Collaboration and Interoperability in Production Management of Ship-Building Industry

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Outline

- Background and characteristics of ship-building industry
- Typical collaboration / interoperability issues in ship-building production and supply chain management
- Model-driven interoperability & methodology for enterprise application software systems in ship-building manufacturing
- Case study in HUANGHAI SHIP-BUILDING Co. LTD in China
Ship-Building Enterprise

The HUANGHAI Ship-Building Factory
(黄海造船工厂)
Ship-Building Processes

- Purchase and inventory (采购与库存)
- Tube /board handling (Part machining) (管材/板材加工)
- Supply Hub-based logistics (collection and distribution) (集配)
- Dock fitting-out (码头舾装)
- Slipway fabrication and fitting-out (ship body assembling & system assembling) (船台合拢和舾装)
- Block assembling and advance fitting-out (Block assembling & system pre-assembling) (分段制造/舾装)
Characteristics of Ship-Building Industry

- **Production Characteristics:**
  - Production modes: ETO (engineering-to-order), OKP (one-kind-of-a-product) and small batch manufacturing
  - The production process is divided into multiple stages.
  - Very large products with complex product structure and multi-functional systems.
  - Thousands of materials, devices, and components come from suppliers.
  - The relationships across multiple enterprises, multiple stages and multiple specialties are complicated.
  - The lead time is very long while the due-date is tight.
- Collaboration and interoperability inside and outside of enterprises are critical for ship-building.
Physical View of ship-building
Typical interoperability problems in ship-building industry

- Interoperability between
  - Product design and production engineering
  - Production engineering and product manufacture / assembly
  - Batch manufacture and project oriented product assembly
  - Manufacturers and strategic suppliers (e.g. engine suppliers, steel material suppliers)
  - Manufacturers and sub-contractors
  - Manufacturers and customers
Typical interoperability problems in ship-building industry

- Interoperability requirements
  - Information level -- data exchange
    - Order data
    - Planning data
    - Progress/Execution data
    - Design data
    - Quality Check data
  - Business level – process coordination
    - Collaborative production planning
    - Collaborative order processing
    - Collaborative quality checking
    - Collaborative order bidding
    - Vendor Managed Inventory
    - Event-based execution controlling and coordination
Requirements of Collaboration and Interoperability in Ship-Building

HUITON CERP (ERP software)

Collaboration between OKP and batch

Collaboration between collection/distribution and part machining

Collaboration between blocks, system and important component

Collaboration among body, system and crucial devices

Collaboration between body assembling and purchased devices

Collaboration between block assembling and purchased components

Collaboration between purchased block assembling and purchased components

Collaboration between block assembling and purchased material

Collaboration between part machining and purchased material

Materials & purchased component supplier

Important component supplier

Important component supplier

Strategic supplier

Critical devices supplier

Ordinary supplier

Materials & purchased component supplier

Purchase/ sub-contract

Materials & purchased component supplier

Purchased components

Warehouse

Block assembling

Advance fitting-out

Fitting-out

Unit fitting-out

Dock fitting-out

Test

Delivery

Customer

Dock

Slipway

Land platform

Ship

Slipway fabrication

Fitting-out

Dock fitting-out

Test

Delivery

Customer

Vendor

HANA (Project Management Software)

HANNA (ERP software)

UFIDA ERP

SAP ERP

Harbin Institute of Technology

HANNA (Project Management Software)

Collaboration with customer
Typical interoperability problems in ship-building industry

- Barriers and difficulty in interoperability
  - Inconsistency in naming
  - Multiple meanings for single terminology
  - In-compatible data format
  - Un-unified units for goods, currency, …
  - Multiple standards of products and business/manufacturing processes
  - Mismatching between business processes
  - Multi-production modes and business processes
  - Heterogeneous platforms, languages and technologies of existing IT system
  - Un-transparency and low openness of existing IT systems
Collaborative Production Management for Ship-Building

Business Cases for Enterprise Interoperability
Collaborative Production Management for Ship-Building

Business Cases for Enterprise Interoperability
Model-driven Collaboration and Interoperability

- **CIM** (Conceptual Model): Project management
  - CIM Collaboration business model (Process/Organization/Information)
  - Product manufacturing management

- **PIM** (Process Model): Data model in HANA system
  - Business object model (Data exchange format/service/process)
    - Transformation to HUITON CERP System
    - Data model & Workflow model in HUITON CERP System
    - Data model in UFIDA system

- **PSM** (Persistence Model): Business/service component model
  - Executable process/workflow model
    - Service component
      - Generation
      - Configure
      - Deploy

- **ESA/code** (System Model): HANA service
  - Re-develop
  - Transform
  - Deploy

- **HANA** service
  - Generate
  - Configure
  - Deploy
  - Deploy

- **UFIDA** System
  - Transform
  - Deploy

Business Cases for Enterprise Interoperability
Model-Driven Interoperability

Business Cases for Enterprise Interoperability
CIM Model
PIM Model

- BO Model
  - BO-R Diagram
  - BO State Diagram

- Workflow Model
  - BO Integrated Diagram
  - BO UseCase Diagram

- Data Model
  - BO Class Diagram
  - BO Data Diagram

- Role Model
Model-Driven Software Generation

Business Cases for Enterprise Interoperability
Collaborative Resource Planning

- **Suppliers**
  - Strategic suppliers
  - Important suppliers
  - Ordinary suppliers

- **Ship-building enterprise**
  - Key devices Req. Planning
  - Important material/comp Req. Planning
  - Ordinary material Req. Planning
  - Purchase planning/order
  - Performance
  - Project progress/cost

- **Customers**
  - Project planning
  - Product planning
  - Sale order

- **Process**
  - Partner selection and evaluation
  - Supplier selection/management/evaluation
  - Project management (Task)
  - Resource balancing
  - Execution
  - Project progress/cost control
  - Project closure

- **Systems**
  - MPS
  - RCCP
  - CRP
  - ERP (product)
Case study: HUANGHAI Ship-Building Co. Ltd in China

Passenger ro-ro ship (Weihai to Dalian)
1020 passengers/615m car lane

600TEU multi-purpose container ship
Exported to Europe in batch
CORP for HUANGHAI SHIP-BUILDING Co. LTD

- CORP Management System
  - Life cycle management for projects
  - Tasks and WBS management
  - Product and materials management
  - Collaborative production planning and execution
  - Organizations and resources management
  - Planning/Scheduling and resource balancing
  - Constraints management
  - Procurement management
  - Supply chain and subcontract management
  - Graphic interaction supported decision making
Business Cases for Enterprise Interoperability
Co-ordination management
Benefits of the Ship-building Co.

- Improved requirements analysis for collaboration and interoperability of shipbuilding manufacturing;
- Decreased term and cost for developing ship-building ESAs;
- Eliminated interoperability barriers
  - Information level: data standardization, technical data exchange, production planning data exchange, order execution data exchange, etc.
  - Business level: production planning collaboration, order processing, event-based coordination, etc.
- Performance improvement:
  - Rate of the orders (ships) which fulfill due-date is increased through collaborative production planning and control;
  - Utilization of key resources, e.g. slipway, is increased by means of collaborative planning;
  - Transactions between partners (e.g. order processing) is accelerated and the cost is decreased;
  - Information and data, e.g. technical data, business data and manufacturing data, are exchanged more quickly.
Thank you! Dank!

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