

# The Shape of Empty Space: Human-centred cognitive foundations in computing for spatial design

Mehul BHATT<sup>1</sup> and Carl SCHULTZ

*Spatial Cognition Research Center (SFB/TR 8), University of Bremen, Germany*

**Abstract.** We propose a human-centred model for abstraction, modelling and computing in function-driven spatial design for architecture. The primitive entities of our design conception ontology and computing framework are driven by classic notions of structure, function, and affordance in design, and are directly based on the fundamental human perceptual and analytical modalities of visual and locomotive exploration of space. With an emphasis on design semantics, our model for spatial design marks a fundamental shift from contemporary modelling and computational foundations underlying engineering-centred computer aided design systems. We demonstrate the application of our model within a system for human-centred computational design analysis and simulation. We also illustrate the manner in which our design modelling and computing framework seamlessly builds on contemporary industry data modelling standards within the architecture and construction informatics communities.

**Keywords.** architectural CAAD, cognitive systems, ontologies (artificial intelligence), declarative languages, knowledge representation and reasoning, geometric and spatial representation and reasoning, computational geometry

## References

- Bhatt, M., Schultz, C., Huang, M. (2012). The Shape of Empty Space: Human-Centred Cognitive Foundations in Computing for Spatial Design. IEEE Symposium on Visual Languages and Human-Centric Computing (VL/HCC) 2012, Innsbruck, Austria
- Bhatt, M., Schultz, C., Freksa, C. (2013). The ‘Space’ in Spatial Assistance Systems: Conception, Formalisation, and Computation. in Thora Tenbrink, Jan Wiener, Christophe Claramunt (editors). Representing space in cognition: Behavior, language, and formal models. Series: Explorations in Language and Space. Oxford University Press, 2013, 978-0-19-967991-1.
- Bhatt, M., Lee, J. H., Schultz, C. (2011). *CLP(QS): A Declarative Spatial Reasoning Framework*. Proceedings of the 10th International Conference on Spatial Information Theory (COSIT 11). Editors: Egenhofer, Max and Giudice, Nicholas and Moratz, Reinhard and Worboys, Michael. Vol. 6899, Pages: 210–230, Springer Berlin / Heidelberg (LNCS), Belfast, Maine. ISBN: 978-3-642-23195-7.

---

<sup>1</sup>Corresponding Author: E-mail: bhatt@informatik.uni-bremen.de