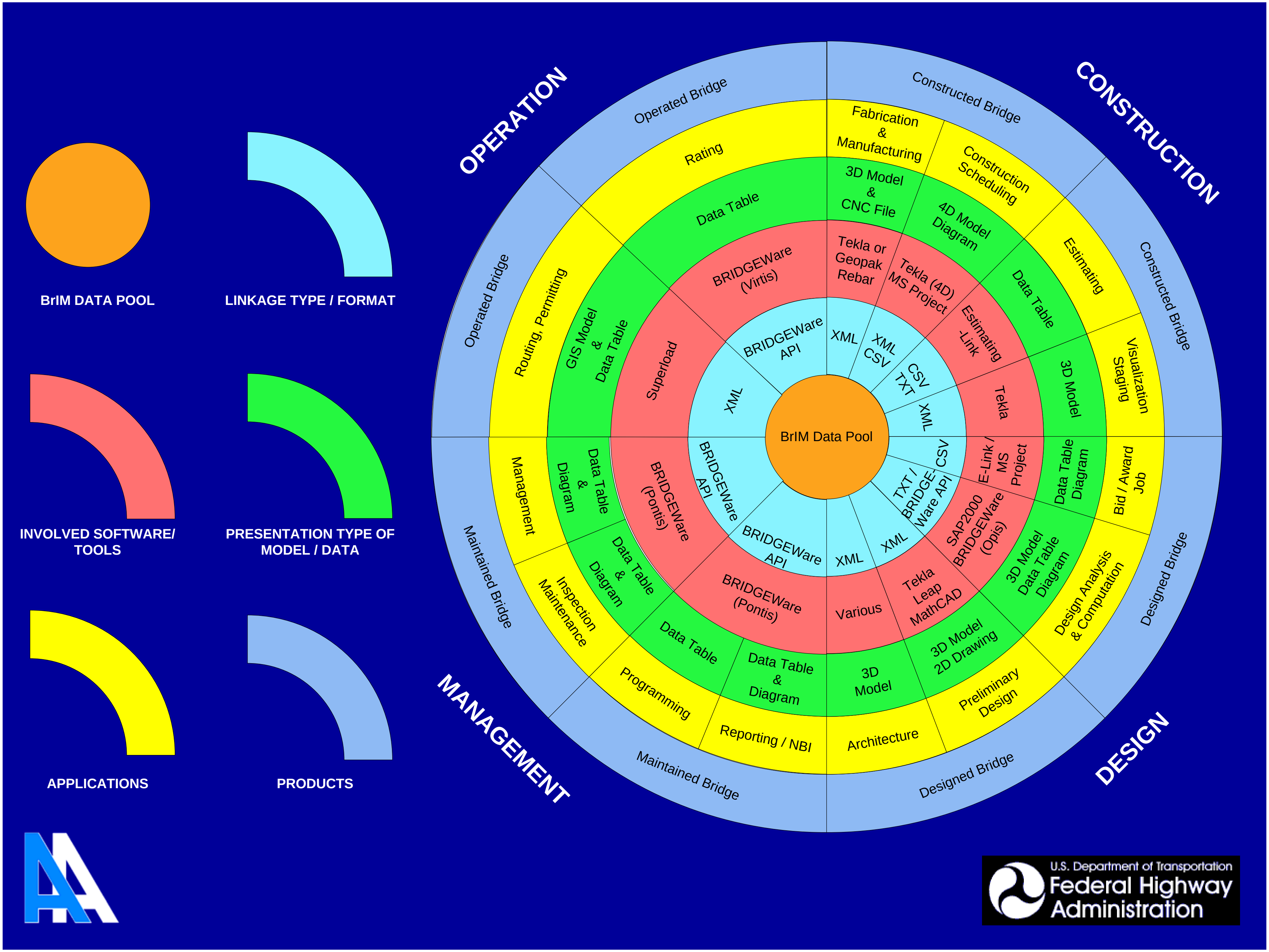
Conceptual View of the Approach



BrIM DATA POOL
LINKAGE TYPE / FORMAT
INVOLVED SOFTWARE/ TOOLS
PRESENTATION TYPE OF MODEL / DATA
APPLICATIONS
PRODUCTS
OPERATION
CONSTRUCTION
MANAGEMENT
DESIGN
BrIM Data Pool
Operated Bridge
Constructed Bridge
Maintained Bridge
Designed Bridge
Rating
Routing, Permitting
Fabrication & Manufacturing
Construction Scheduling
Estimating
Visualization Staging
Bid / Award Job
Design Analysis & Computation
Preliminary Design
Architecture
Reporting / NBI
Programming
Inspection Maintenance
Management
Data Table
GIS Model & Data Table
3D Model & CNC File
4D Model Diagram
Data Table
3D Model
Data Table Diagram
3D Model Data Table Diagram
3D Model 2D Drawing
3D Model
Data Table & Diagram
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BRIDGEWare (Virtis)
Superload
Tekla or Geopak Rebar
Tekla (4D) MS Project
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Tekla
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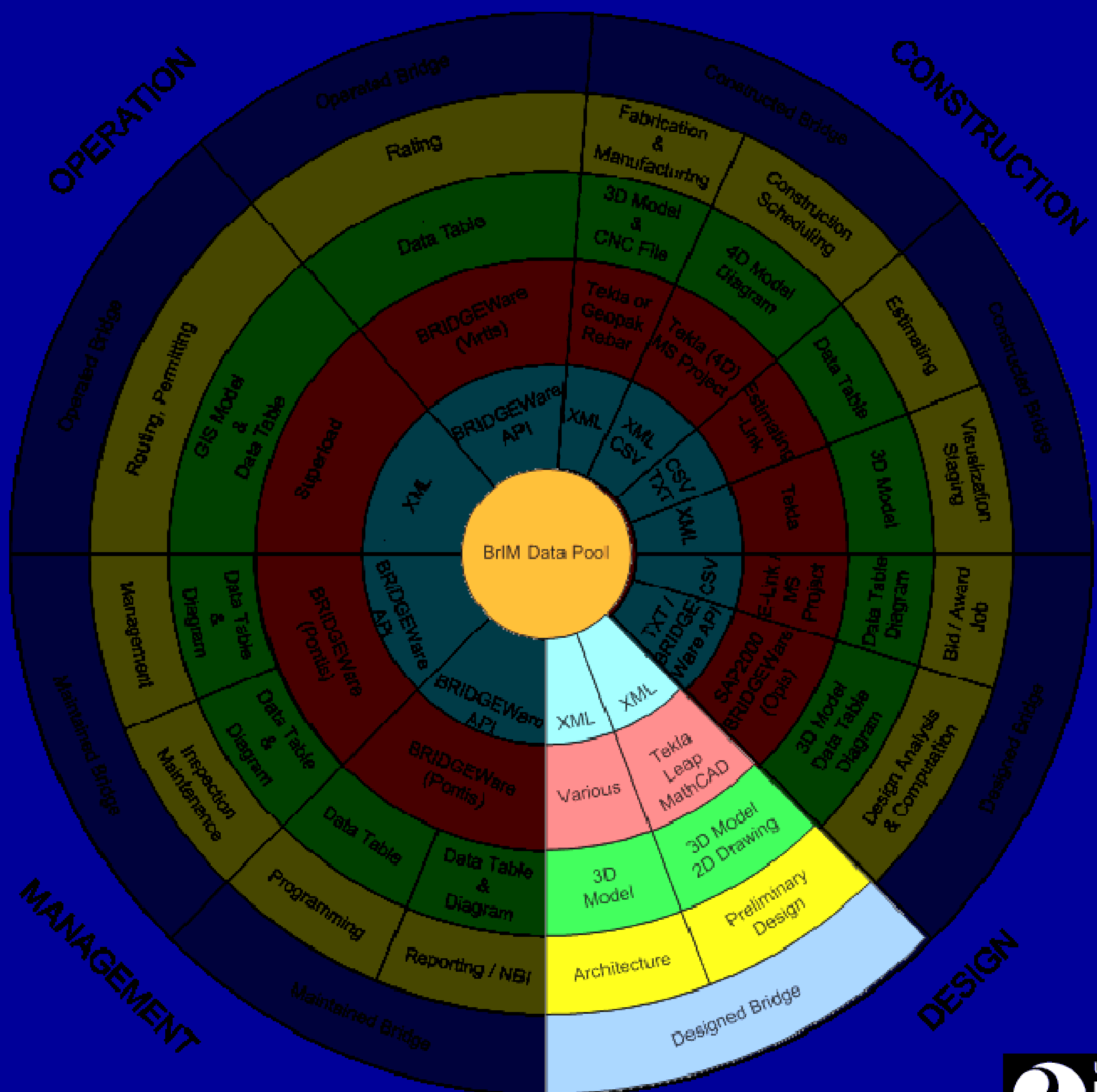

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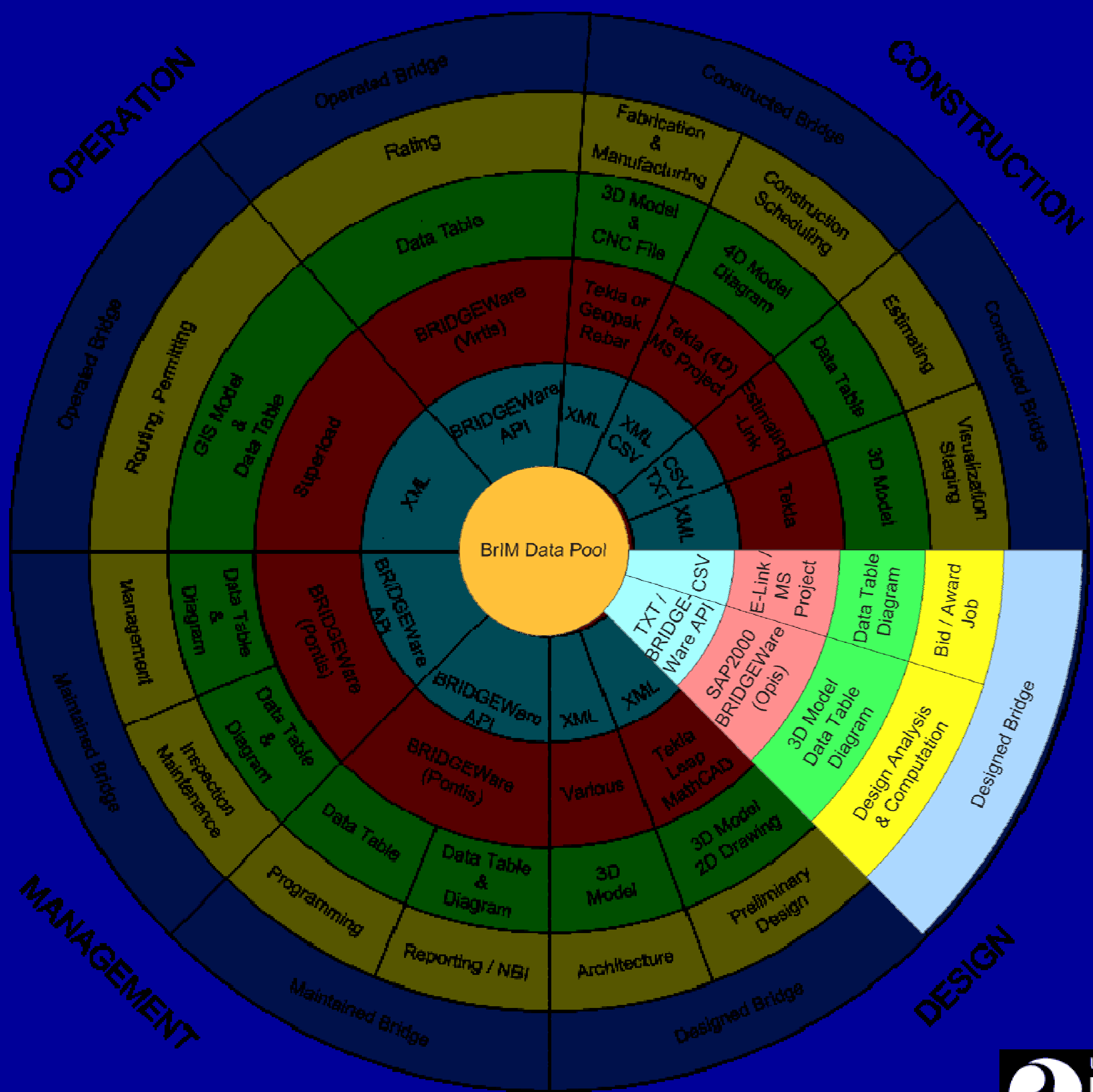
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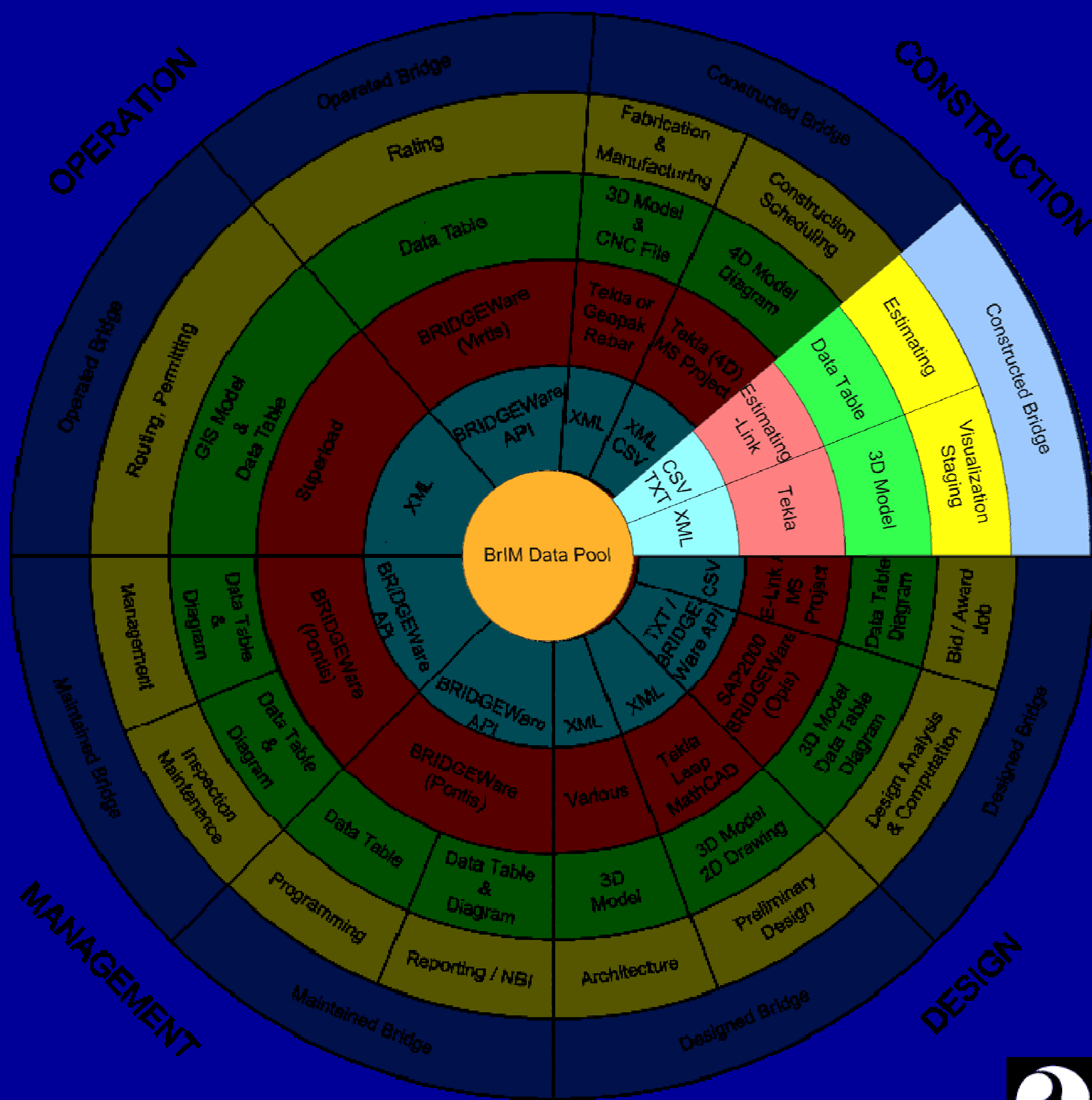

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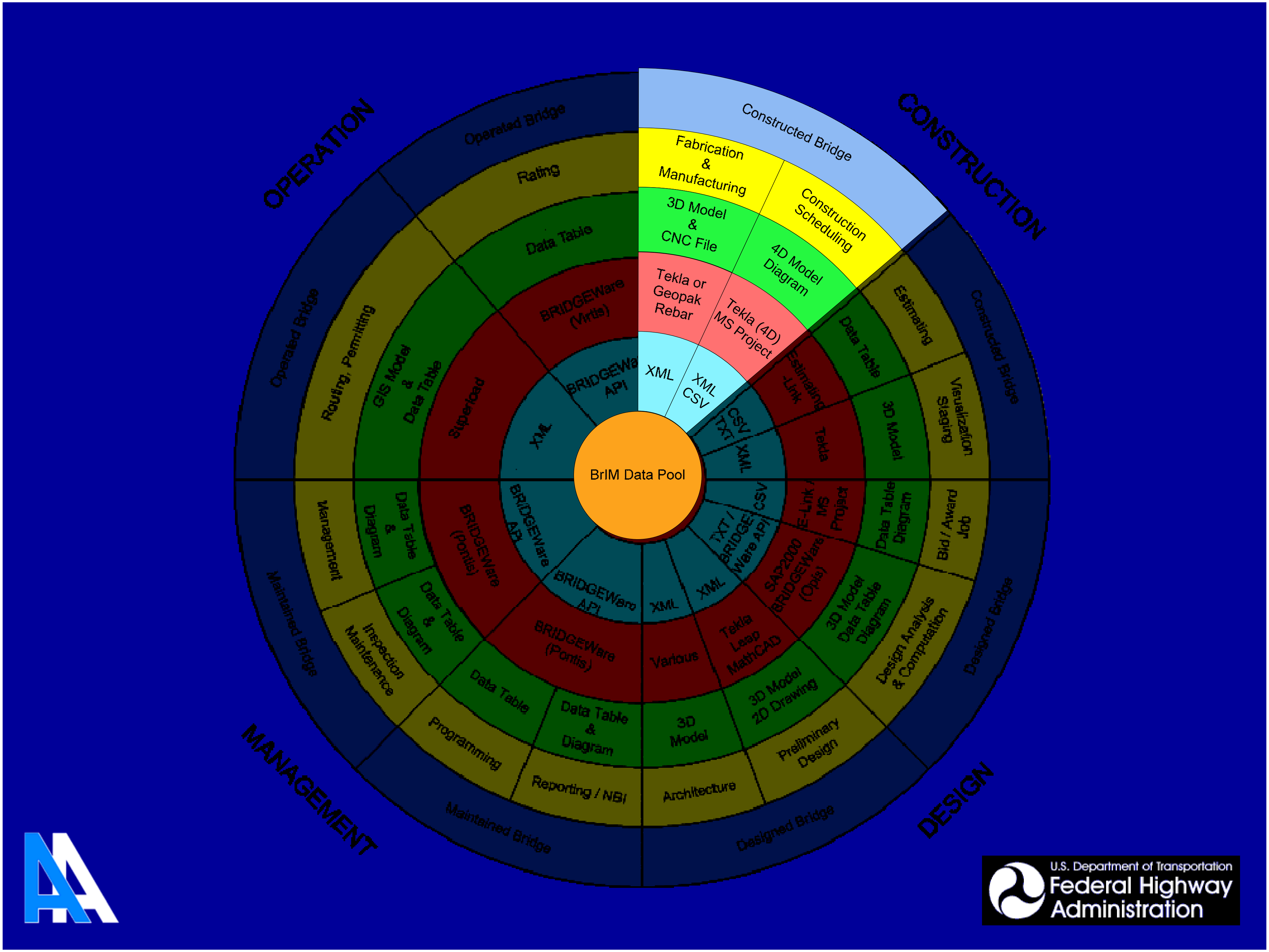
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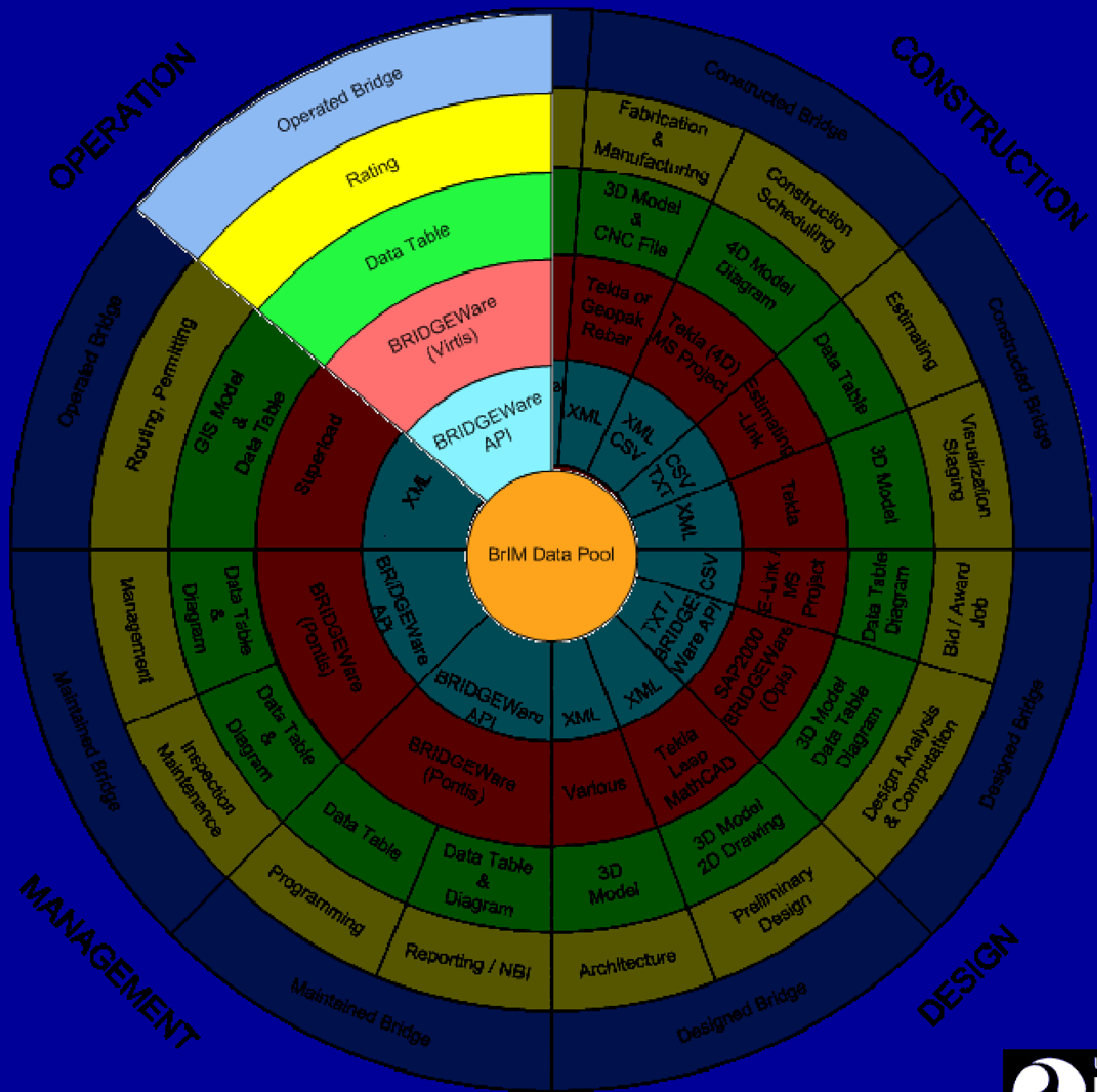

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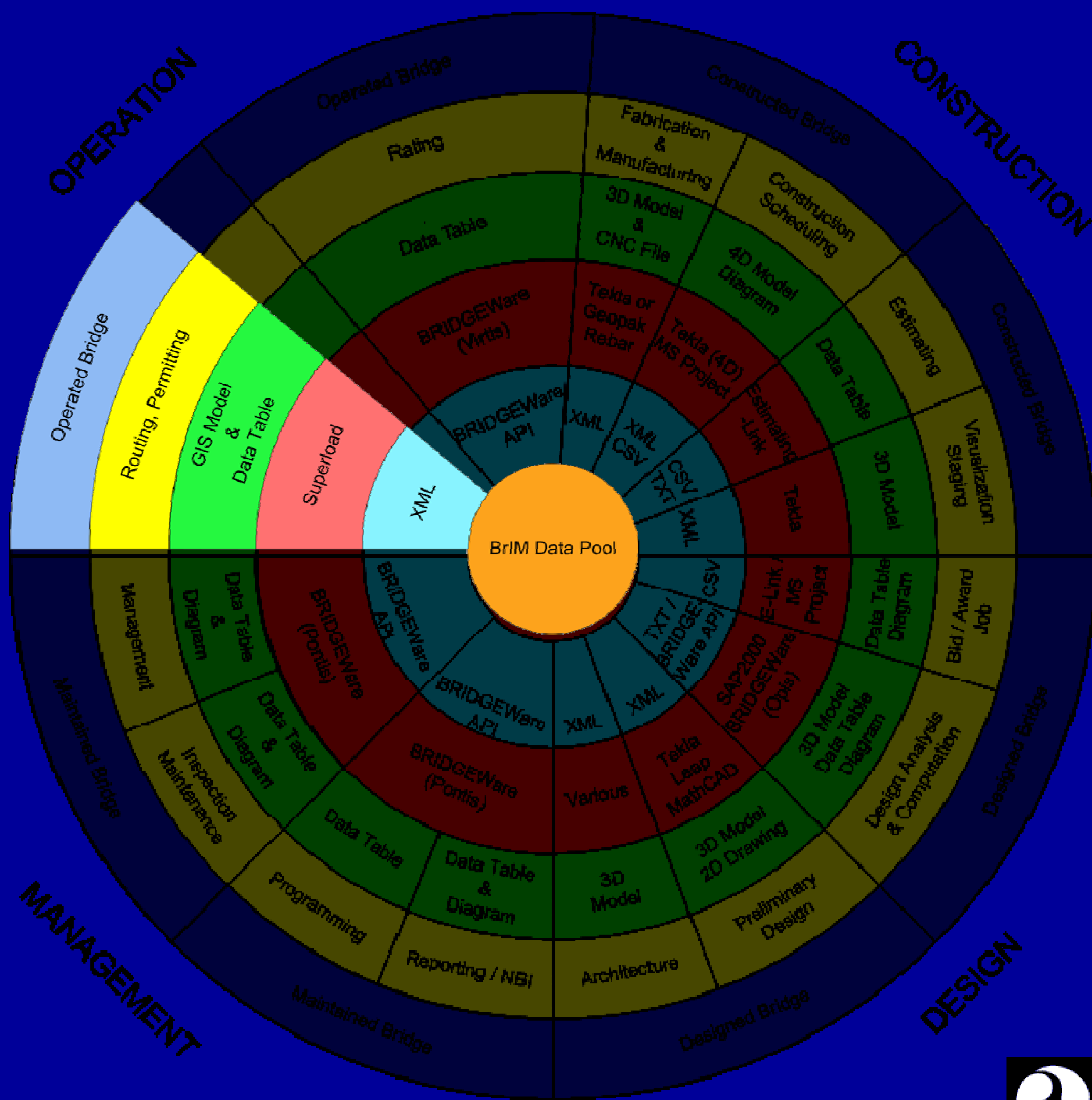

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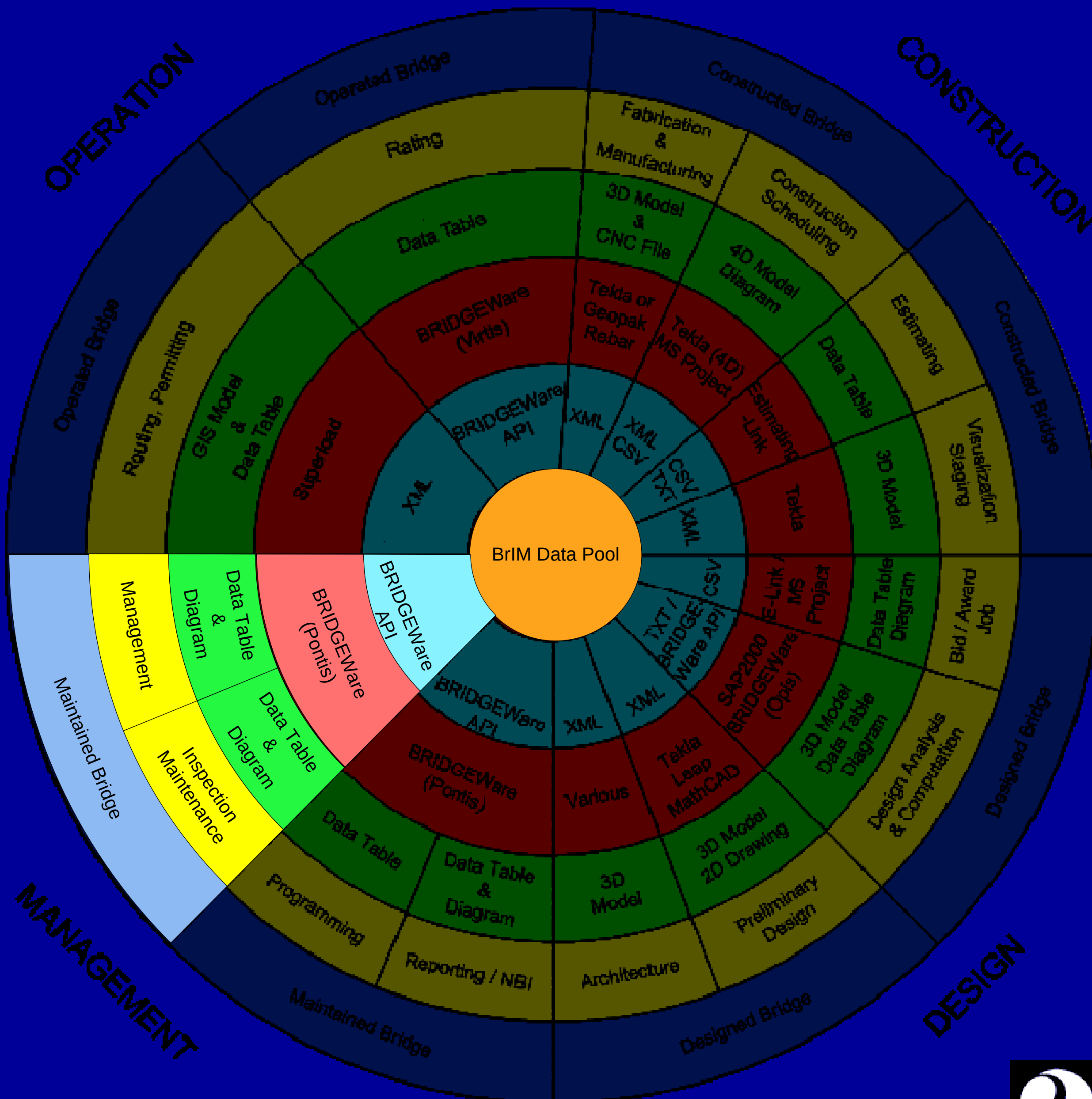

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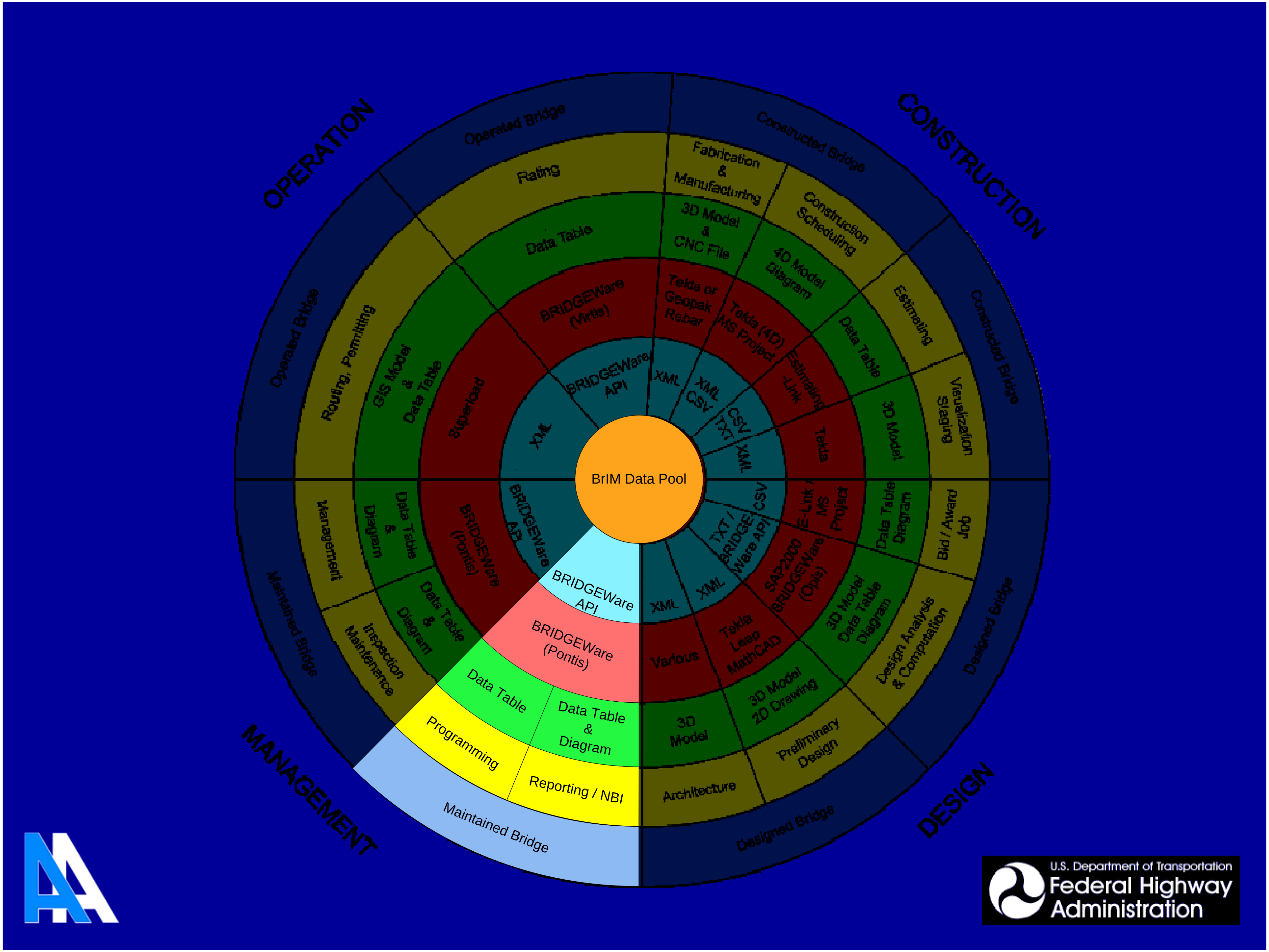

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Summary

- Complex and a non-typical R&D project
- Aimed at establishing the viability of integrated bridge project delivery and life cycle management
- Resulting product:

  An integrated prototype system, with linking software, that connects existing commercial software for all major phases of bridge life

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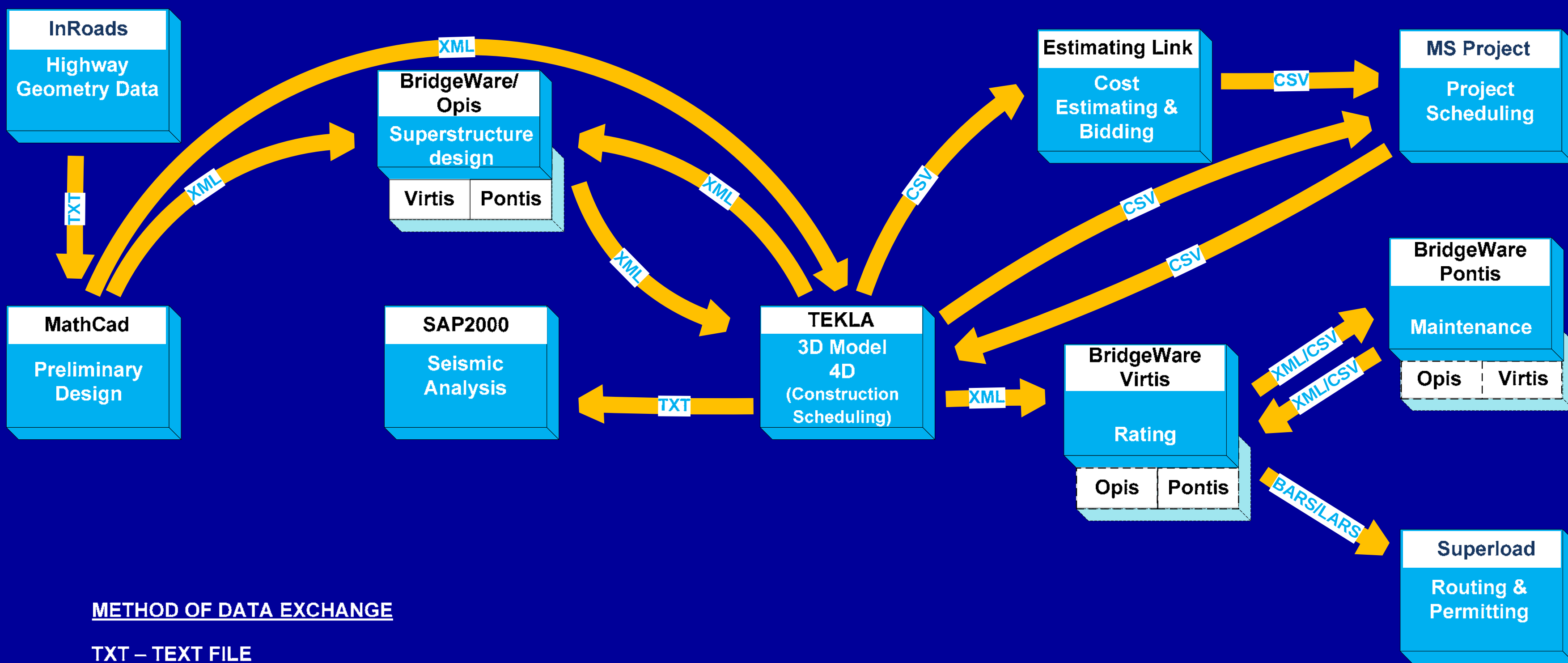
Information Workflow

Steel Alternate



<u>METHOD OF DATA EXCHANGE</u>

TXT – TEXT FILE

XML – EXTENSIBLE MARKUP LANGUAGE

VBA – VISUAL BASIC FOR APPLICATIONS

CSV – COMMA SEPARATED VALUES

BARS/LARS – AASHTOWARE AND BENTLEY SOFTWARE

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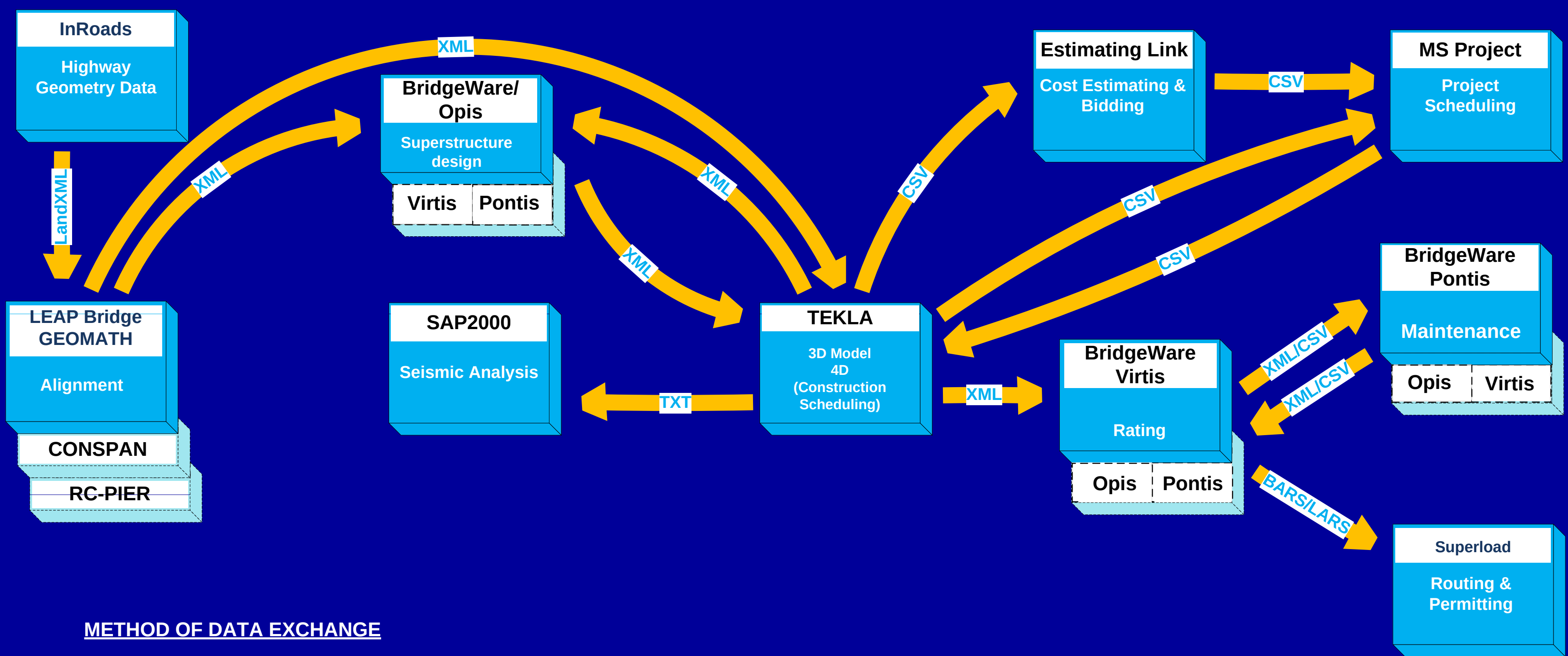
Information Workflow

Concrete Alternate



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