Object Interaction Query
A context awareness tool for evaluating BIM components’ interactions

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Ongoing research initiated at the MIT Design and Computation Group

*Computational Design Lab: Reinventing BIM,*

MIT Professors: Terry Knight and Takehiko Nagakura

January – May, 2012
Relations between objects - Key to the enterprise of Design

- Are there any unwanted objects obstructing views of windows?
- Is there enough clearance around mechanical equipment for installation and repair?
- Is there enough space around the hospital bed to allow for proper circulation?
- Are rooms properly placed to comply with desired adjacencies?

Conflicts [in design] are not always visible!
Presentation Overview

- Problem: Design evaluation during the creative process.
- BIM as an aid to that process
- Background survey: related research and commercial initiatives
- Proof-of-concept: Implementation and Video Demonstration
- Contributions and future steps
Problem

- Lack of design oriented query systems in BIM.
- The need for query system which includes not only the queried objects but also their context and relations to other components as part of the computation.

Drawings by Le Corbusier
The Role of BIM

- Embedded **information** in architectural components **beyond geometry**: functions, materials, scheduling, dependencies and hosted elements, etc. Information can be extracted on demand.
- Possibilities for automation of design evaluation and conflict detection.
### Information ≠ Knowledge

- Embedded Information in BIM is value and context free.
- Designers contribute their expert knowledge about spatial relations.

**In context of design:**

Knowledge = the [human] Designer + Information
Background Survey

Commercial and Research applications for:

1. **Clash detection:**
   - Detection of geometric overlaps
   - Built-in and Stand alone applications
Background Survey

Commercial and Research applications for:

2. Rule-based checking
   - Evaluation of compliance with conditions encoded into machine-readable rules.
   - Primarily stand alone applications
   - Research by: S. Zhang, C. Eastman, A. Borrmann et al.

IMAGES SOURCES:
Survey Summary

- Most surveyed approaches - enable easy sharing, but place the evaluation outside the design environment

- Lack of tools which focus on spatial relations
Proposal: oIQ

\[ \text{oIQ} = \text{‘inside’ design} + \text{‘spatial relations’ assessment} \]

- A novel way to query BIM models about the relations among the architectural components
- oIQ is an application proposed for BIM which aids the design process by enabling automated evaluations of projects.
oIQ: Types of Queries

DIRECT QUERY – can be answered directly with extracted information

• Is the width of the door ADA-compliant?

INDIRECT QUERY – requires computation of extracted information

• Is there enough clearance around mechanical equipment for installation and repair?
• Are there any unwanted objects obstructing views of windows?
• Are any elements obstructing the projected door swing area?
• Is the desired clearance for stair landings being applied to all areas of the building?
oIQ: Types of Queries

DIRECT QUERY:
• Answered through embedded information.
  - Is the ceiling height complying with a certain minimum dimension?

INDIRECT QUERY:
• Answered through embedded information + spatial conditions
  - Which objects are surrounding a certain component?
The **Query Volume** (QV) is used ‘behind-the-scene’ to transpose the users’ expert knowledge into a computable algorithm. Used to fulfill *Indirect* queries.

The QV is not a mere offset of recognized component geometry, but it also adapts to the performance capacities of components, e.g. the swing of a door.
oIQ: Objectives

A. Including the evaluation inside the design process
B. Taking advantage of the information embedded in BIM components
C. Enabling the inclusion of the user’s expert knowledge in the evaluation
D. Allowing for rule customization
E. Reporting feedback in user-friendly formats
Proof-of-Concept: oIQ Implementation

• Plug in for Revit developed through the API

• TEST CASE:

  Queries doors for compliance with 3 conditions:

  Minimum height (direct query)
  Minimum Width (direct query)
  Clearance of door swing and projection area (indirect query)

• Tested successfully on a basic BIM model of a residential building
oIQ Implementation: VIDEO DEMONSTRATION
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oIQ Implementation Results

- The tool was able to identify all the conflicts between doors and surrounding objects, as well as violations of height and width minimum conditions.

- User input via UI was successfully incorporated in the computation.

- After conflicts in scene were handled by user, no conflicts were reported upon re-execution of the oIQ-tool.
1. MAIN CONTRIBUTION:

Context awareness tool, embedded into the design environment, which allows users to perform customized design queries.

oIQ aids the design process by allowing for fast and informed decision making.

2. Enables the inclusion of user’s expert knowledge.

3. Intuitive UI allows users to select rules and set values for query.

oIQ Future steps:

- Data structure
- Management of rules
- Management of input & output data