Analysis and Resolution of Equipment Workspace Conflicts

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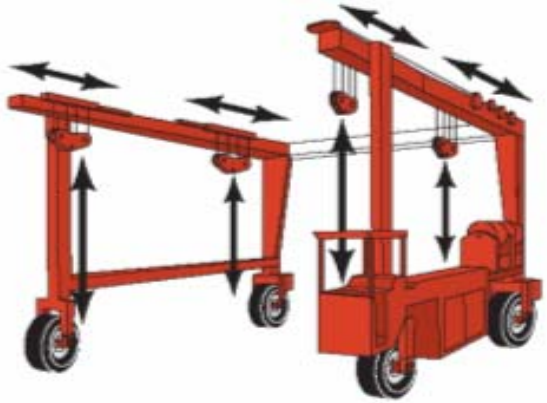
Introduction

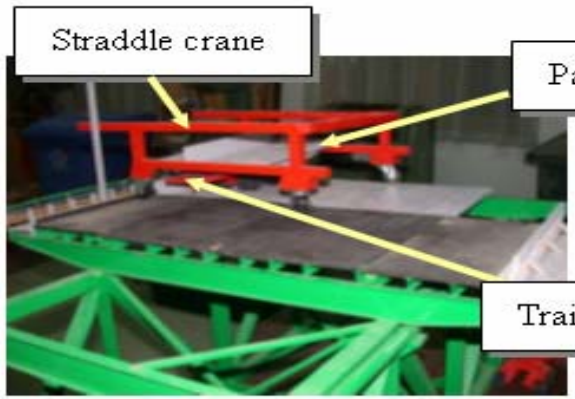
- Workspace conflicts are one of the important problems that can delay construction activities, reduce productivity, or cause accidents that threaten the safety of workers.
- Workspace planning is particularly important in the case of large infrastructure projects, such as bridge construction and rehabilitation, where heavy equipment is required.

Workspace Simulation Using Physical Models

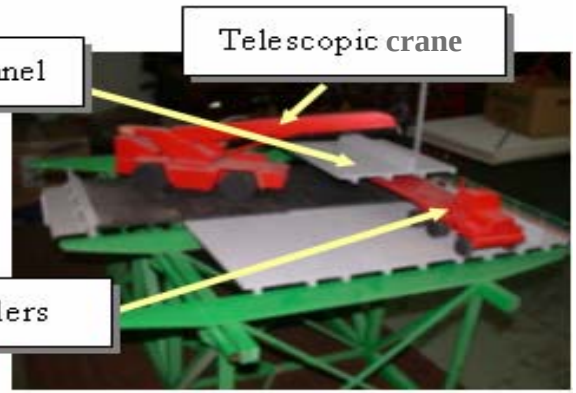


Straddle crane

Telescopic cranes



Bridge model with straddle crane



Bridge model with telescopic crane

Objectives: Virtual Workspace Analysis

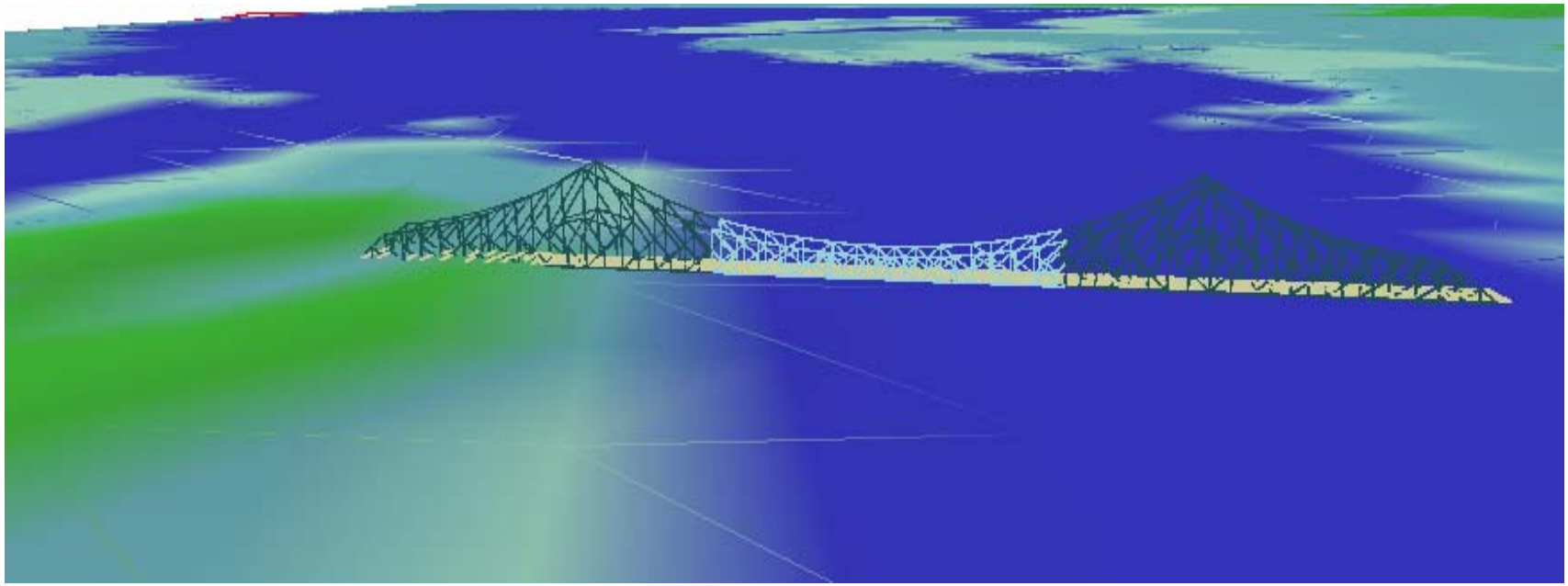
This research aims to apply workspace analysis and conflict resolution in the case of large infrastructure projects focusing on:

- Specific **representation** of workspaces related to heavy construction equipment;
- More realistic workspace definition using **composite** shapes based on Constructive Solid Geometry (CSG);
- Semi-automatic **conflict resolution** based on a decision-support expert sub-system; and
- Development of a **CAD-independent system** that can automatically generate workspaces, detect spatio-temporal conflicts, and support the decision-making process of resolving them.

Digital Workspace Analysis Requirements

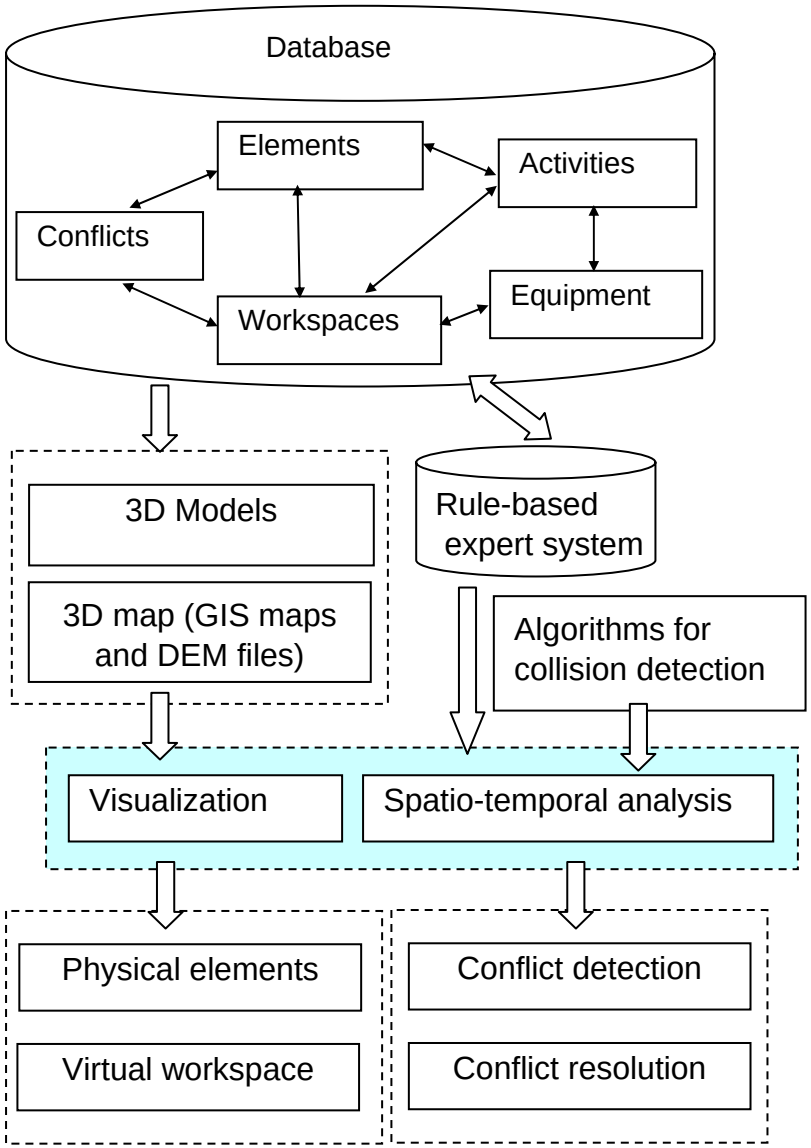
- 4D models
- Database of activities and related workspaces information
- Automatic generation and analysis of workspaces with complex shapes
- Rule-based conflict resolution

4D Bridge Model

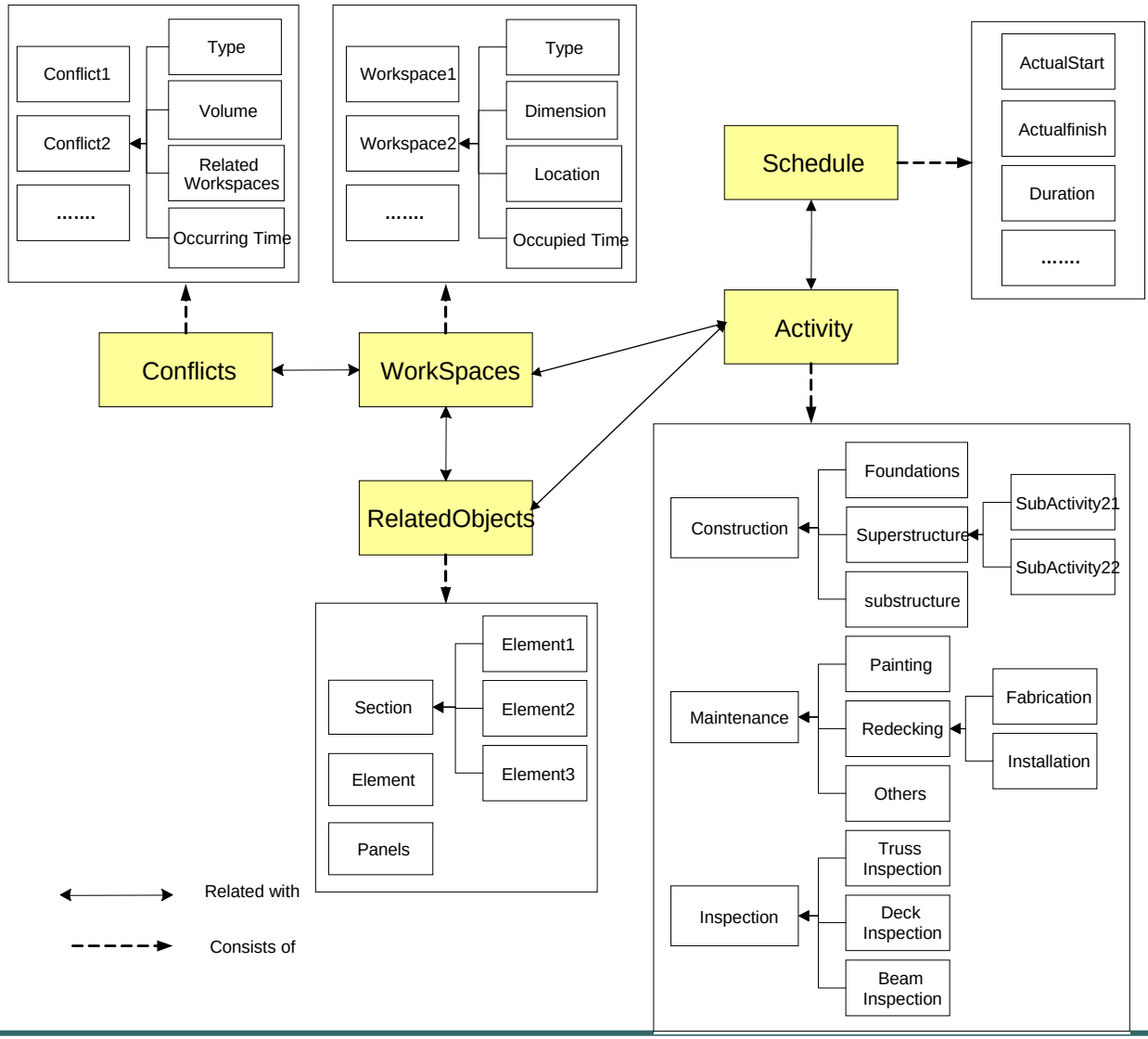


- 4D bridge model based on spatio-temporal information of the lifecycle
- 3D map of the whole area with Digital Elevation Model

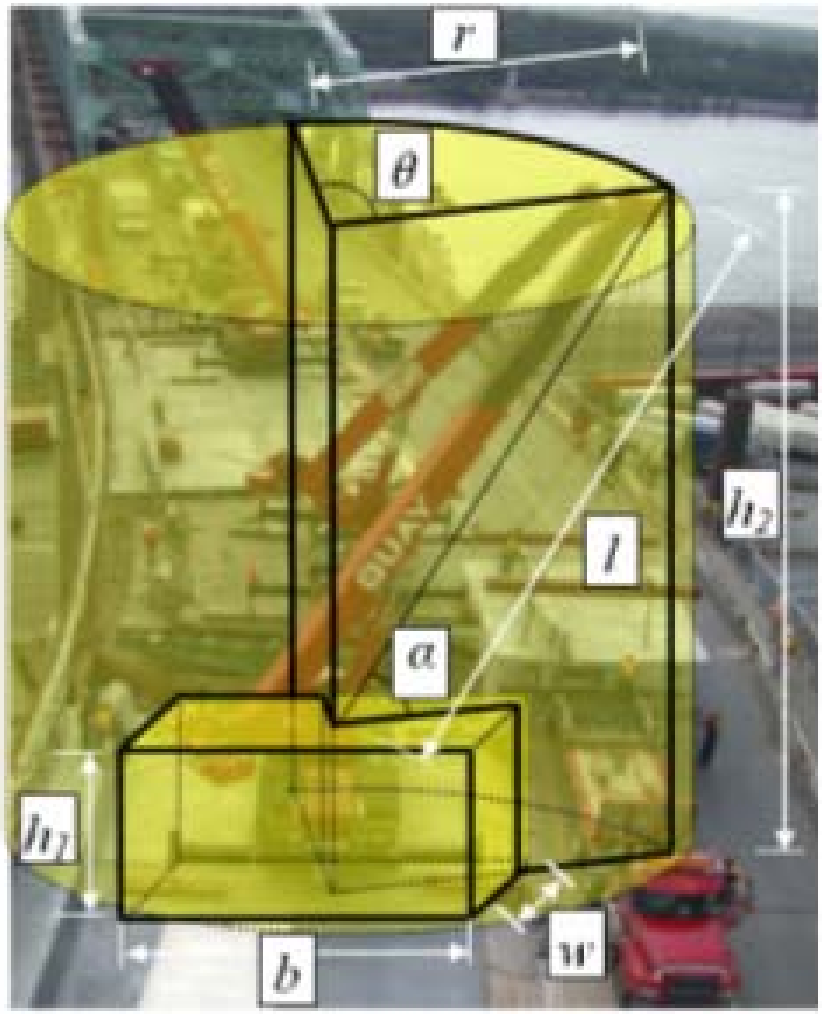
System Structure



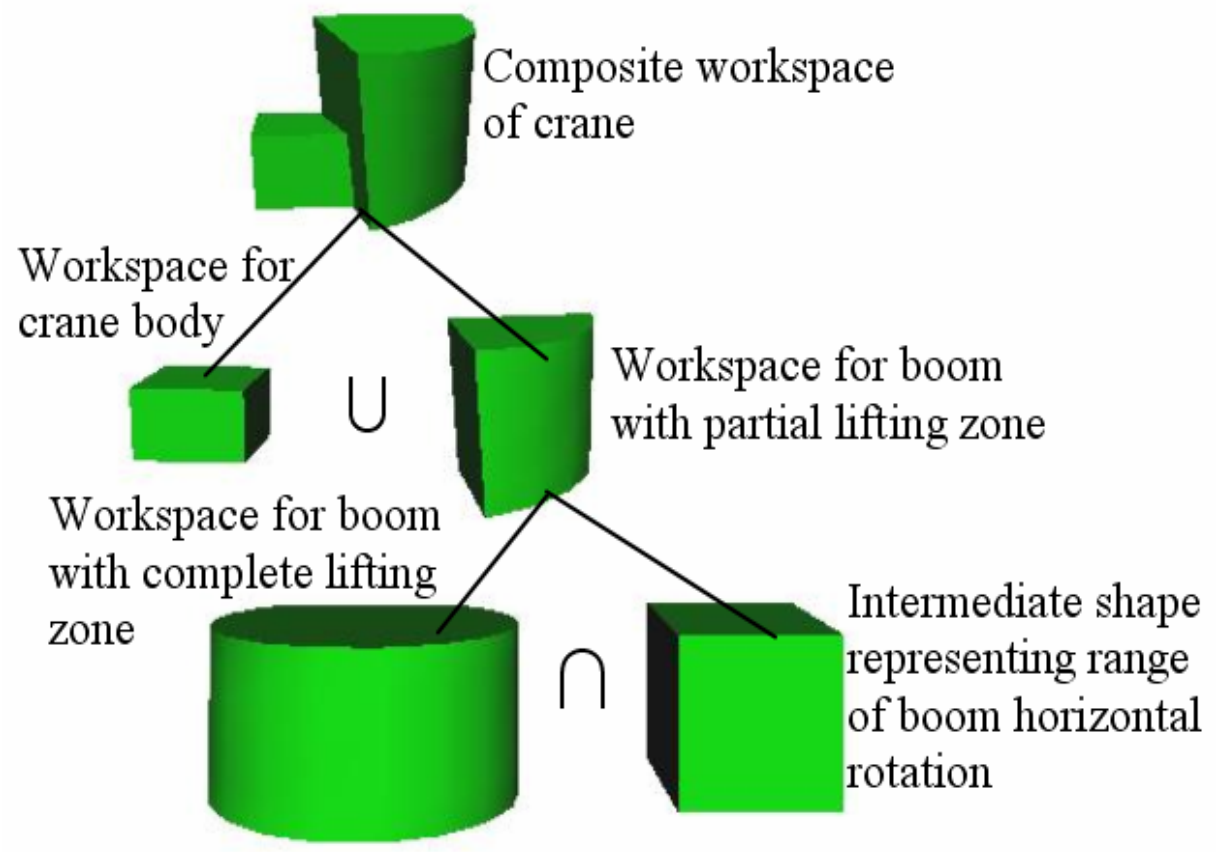
Data Structure for Activities and Workspaces



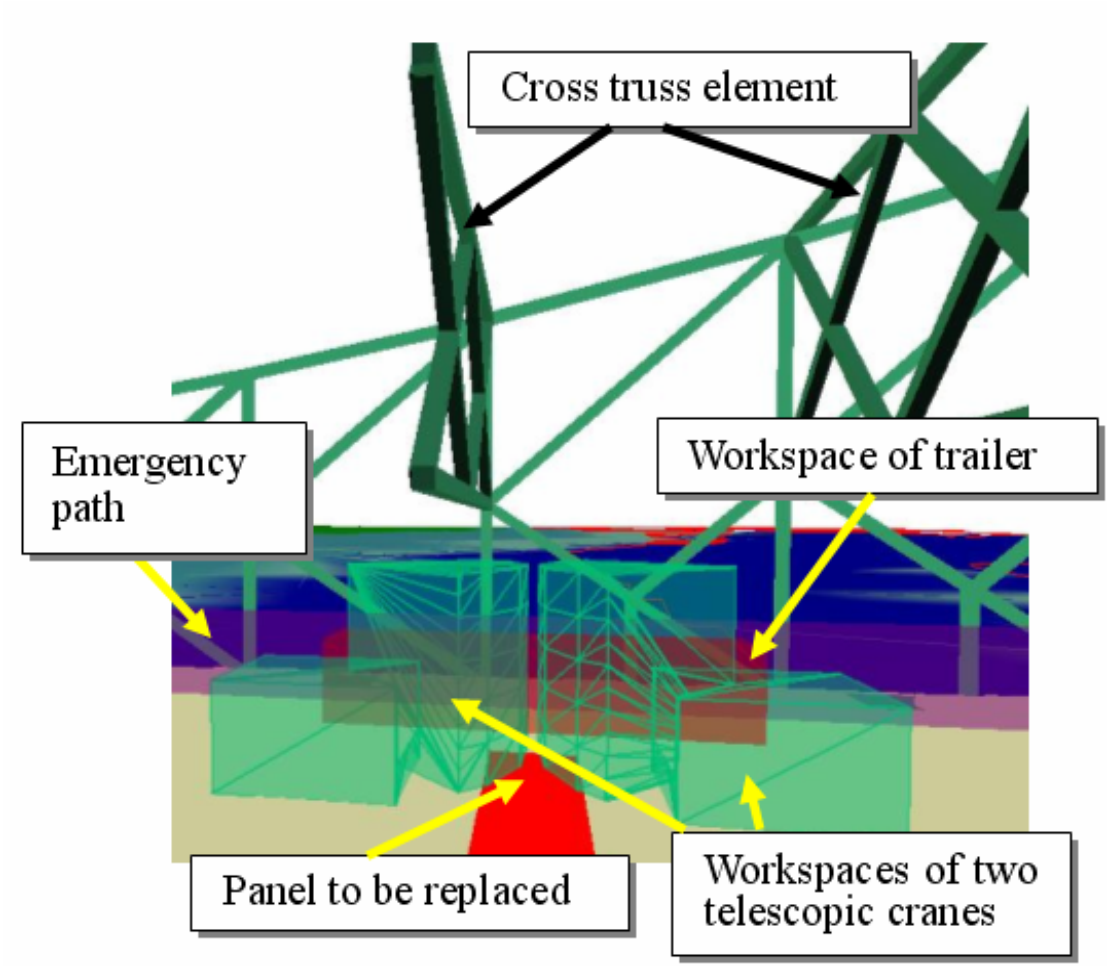
Crane Workspace Representation



Representing Workspace of Crane Using CSG



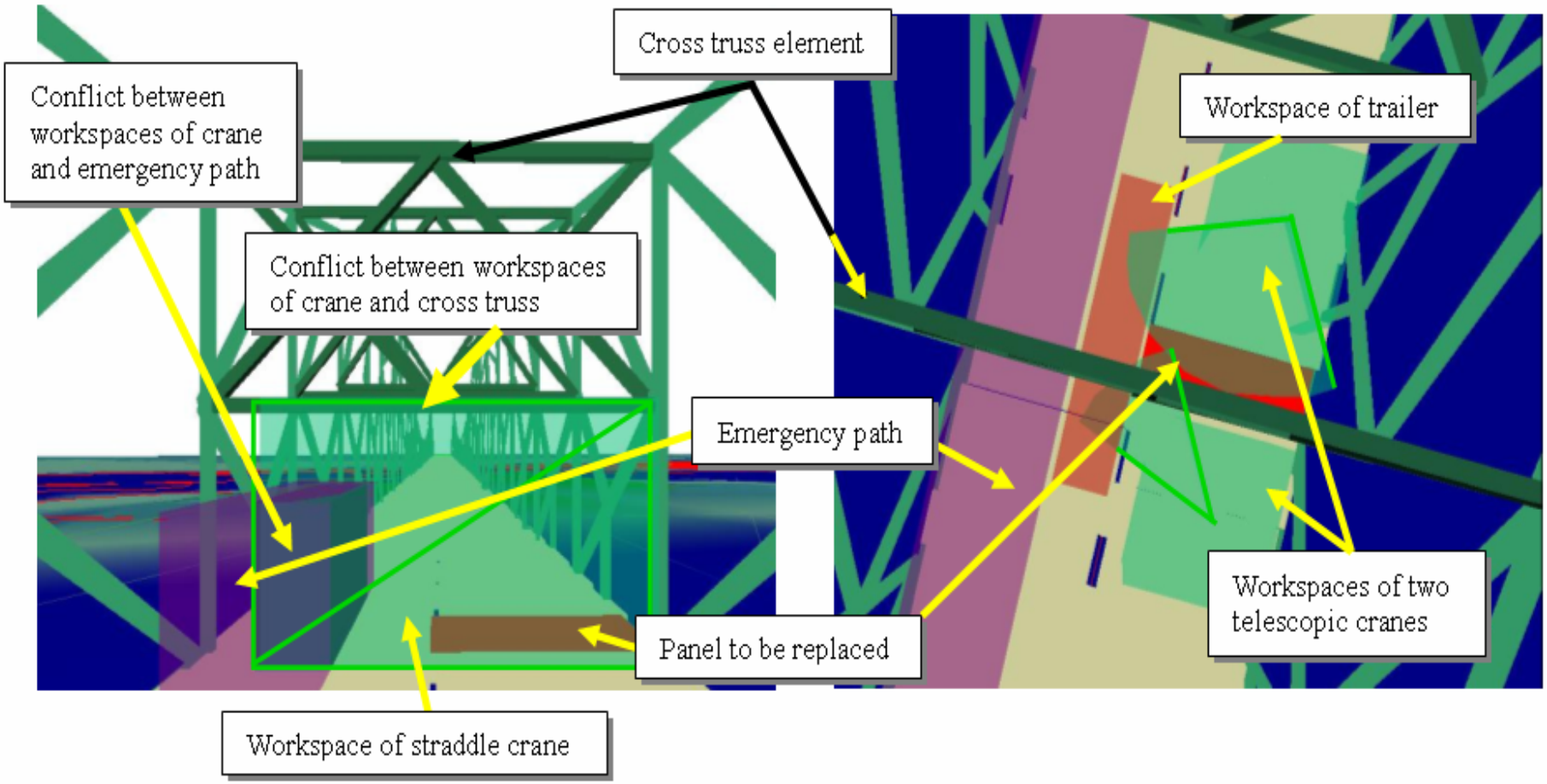
Workspaces Representation



Conflict Resolution Using Rule-Based Expert Sub-System

- A series of criteria is developed for analyzing conflict characteristics and assisting in deciding which activity requires adjustment:
  - changing the logical sequence of activities,
  - changing the time of activities that are not on the critical path,
  - considering workspace divisibility,
  - changing the location, space size, start time of conflicting space occupation, or length of occupancy time.

Workspace Conflict Detection



Future Work

- Many constraints given in the safety manuals need to be considered in further development of the rules of the expert sub-system.
- Additional development is needed to accommodate the automatic generation of the workspaces of equipment so that the system could be easily used in practice.
- Another extension of the system would be to integrate it with discrete event simulation tools in order to create the workspaces based on detailed simulation data.