Warehousing Systems Design

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Credits

- Industry
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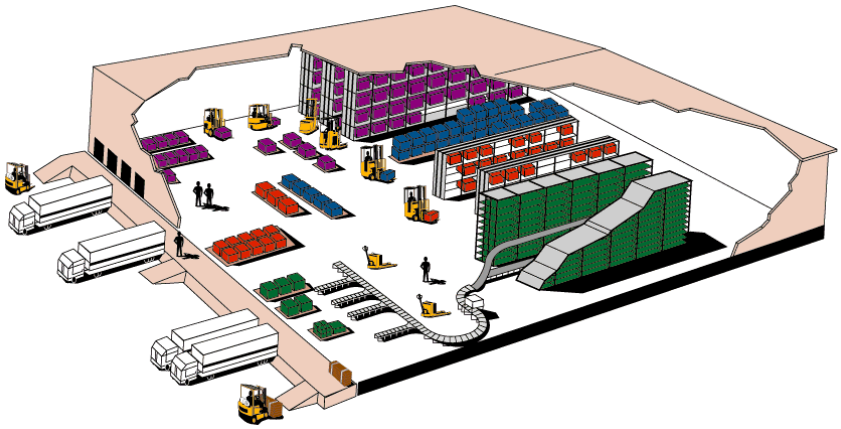
- Graduate Students
  - E. Blanco, M. Insalaco, P. Bellur, A. Parfenov
- Sponsors
  - NSF, Ford Motor, UPS WWL, Keck Foundation

Distribution Warehouse Functional Areas Illustration



Changing Warehousing Requirements

- Faster Turns, Shorter Life Cycles
  - Warehouse operations
  - Warehouse design
- Proliferation of Information Technology
  - WMS, tracking
- Design-As-Usual

Warehousing Design Objective

The goal of warehouse design is to

minimize the discounted present value of the costs of

establishing and operating the warehouse over some horizon specified by the decision-maker,

subject to a number of resource and performance constraints.

State-of-the-Art in Warehousing Design

- Reviews and Bibliography
  - Rouwenhorst, Goetschalckx (www)
- Analysis of Isolated Components
  - Numerous, focussed, uneven
  - Detailed simulation and animation
  - Clearly suboptimal
  - No impact on the practice of warehousing design

State-of-the-Art in Warehousing Design continued

- No Structured, Integrated Design Methodology
  - No model for warehousing operations
  - No explicit design theory
- Consulting-University Cooperatives for DSS and Education
  - Twente, Dortmund, Darmstadt, Georgia Tech

Warehousing Design Methodology Needs

- Integration of Isolated Research and Methods
- Rich Empirical Data Sets
- Rigorous Mathematical Models
- Synthesis and Design Tools

Warehousing Design and Operations Education Status

- Mirrors State-of-the-Art
  - Focussed, uneven, analysis
- High Demand
  - Bachelors, Graduate, and Professional
- Few Educational Materials
  - MHI and CICMHE
  - Several books in preparation

Warehousing Design Education Effort at Georgia Tech

- Asynchronous Education
  - www (http://www.isye.gatech.edu /warehousing)
    - standard software (html, vrml…)
  - client-server architecture
    - common and private components
- Rich, Industry-Grade Case Studies

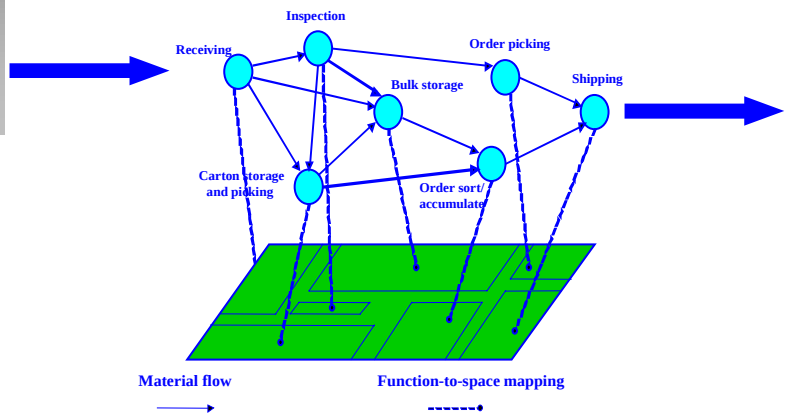
Warehousing Design Development at Georgia Tech

- Functional Flow Network
- Object Oriented Data Base
- Mathematical Design Models
- Visualization

Warehousing Functions

- Receiving
- Storage - Holding
- Order Picking - Retrieval
- Consolidation - Sorting
- Shipping

Functional Flow Network for Basic Warehousing Functions



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Functional Flow Network Characteristics

- Every Warehouse Has a Different Functional Flow Network
- Different Products Can Follow Different and Multiple Paths
- Functions are Mapped to Areas, Areas are Mapped to Material Handling and Storage Equipment

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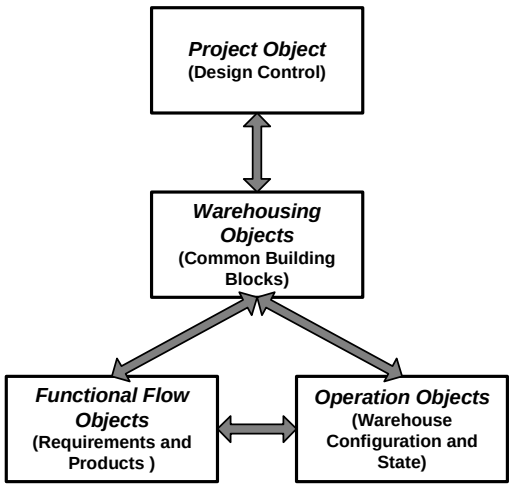
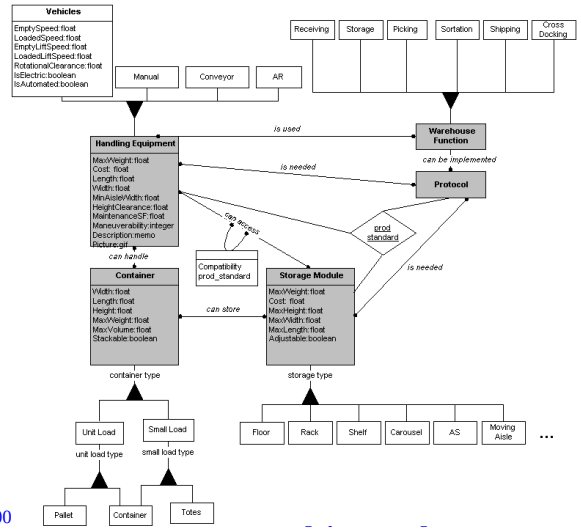
Object Classes in Warehouse Design



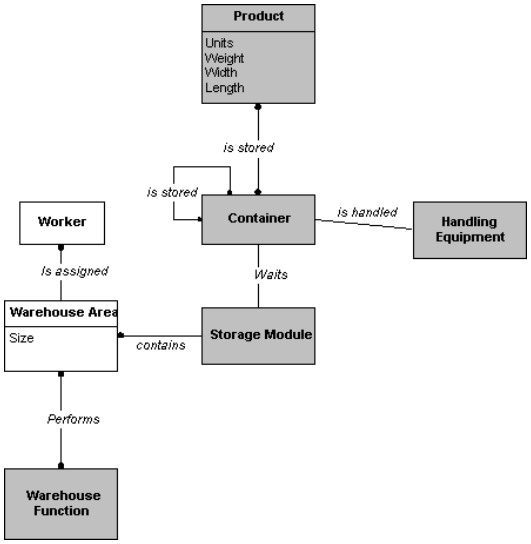
Object Classes

- Design Object
  - Design project status
- Warehousing Objects
  - Equipment and policies and protocols
- Functional Flow Objects
  - Products and flows requirements
- Operations Objects
  - Design specification

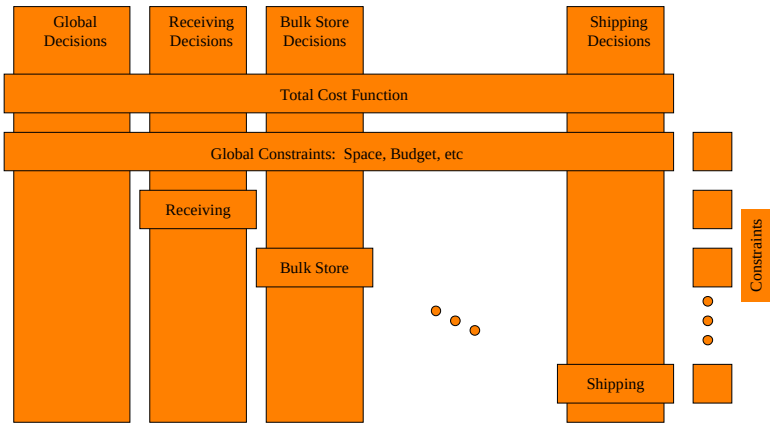
Warehousing Objects Structure (Equipment and Personnel)



Operations Object Structure (Warehouse State)



Design Optimization Model



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Optimization Model Characteristics

- *Optimization Decomposed by Functional Areas*
- *Joint Space (Area), Manpower, Budget Constraints*
- *Economic Analysis Joint Objective Function*

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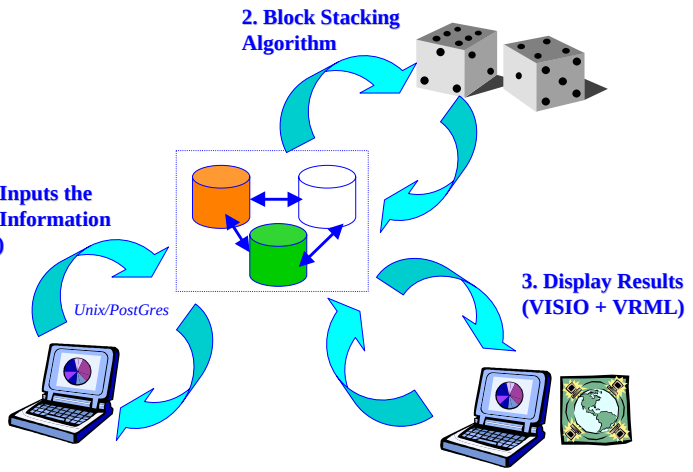
Block Stacking Example: Software Program Interactions



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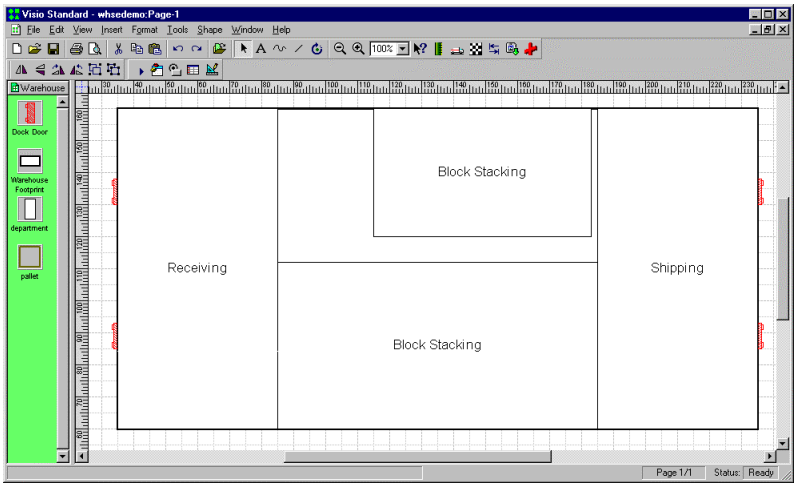
Department Block Layout in Visio



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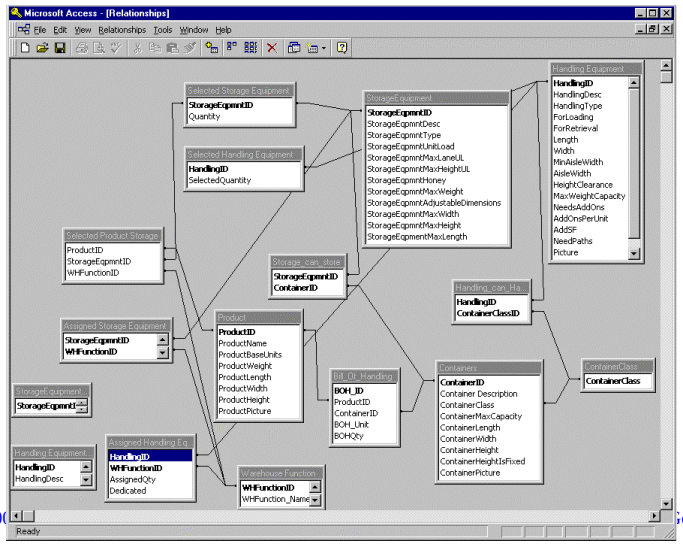
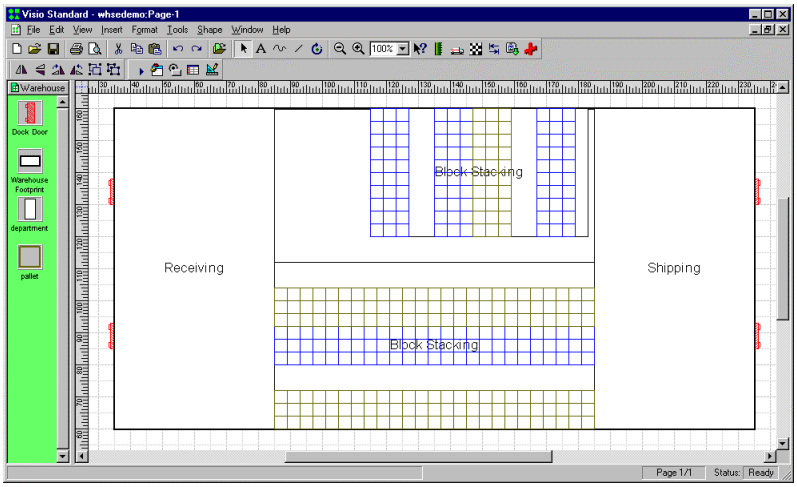
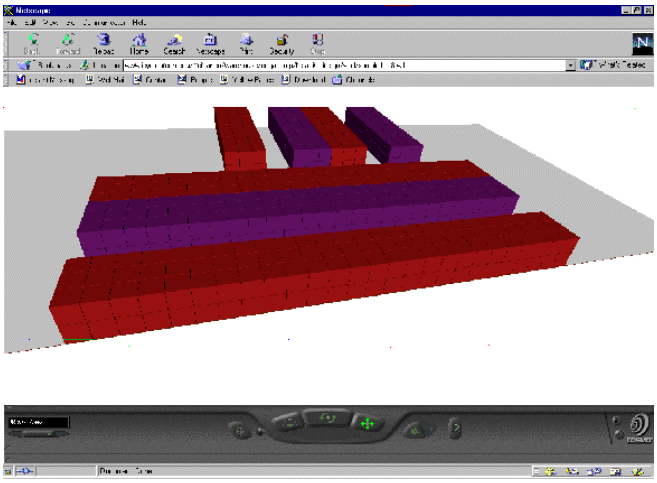
Access Tables and Relations



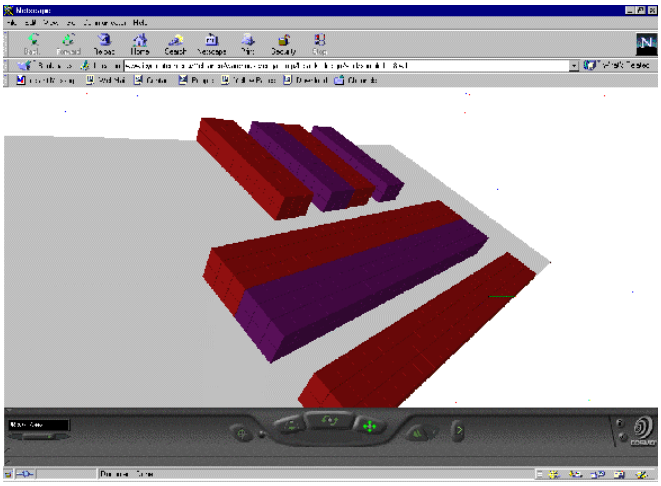
Block Stacking Layout in Visio



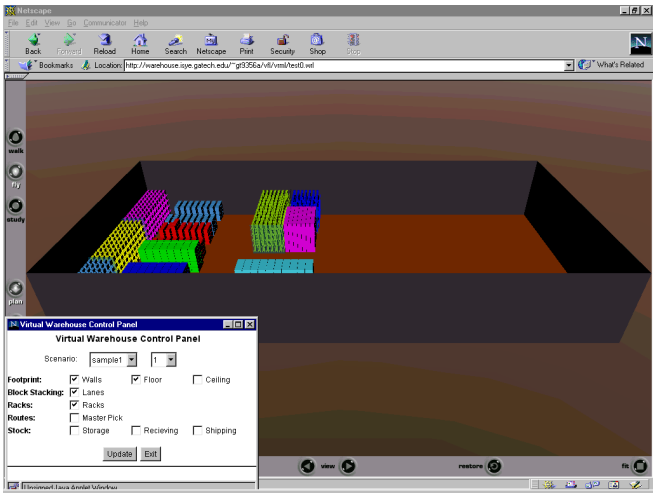
Block Stacking Layout in VRML



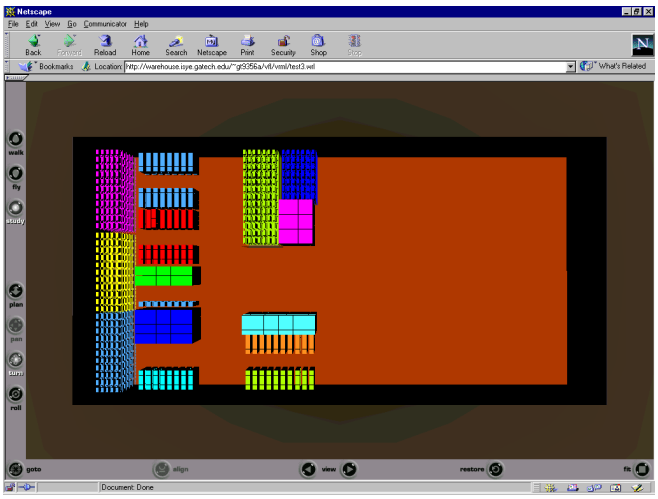
Rotated Block Stacking Layout in VRML



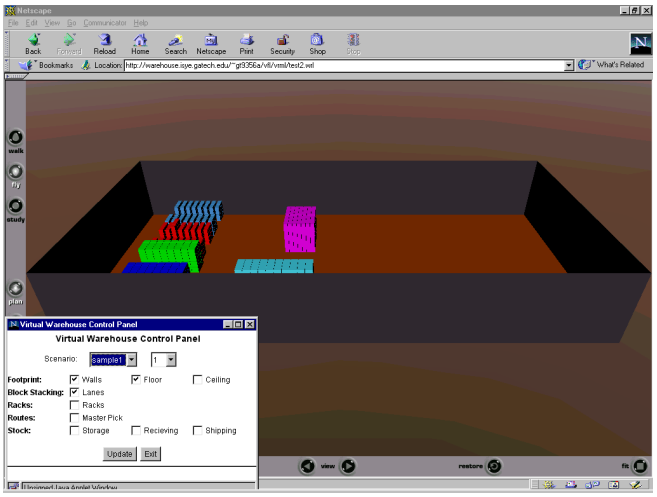
Warehouse VRML Visualization: Side View with Storage Systems



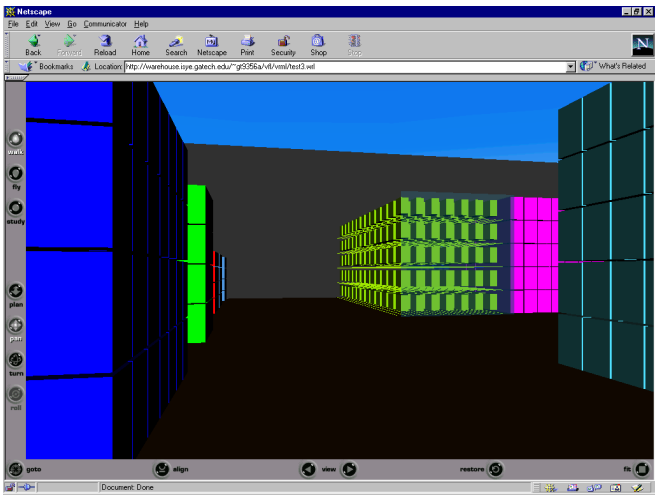
Warehouse VRML Visualization: Top View with Storage Systems



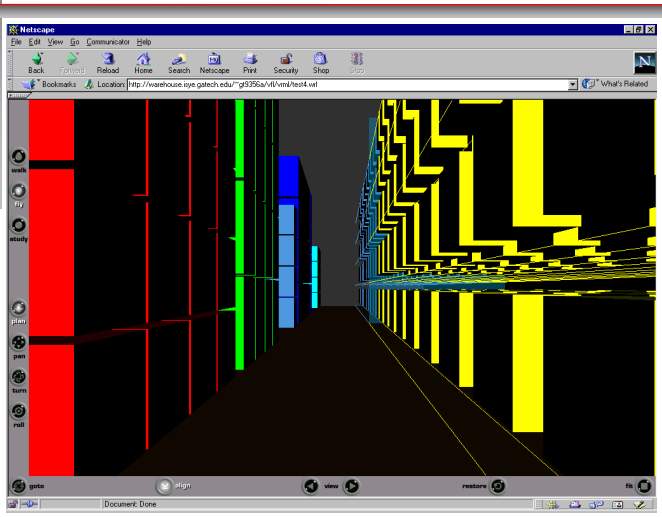
Warehouse VRML Visualization: Side View with Floor Stacking



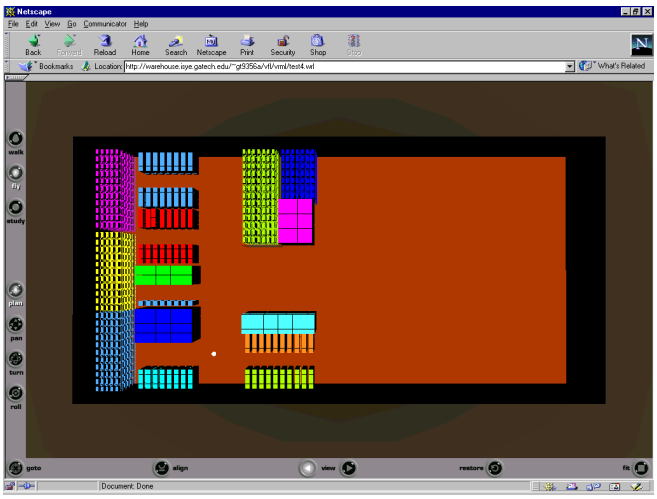
Warehouse VRML Visualization: Interior View



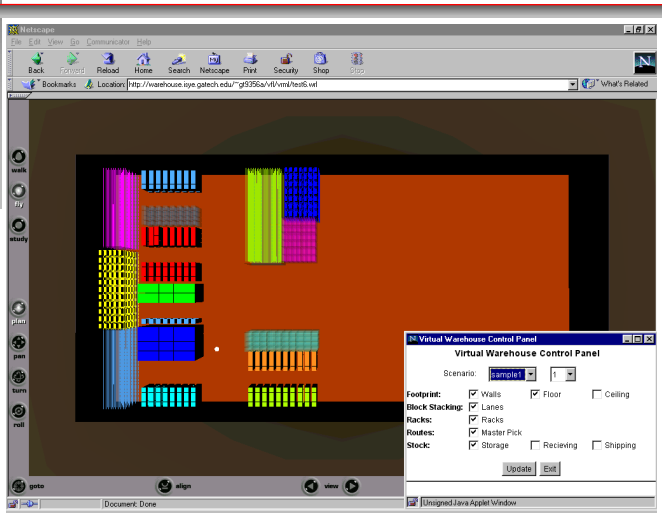
Warehouse VRML Visualization: Inside the Aisle View



Warehouse VRML Visualization: Truck View Animation



Warehouse VRML Visualization: Top View with All Elements



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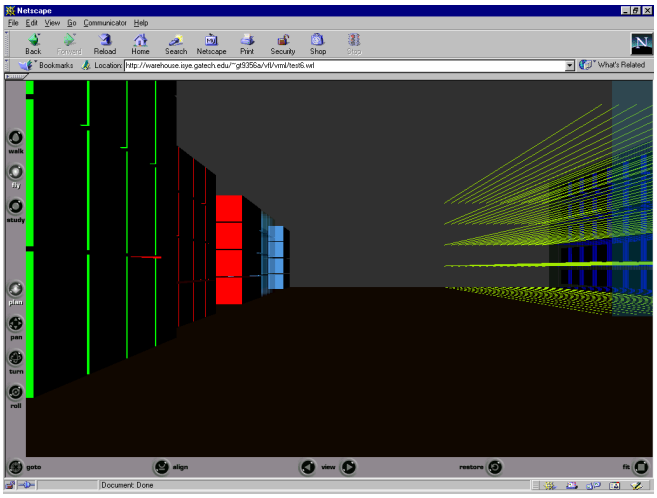
Warehouse VRML Visualization: Interior View without Stock



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Thank You
Can I Answer Any Questions?