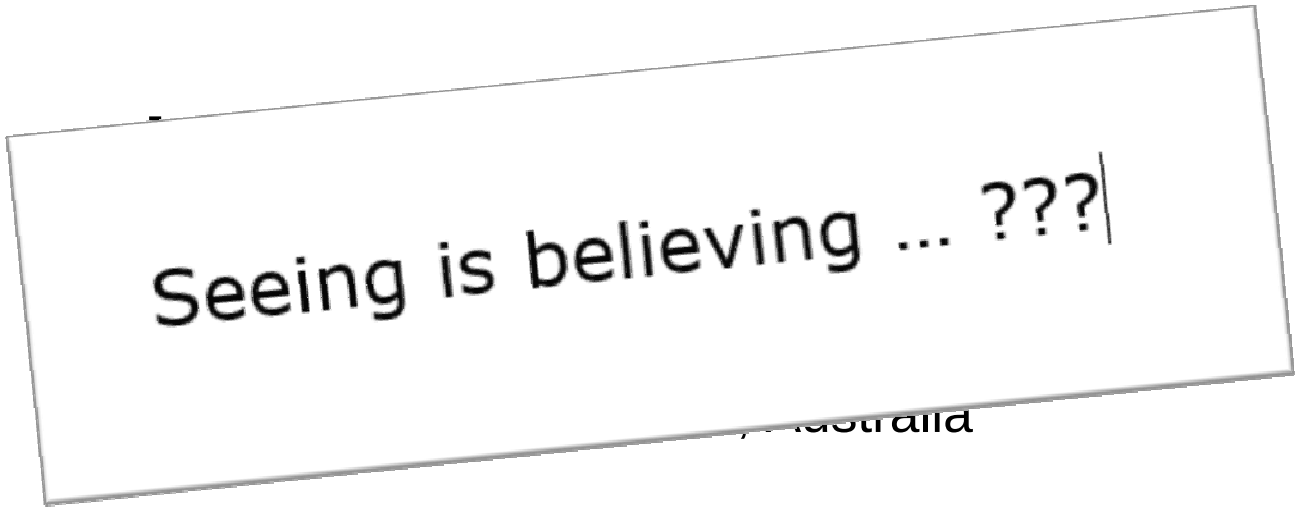
3D Cadastre Visualization: Recent Progress and Future Directions



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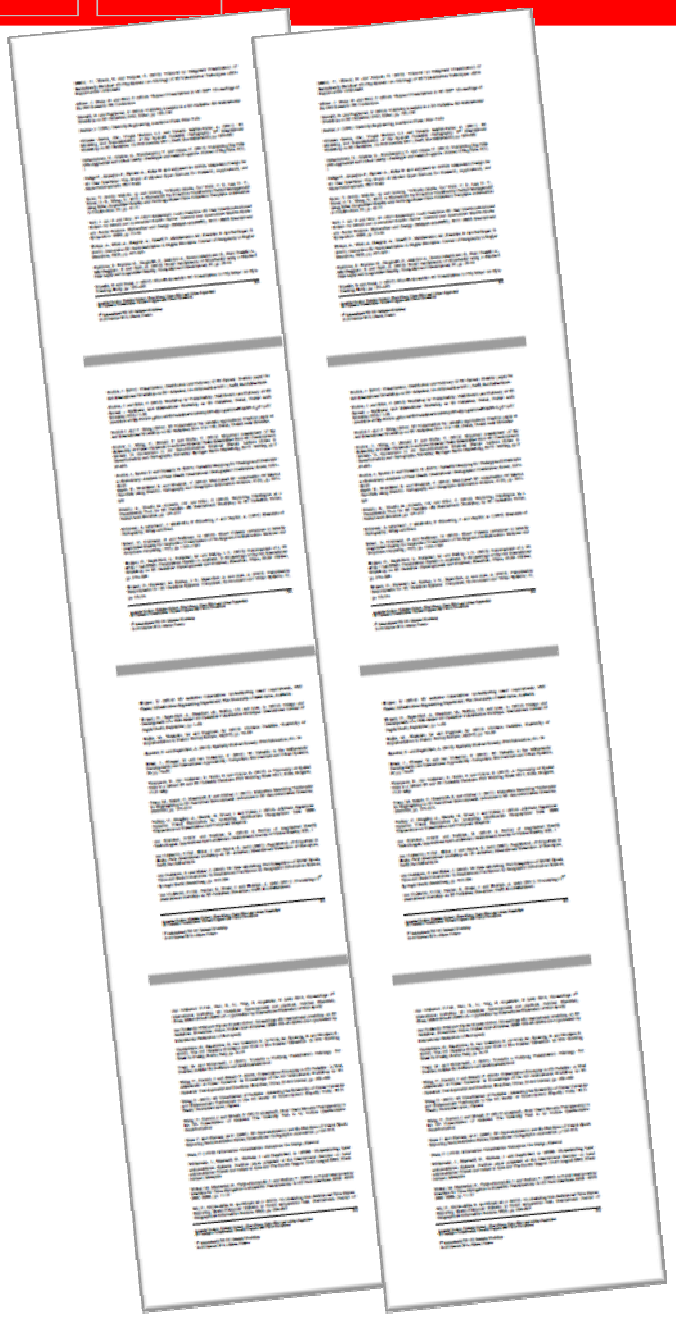
I invite you to read the paper!!

8 pages of references



Multipurpose 3D Cadastre
(3D Land Information System)
To support:

- ✓ **Land Tenure**
- ✓ **Land Value**
- ✓ **Land-Use**
- ✓ **Land Development**

Two parts

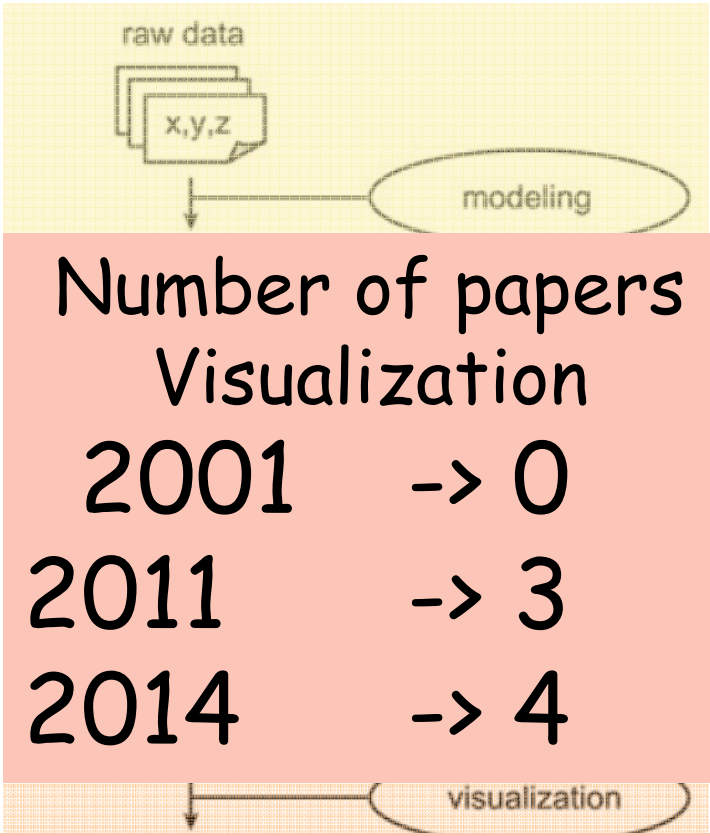
- Part 1
  - Summarize progress made in the last 5 years in 3D cadastral visualization
- Part 2
  - 3D Visualization ⇔ 3D Cadastre Visualization
    - highlight potential research and application trends

Part 1 –
Summary of progress made in the last years in 3D cadastral visualization

Established from previous 3D Cadastre workshops and literature

Many thanks to Peter for the website and 3D cadastre group!

Literature background



3D CADASTRE 2001, 2011, 2014
(108 contributions)

⇦ 45%

Number of papers
Visualization

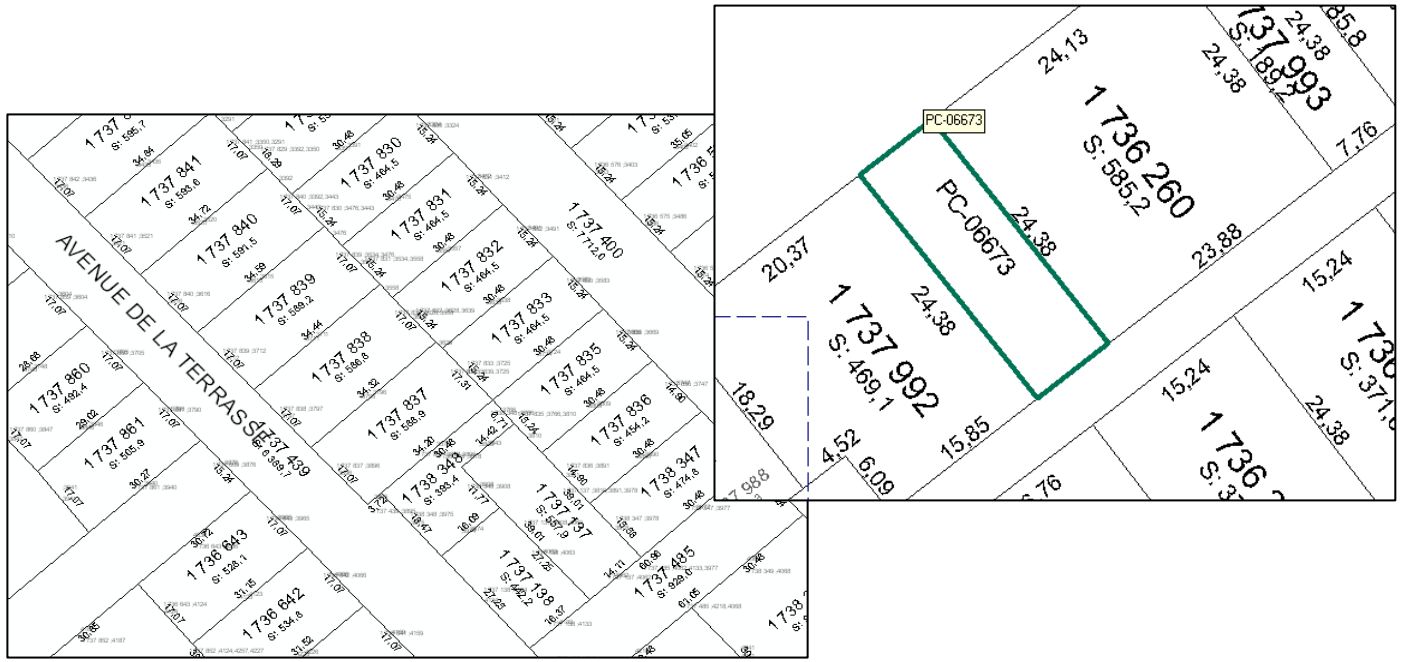
2001 -> 0
2011 -> 3
2014 -> 4

⇦ 6%

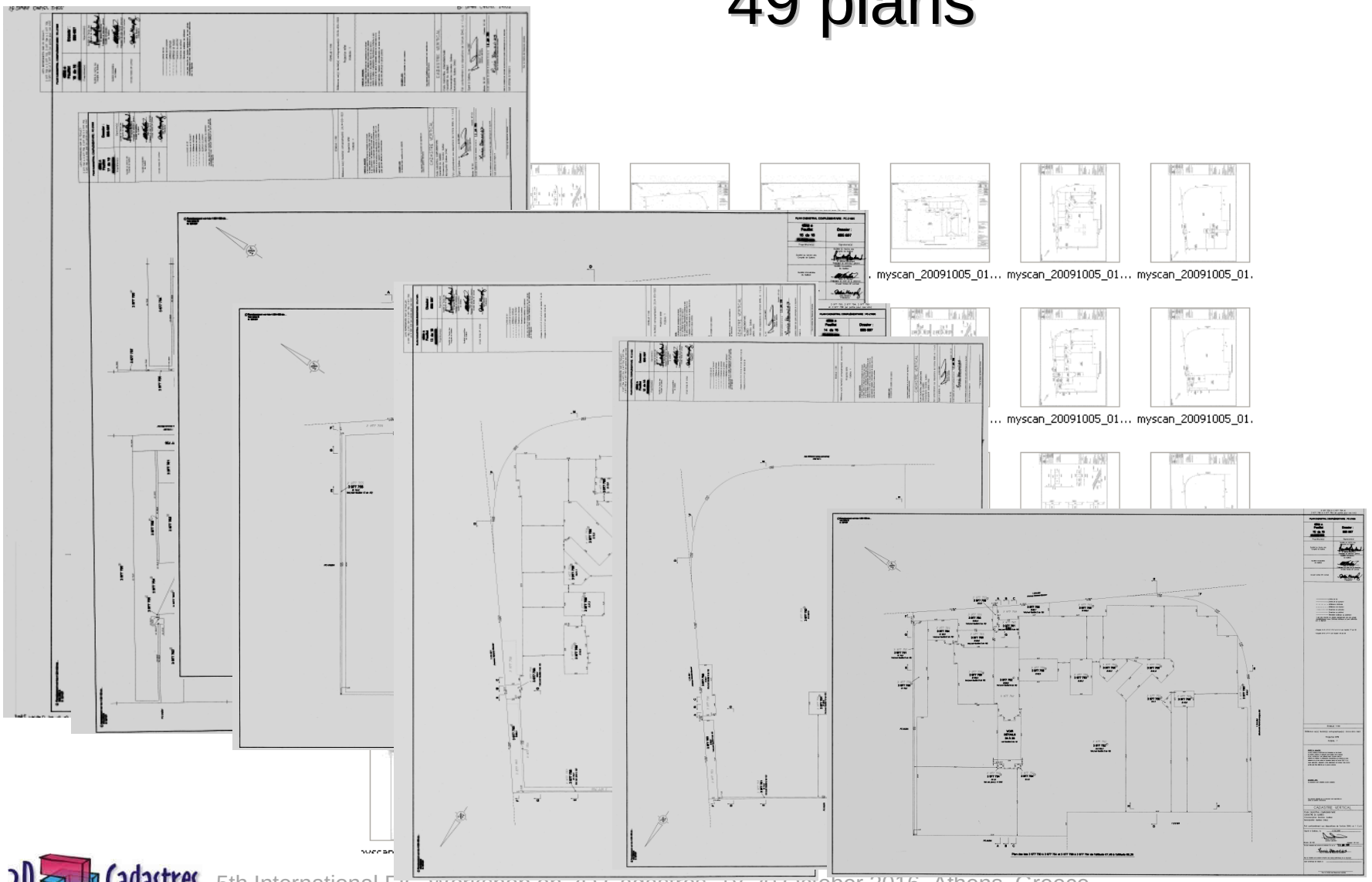
The number of publications increased,
is the same applied to progress?

3D Cadastre visualization – NOW (1/4)

- Still lots of 2D plans, vertical profiles or cross-sections
  - 3D Visualization does not replace existing 2D visualization solutions that managed honestly 3D situations



49 plans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3D Cadastre visualization – NOW (2/4)

- A higher number of prototypes that include 3D visualization
  - Australia (Karki et al 2011; Shojaei et al 2012;2014)
  - China (Guo et al 2013)
  - Indonesia (Aditya et al 2011)
  - Korea (Jeong, et al 2011)
  - Russia (Vandysheva et al 2011; 2012)
  - Germany (Seifert et al 2016)
- Main focus on software enhancements of existing 3D solutions (e.g. Google Earth, CityEngine) with concern to user requirements

3D Cadastre visualization – NOW (3/4)

- Few work on symbolization and graphic design
  - Visual variables (transparency)
    - Pouliot et al 2014; Wang et al 2016
  - Highlighting techniques (color rectangle, adding annotation, detaching floors, slicing)

    Pouliot et al 2013; Shojaei 2014; Vandysheva et al 2012

3D Cadastre visualization – NOW (4/4)

- A number of visualization realization and interaction
  - Web-based, Web-Services
    - Aditya et al 2011; Olivares Garcia et al 2011; Shojaei et al 2014
  - Interaction (visual selection and query's result)
    - Jeong et al 2011; Ribeiro et al 2014; Shojaei et al 2014; Vandysheva et al 2012
  - 3D visibility analysis
    - Navratil and Fogliaroni 2014

3D Cadastre visualization - SUMMARY

- Categories of ‘’cadastre’’ object to be visualized:
  - Mainly buildings
  - Little for underground network
  - Little with *Intangible* boundaries like legal boundary, servitude, restrictions, distinction between common and private properties
- Very little focus on cadastre visualization tasks and visual design
  - Lack of focus on user needs
- The value added of 3D visualization still needs to be demonstrated
- The learning curve of 3D cadastre visualization is deep

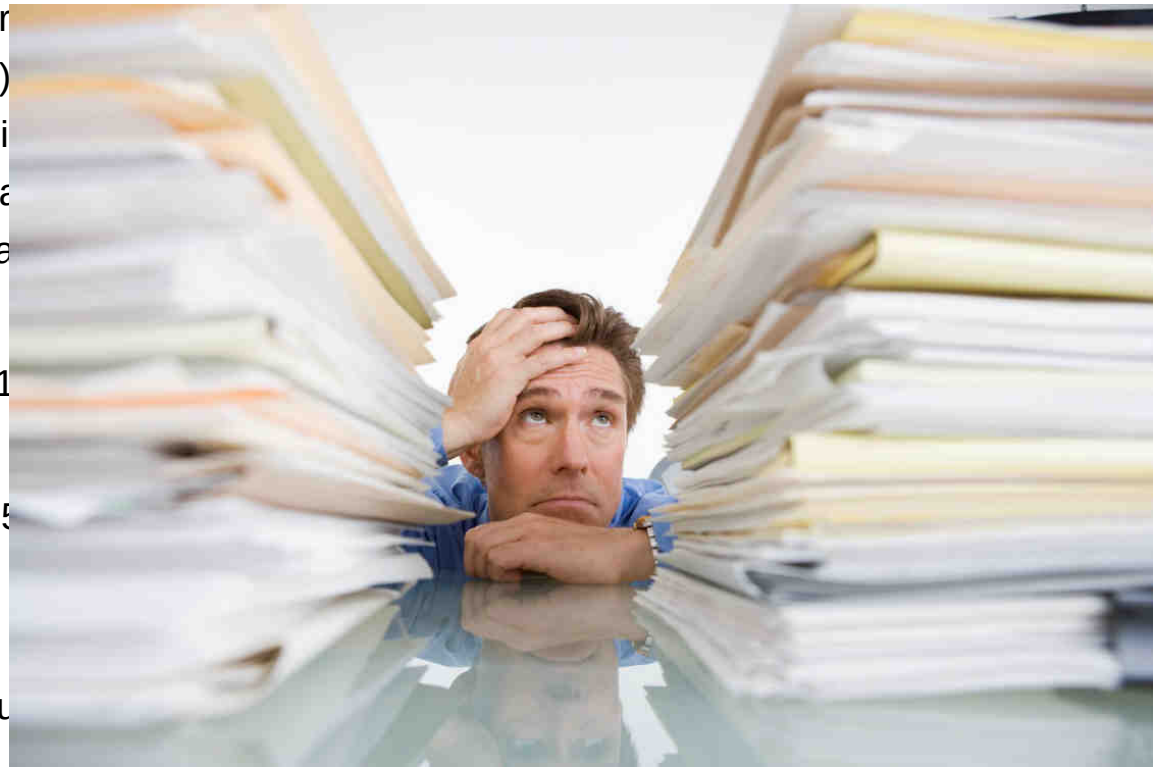
Part 2 –
3D Visualization

Two aspects:

- Back to the fundamentals !
- What is hot !

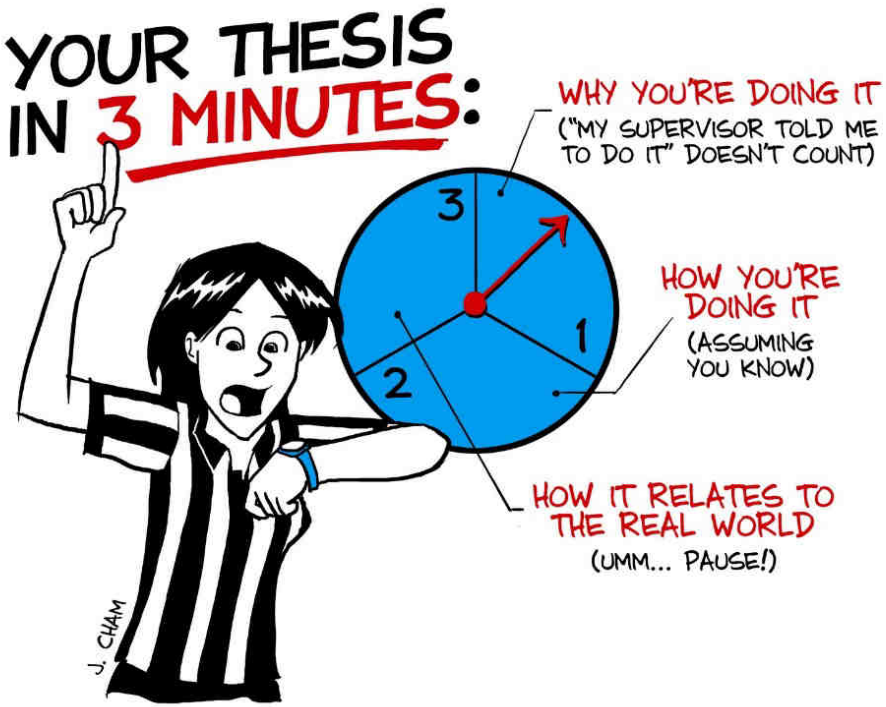
literature – Data Visualization (2D-3D)

- Cartography and Geovisualization
  - Visualization pipeline from data to r
  - Semiotics of graphics (Bertin 1983)
  - Quantitative Information and Envisi
  - Perceptual science, the 3Gs (Gesta
  - Maps, Generalization and geovisua
- Cognitive science
  - Information visualization (Ware 201
- Human-computer interaction
  - Usability Engineering (Nielsen 199
- Quality assessment
  - ISO, IEC, IEEE standards
  - e.g. Trouble with Computers: Usefu
- User needs
  - What is the purpose of cadastre, the users, e.g. Land Administration System (Dale & McLaughlin 1999; Enemark et al 2014; Williamson et al 2010)



Trends in 3D Visualization

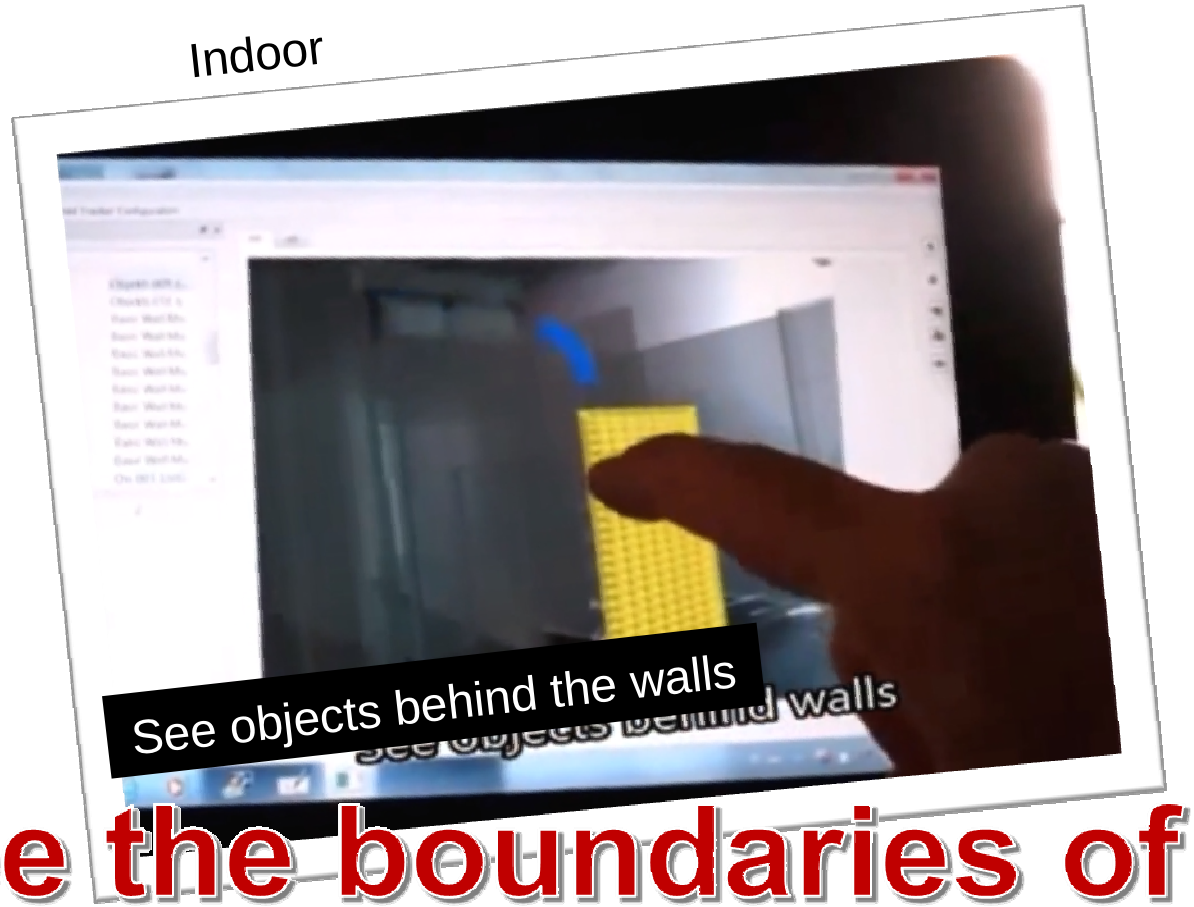
- Hot topics
  - Visualization and Geovisualiz
  - Computers & Graphics
  - Interacting and scientific Com
    - Computer-Human Interactions
  - 3D Vision
  - Augmented Reality
  - Cartography
  - Big Data



What is the link with 3D Cadastre Visualization ?

Augmented reality (on-site)

http://virtual.vtt.fi/virtual/proj2/multimedia/media/images/mobile-ar-maintenance.jpg



See the boundaries of MY property!

Augmented reality (on-site)

Rajabifard, keynote talk 2014

Outdoor

Verifying as-built 3D models of condo with occupancy

Augmented reality

atial/augmented-reality/

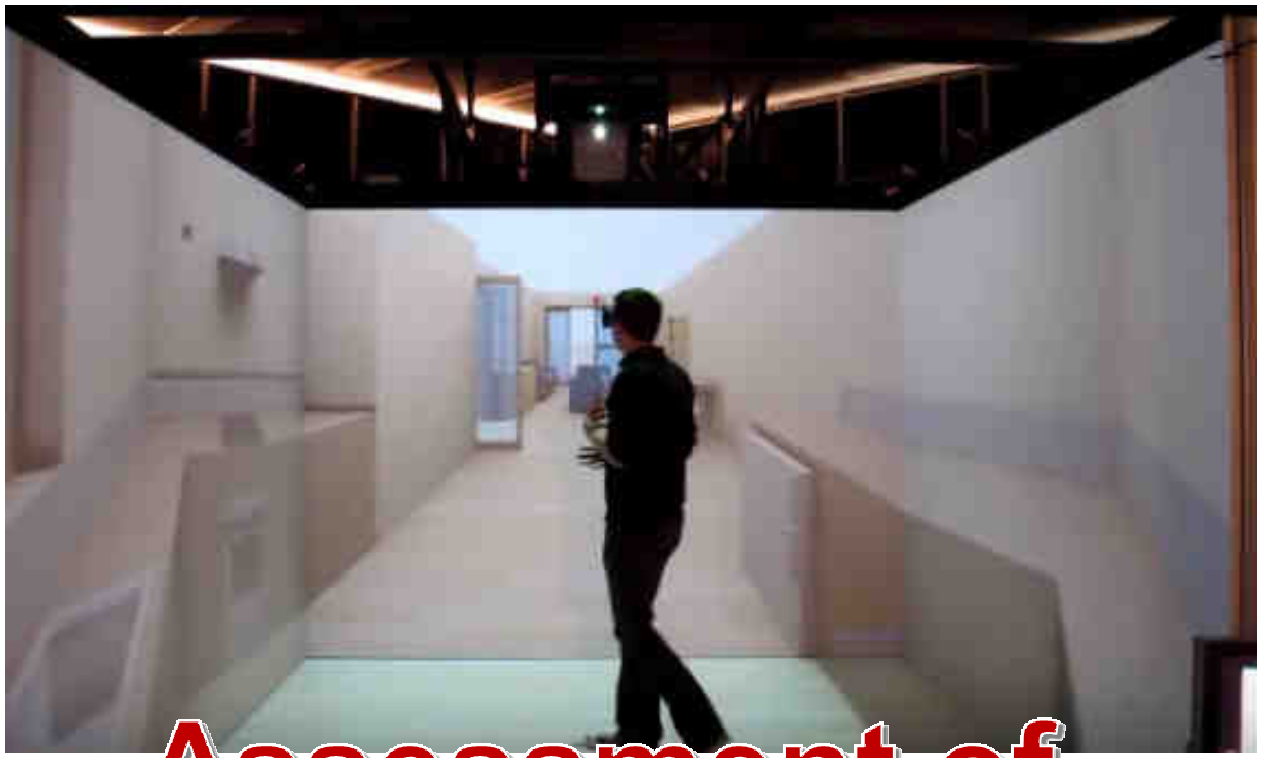
On-site visualization of easement localization

“Spatially enabled citizen”

Steudler and Rajabifard 2012

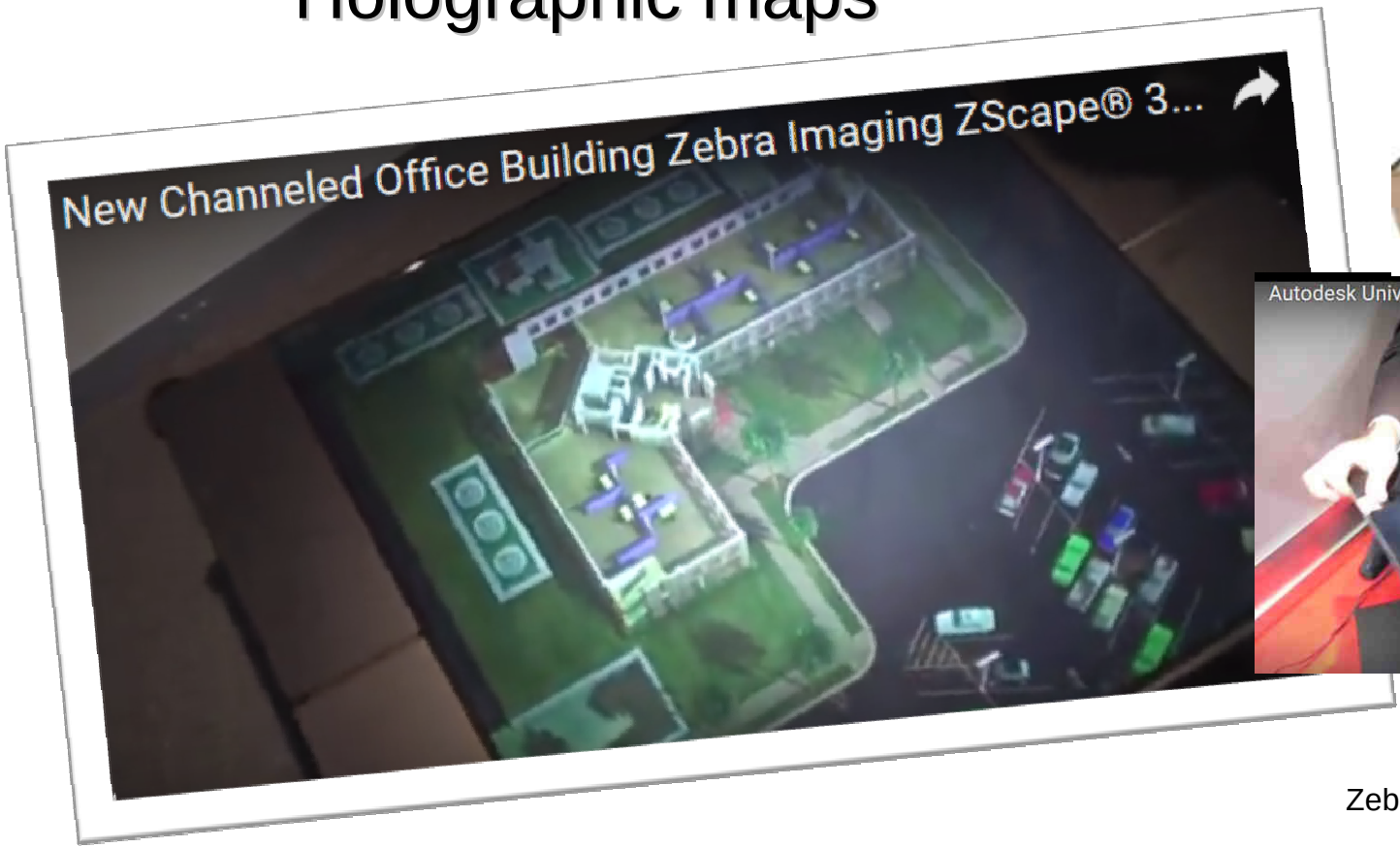
3D immersive and 3D interactive environments

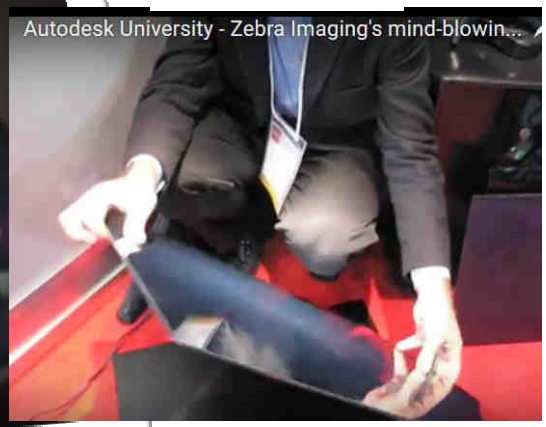
CASALA Centre
www.youtube.com/watch?v=dIg1HNpX8Qo



Assessment of real estate value

Holographic maps

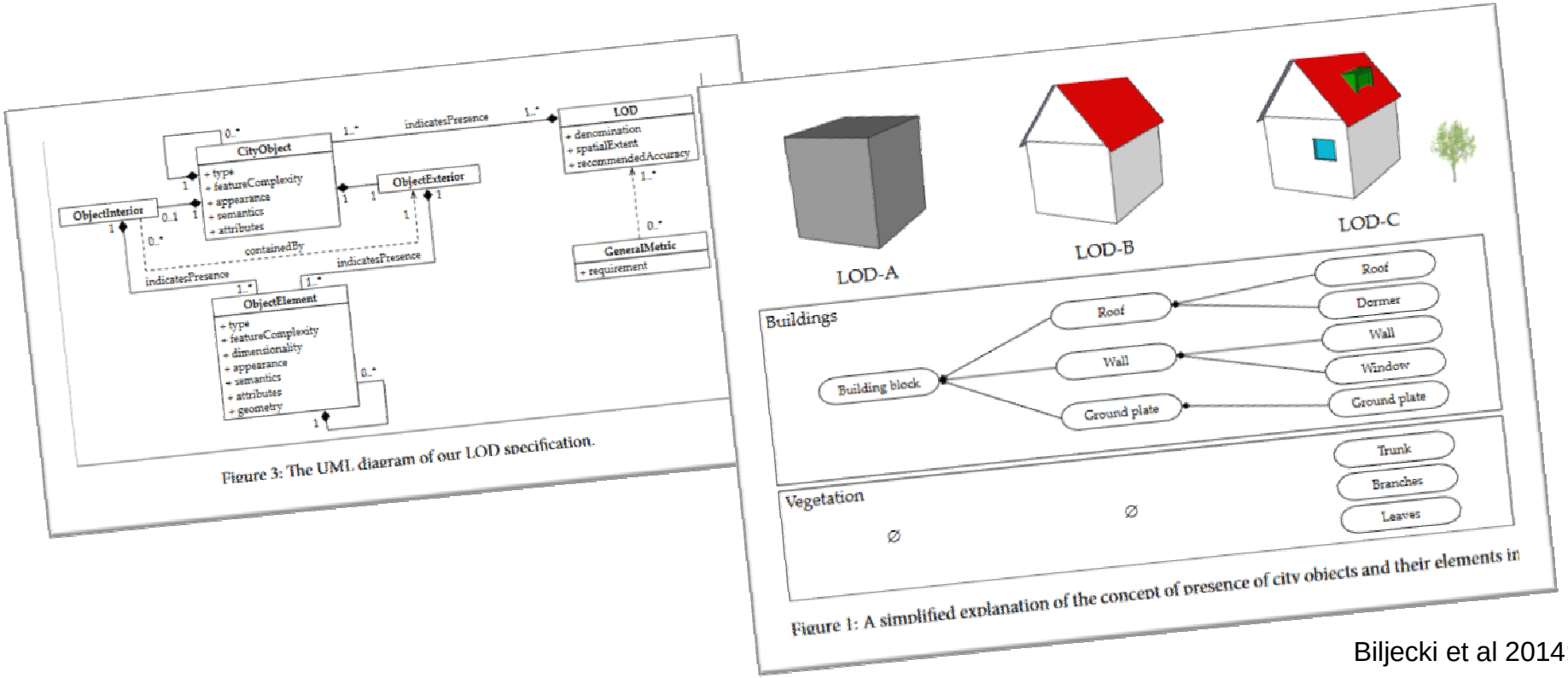




Zebra imaging (Zscape)

Marketing 3D models of Cadastre

3D Multiple Representations - LoD

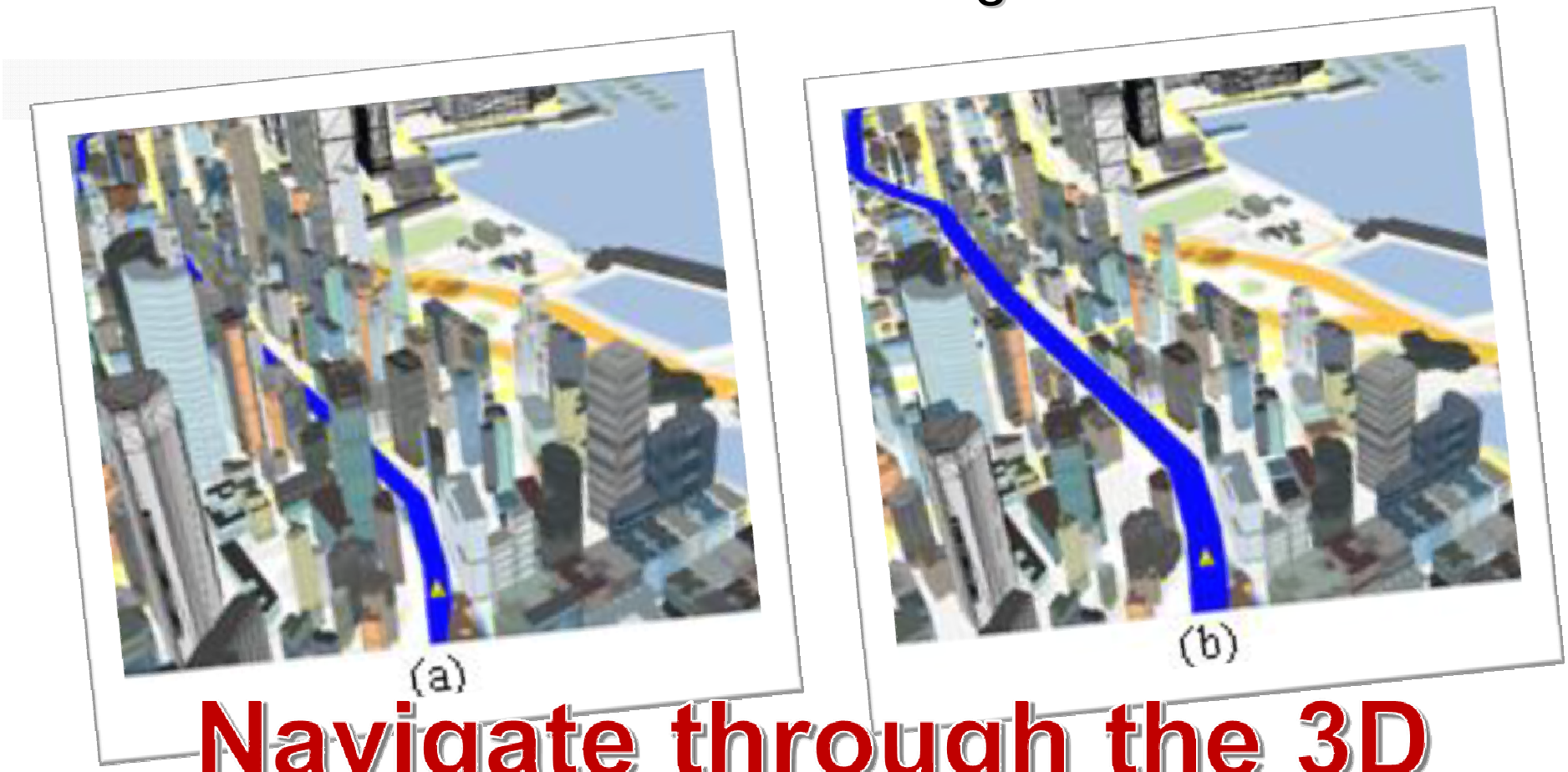


Biljecki et al 2014; 2016

Searching a unit in an integrated 3D LIS

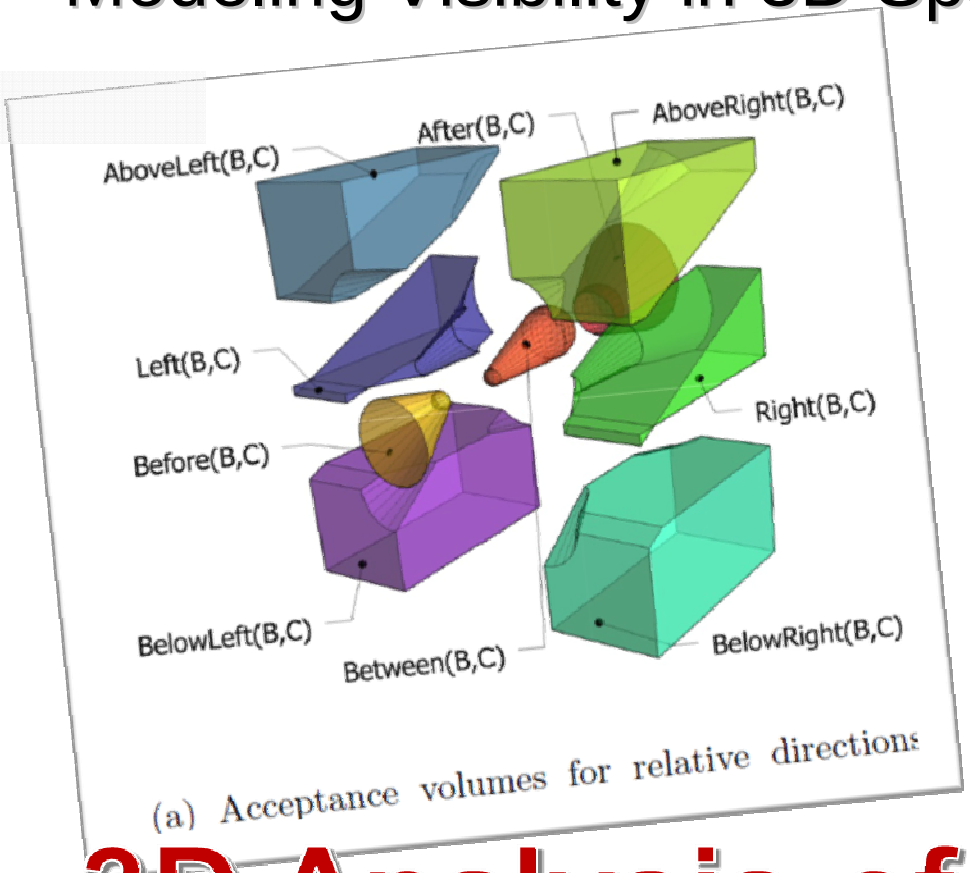
Occlusion management

Zhang et al 2016



Navigate through the 3D cadastre model

Modeling Visibility in 3D Space

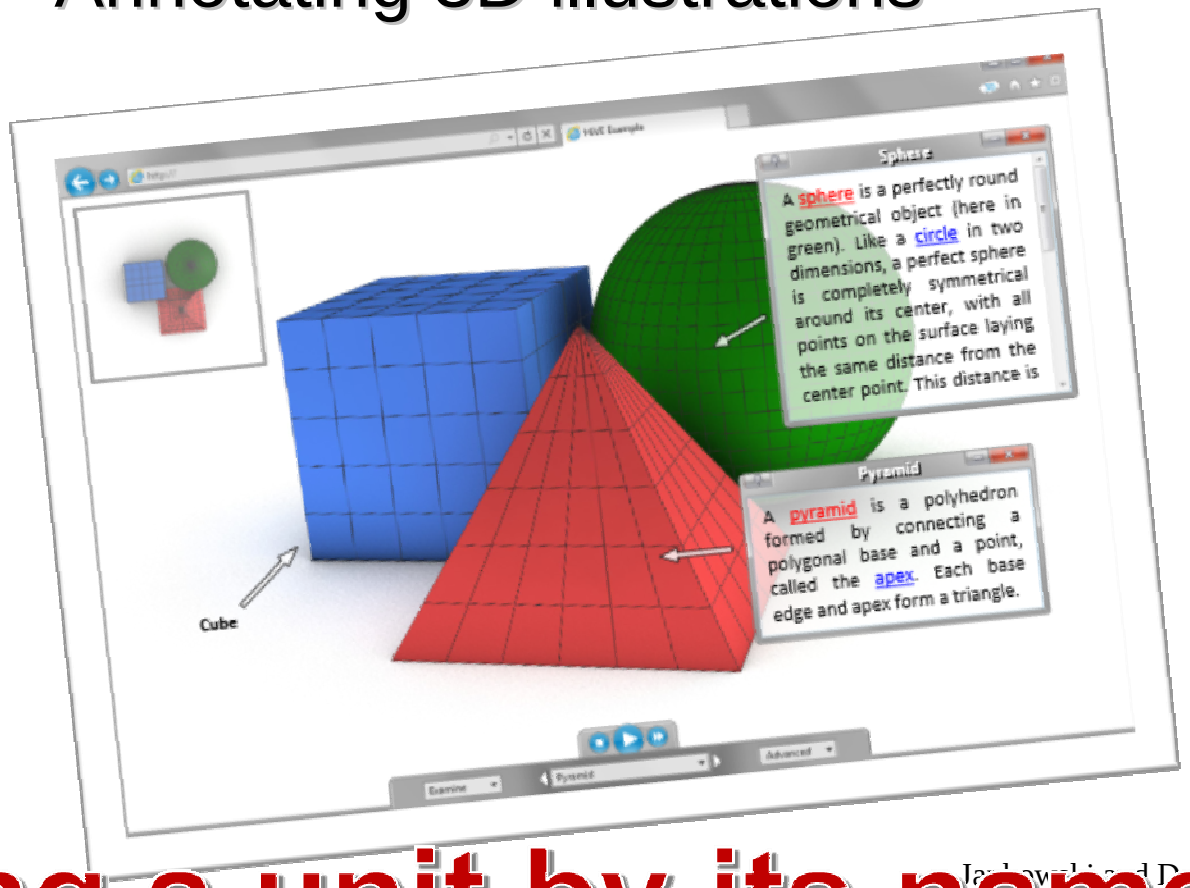


(a) Acceptance volumes for relative directions

Fogliaroni and Clementini 2014
Billen and Clementini 2006

3D Analysis of servitude of view

Annotating 3D illustrations

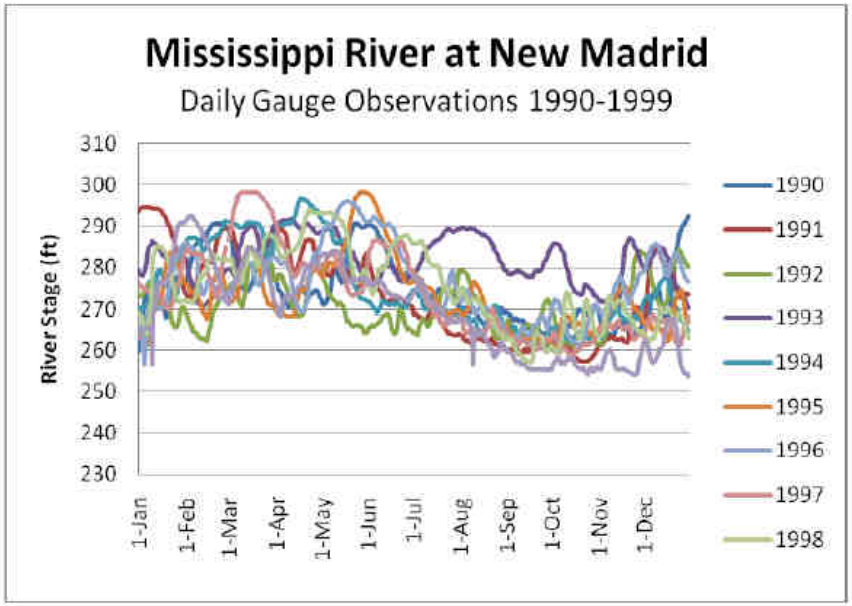


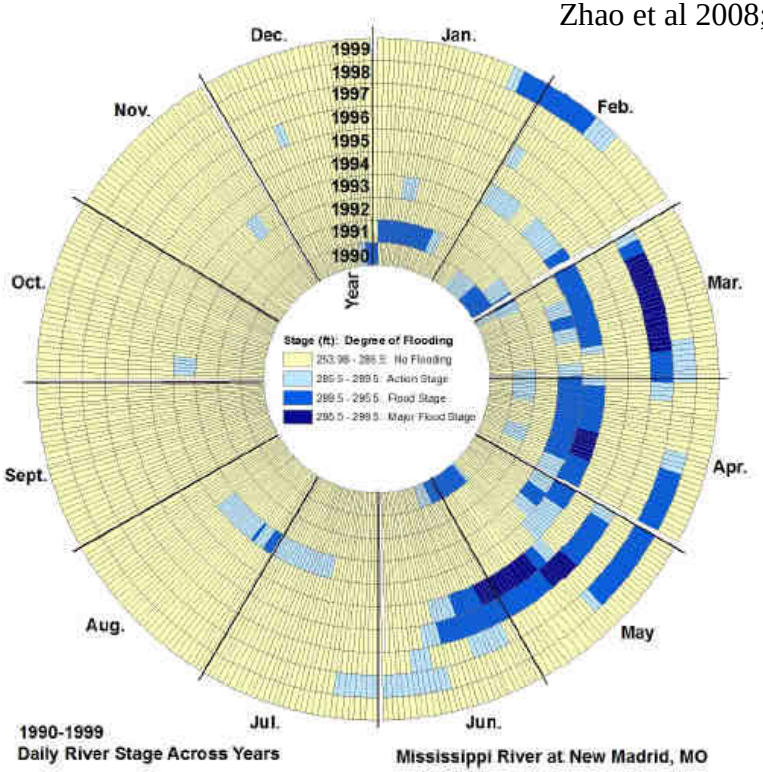
Jankowski and Decker (2012)

Pointing a unit by its name, viewing title extract

Integrating Time - Ringmaps

Zhao et al 2008; Nelson 2010



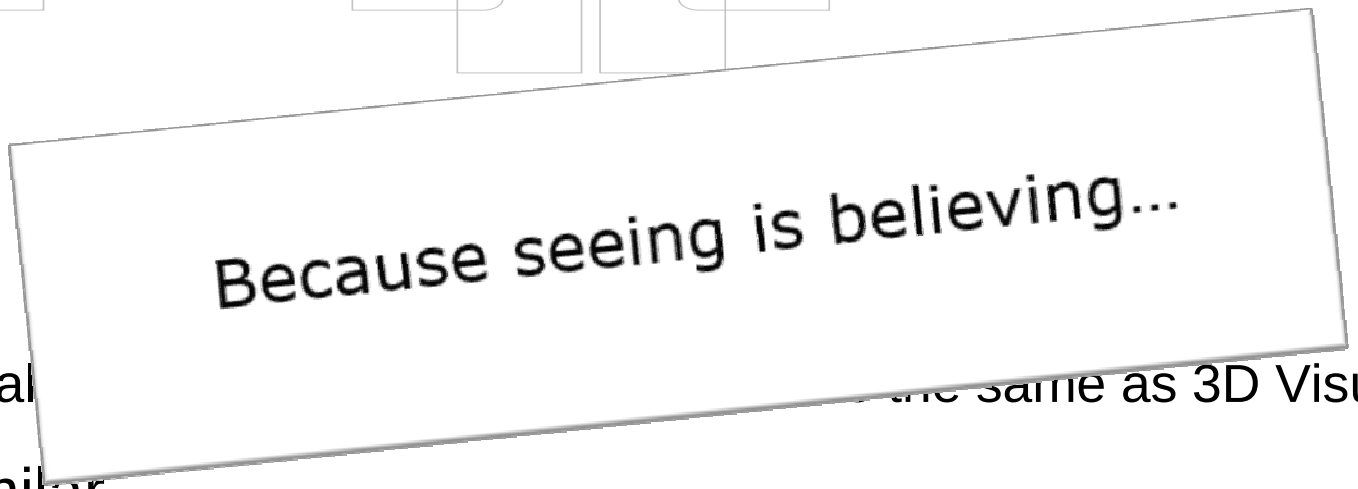


Trend analyses (real estate transactions/month/quarter)

Conclusion (1/2)

- Increased number of papers, so it does for implementation
  - More 3D cadastre prototypes
- Very little innovative research on the visualization aspects
  - need to diversify the research domains
- Learn from other disciplines

What make 3D Cadastre visualization distinct or similar to 3D spatial data visualization ?



- If similar
  - The chal… …e same as 3D Visualization
- If not similar
  - Viewing ‘’intangible’’ boundaries, multilayers and multipurpose
  - Interacting with users and usages in relation with laws and regulations
    - Extensive and very long text-based information (semantics) to be viewed in association with 3D geometry
  - Users not *tech guy*, need more investigations on usability/usefulness
  - Do not forget: Visualization of 3D data ≠ 3D visualization of data

Support the visualization of tasks that request 3D data