

# Towards computational dialogue types for BIM collaborative design: An initial Study

Alice Toniolo<sup>1</sup>, Marianthi Leon<sup>2</sup>

<sup>1</sup>School of Computer Science, University of St Andrews

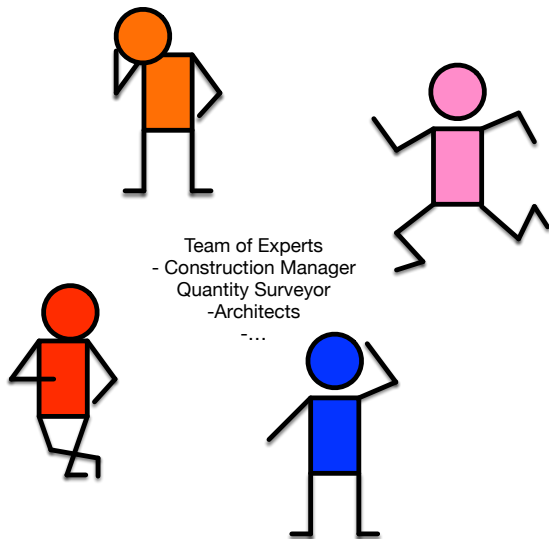
<sup>2</sup>Scott Sutherland School of Architecture and the Built Environment, Robert Gordon University

November 17th, 2017

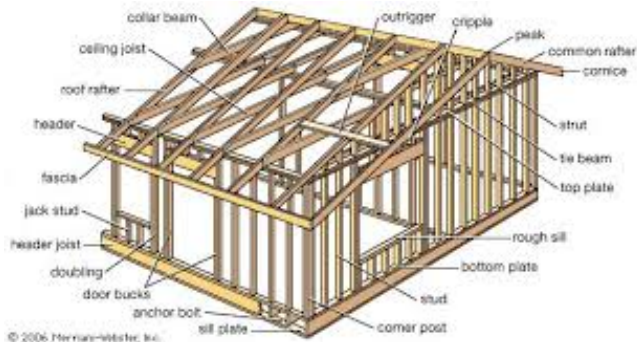
# New Home Example



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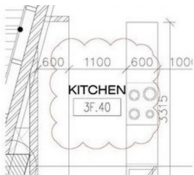
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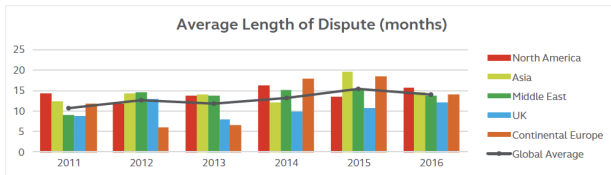
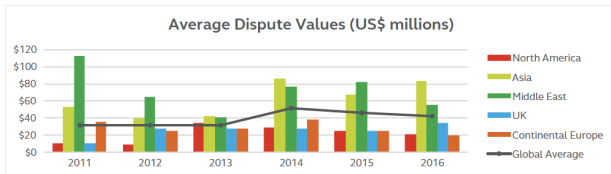
# New Home Example



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# Construction Dispute Revenue





# Causes

- Failure to properly administer the contract
- Poorly drafted or incomplete and unsubstantiated claims
- Employer/Contractor/Subcontractor failing to understand and/or comply with its contractual obligation
- **Errors and/or omissions in the contract document**
- **Incomplete design information or employer requirements (for Design-Build and Design & Construction)**

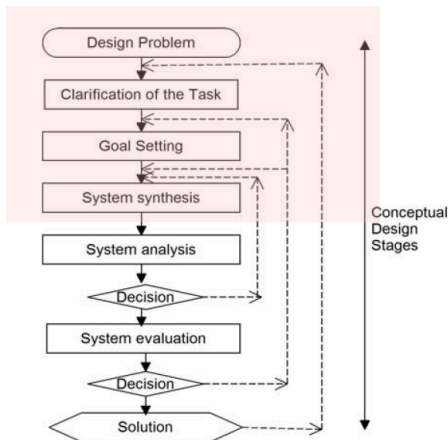
# How to manage? – Regulations

- Regulations Egan Report (1994), Latham Reports (1998-2008)
- BIM Mandate (Building Information Modelling) 2016/2017
- The Architecture Engineering and Construction (AEC) industry is shifting its focus in relation to projects delivery, from the chain of activities to managing an efficient **collaboration** and innovative ways of creating, sharing and collecting relevant information among AEC professionals – with BIM acting as a catalyst.

# How to manage? – Collaboration

- Collaboration & communication central for successful construction and infrastructure projects
- But to avoid errors and improve outcome:
  - ▶ More efficient collaboration
  - ▶ Monitoring collaboration
  - ▶ Improve and streamline collaboration at the early stage of design
  - ▶ More transparency

# Protocol for collaboration in the AEC industry



Use of a facilitator to set goals and decision at the early stages significantly improve collaboration

M. Leon, R. Laing, J. Malins, and H. Salman. Development and testing of a design protocol for computer mediated multidisciplinary collaboration during the concept stages with application to the built environment, 2014

# How can argumentation help?

Overarching Research Problem:

- How can we improve this phase of collaboration to help AEC professional reduce errors?
  - ▶ Analysis of the reasoning process to identify sources of error
  - ▶ If any error was committed, analysis of the critical points that led to the error & log of why a decision was made in a certain way.
  - ▶ Forensic investigation of what was decided and why

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  - ▶ Forensic investigation of what was decided and why
  - ▶ Why not earlier?

# Design Requirements

- Kunz & Rittel (1970) – IBIS (Issue-based Information Systems) – Design rationale
- Baroni, et al (2013)<sup>\*</sup> structure requirements as arguments in advance but more complex argument analysis
- ...
- Black, et al (2013)<sup>†</sup> analysis of the design debates for a new protocol

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<sup>\*</sup> P. Baroni et al. An argumentation-based approach for automatic evaluation of design debates. In Computational logic in multi-agent systems, 2013.

<sup>†</sup> E. Black et al. Towards agent dialogue as a tool for capturing software design discussions. In TAFE 2013, Springer 2014.

# Design Requirements

- AEC design is a collaborative design process
- Graphical representation of design requirements may be helpful in clarity of requirements
- This can then be analysed formally
- But...



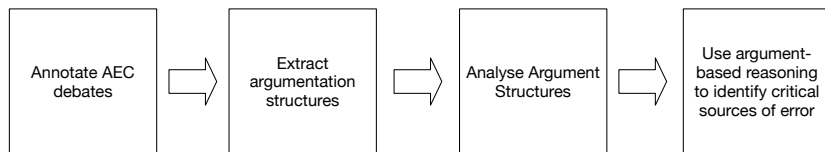
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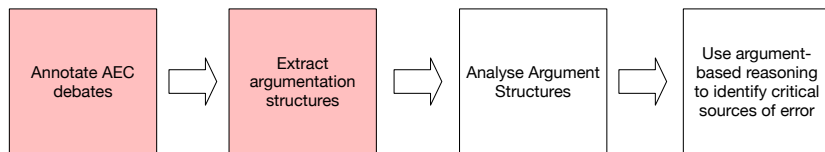


- + Hamper Creativity

# The pipeline



# The pipeline



# Dialogue extract Example

"We should elevate the building on stilts to control humidity"

*1<sup>st</sup> Architect*

"The building is on a slope and a ramp may lead to the entrance, **which will not impede the access**"

*Construction Manager*

"An elevated structure will cause **problems with the access** the building"

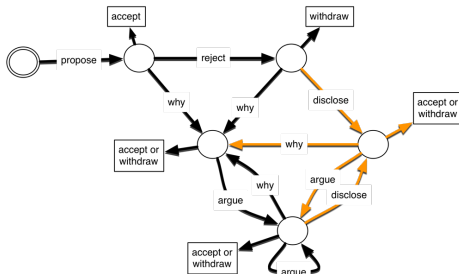
*2<sup>nd</sup> Architect*

Typical deliberation dialogue + practical reasoning

# Deliberation models

How to enhance existing models of autonomous deliberation to capture the complexity of natural deliberation?

- New information (Walton, Toniolo, Norman, 2016)
- Regulated by norms (Walton, Toniolo, Norman, 2015)
- Revision of issues and new information



- Pncir: Only attacking arguments for negative consequence of adopting a new action
- Pcir: More flexible protocol, permits agent to take the initiative of sharing information about circumstances

# First step - Aim

- Analysis of existing dialogue between AEC professional
- Extract arguments & Understand dialogue context
- Thematic analysis provided by the enforced AEC protocol analysis (qualitative data analysis)
- Hypothesis: Thematic analysis has similar characteristics of Walton & Krabbe's dialogue types
- Question: would this contextual analysis be useful in providing context to the dialogue to help with argument extraction?

# Study Context

- **Analysis of:**
  - ▶ Analysis of segments of dialogue from 2 studies among AEC professionals in the task of designing a small educational and research building
  - ▶ 6 Participants:  
Architects, Project Manager, Quantity Surveyor, Building Surveyor, Construction Manager
- **Qualitative/thematic analysis** considering conceptual phases of dialogue
- **Argument-based analysis:**
  - ▶ domain knowledge, design solutions, design criteria (regulations, style, costs, client requests) and design goals (brief).
  - ▶ reasons for and against adopting a solution/criteria/goal

## Studies Monitoring: examining a collaborative design process

Study 1



Study 2





# First step - Arguments

## Data Analysis



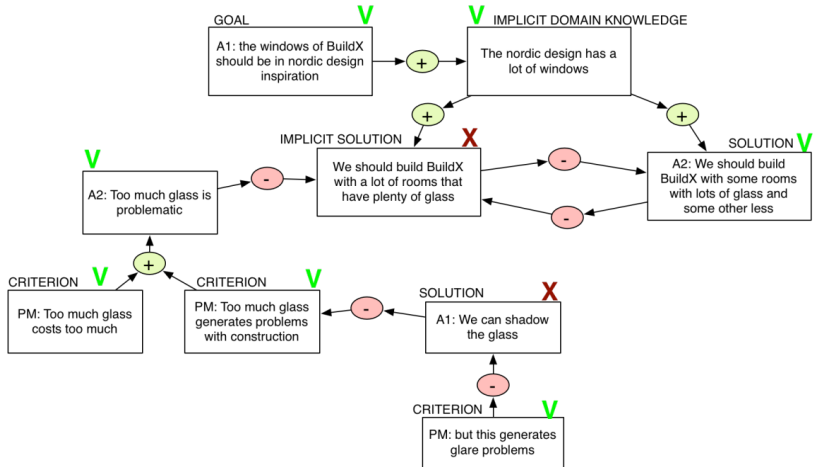
# First step - Arguments

## Text to Arguments:

- A1: Comments about the materials, adds that they all agree about their preference to large glazing-covered areas and Nordic design inspiration
- A2: Argues that too many windows might be a problem
- PM: Adds that too much glazing can cost a lot and might cause problems to the construction
- A1: Replies that you can shadow it, thus providing solutions
- PM: Talks about problems with glare
- A2: States that some rooms can have controlled shading while others can be more or less glazed depending on the heating loads and working needs.
- QS: Agrees and further comments on it

# First step - Arguments

Text to Arguments:



And evaluation

using a tool called CISpaces ([cispaces.org](http://cispaces.org)) similar to OVA ([arg-tech.org](http://arg-tech.org))

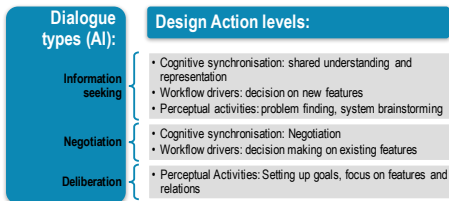
# Second Step - Dialogue

Thematic analysis: Design thinking actions' coding scheme

Actions levels	
Collaboration	Cognitive synchronization: argumentation / negotiation
	Workflow driver
Perception & Concept	Perceptual Activities
	Set up Goals
	Co-Evolution & brainstorming
Physical Actions	Sketching/ Drawing

# Map to Walton & Krabbe Dialogue Types

Proposed connection between the dialogue context and the actions' coding scheme:



# Dialogue Examples

BS: What kind of storage do we need? What is going to be stored?

A1: Models

BS: Are these models small or large?

A1: I suppose sometimes they might be large models

BS: Storage space would need to be reasonably sizable.

A1: It depends how much you value the workshop, if the strategy of the client is to value the model making, workshops and storage should be big

BS: Yes, especially if it is for archive. How long do we have to keep documents for?

QS: Five years

BS: Hence we need a sizeable paper storage as well as space for models.

A1: And also, I suppose, this kind of facilities needs things like boards, or drawing tables

Relevant Clip Annotations:

Collaboration – Cognitive Synchronization: Shared Understanding and Representation

Collaboration – Workflow Driver: Decisions on New Features

Concept and Perception – Perceptual Activities: Problem finding

Concept and Perception – Co-Evolution: System Brainstorming

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Information  
Seeking  
Dialogue

Context

# Dialogue Examples

BS: From building regulations, the minimum occupancy factor is 6, so each office space must be a minimum of 6 square meters  
A2: But we should go for the best quality of the space, so if we are designing an office for research and design we should aim for bigger desks and room for devices  
BS: Yes, a building that is used to function, people need space to be creative. From a cost point of view we should design what we want  
QS: But a flexible budget is unrealistic, we should make it functional. We have to define priorities in terms of what we want and what we can really afford.  
BS: otherwise we get a disparity between the budget and where ideally we want to be.  
QS: At this stage, you made an assumption of a four storey building, let's not make that assumption just yet because the higher we go the more expensive it is going to be. We need to design for a big number of people, now, it might have an influence on what type of structure we are going to use.  
BS: It is going to be an issue anyway because of the slope of the site  
QS: If you are going for steel you are going to struggle to get it to the site  
BS: I was initially thinking that it would be concrete, if you post tension it, you get slimmer floor elements, with open plan spaces w  
QS: More expensive frame but you save in terms of height and materials  
BS: Yes, and you get more usable space as well.

## Relevant Clip Annotations:

Collaboration - Cognitive Synchronization: Shared Understanding and Representation

Collaboration - Cognitive Synchronization: Negotiation

Collaboration - Workflow Driver: Decisions on Existing Features

Concept and Perception - Set-up Goals: Goals for Objectives and Functions

Concept and Perception - Perceptual Activities: Focus on Features and Relations]

Negotiation

Context

Deliberation



# Conclusion & Future work

- A preliminary work
- We presented an initial mapping between collaborative, conceptual and perceptual activities related to AEC design processes to information seeking, deliberation and negotiation.

Future work:

- Include automatic extraction using a combination of speech acts and conceptual annotation
- Develop sensitivity analysis and mitigation of risk of construction errors

# Future work

The design process underpinning early building and construction design stages has potential for further future research:

- dialogue with focus on dialogue shifts and practical reasoning
- mixed-initiative argumentation-based dialogue between professionals and mediating agents to improve conflict detection and prevent errors

Thank you for your attention...

Any suggestion/questions?