PhD Topic 2: Ontologies to Model the Construction and the Use Processes in the Built Environment

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Primary Field	Information Semantics, Management and Integration
Secondary Field	Smart Solutions
Interdisciplinary References	A2, A3, A4

The field of building information modeling moves forward from static models of the geometry and material properties of buildings and their constituent parts towards dynamic models of the processes connected to the built environment. Models of the processes to the built environment are oscillating between models focused on the construction processes and processes describing the use of the building – with strong interdependence between the two points of view. For example, from the description of the construction process, with materials actually used, dimensions achieved etc., the physical parameters for the economic and eco-friendly operation of the building are given; in the other direction, modeling the buildings operation and optimizing the physical parameters should inform the building process. Air-conditioning and heating, as one of the major energy intense processes, are perfect examples and could serve as a leading case in the research. The intended and the actual use of the finished building influences further the optimal operation and must be included in the model: how many people?, what technical equipment?, which comfort level? hours of use? etc. etc.

The current methods to describe building semantics are mostly static. Techniques like Semantic Web, or the very successful Resource Description Framework (RDF) are useful to establish taxonomies; currently trade-offs between the expressive power and the computational efficiency of variants of the Web Ontology Language (OWL), OWL Light, OWL DL, OWL Full or other languages based on description logics, are discussed.

The goal of this research is to build models of interacting processes (construction and use). Process ontologies are currently mostly studied in the context of business processes and in GIScience; results from these disciplines should be useful in building process models, but are not sufficient. Business processes deal mostly with “socially constructed” facts, not the reality resulting from carrying out imperfect building processes in an environment, which is only partially controlled.

The experience in related disciplines shows, that flexible process ontologies are not effectively doable in a first order language, e.g., description logics, and a current hypothesis is, that languages based on lambda calculus (a second order logic language, introduced by Alonso Church) are suitable to model processes, which change the state of the environment. The use of a typed lambda calculus and polymorphic functions will be necessary to combine high level, abstract knowledge with detailed description of processes.

The theory elaborated must be mapped to a simplified building in the planning phase and the planned use processes of the future building, the planning of the construction as processes and the final optimal operating of the building in controlling the facilities processes and adapt them to the less-controllable building use processes. It is assumed that implementations of parts of lambda calculus which can be computed efficiently in functional programming language will be a valuable tool to test the theory and produce simulations directly from the ontological specifications.

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