Biomimetic utilization of thermoregulation for dynamic façades

Development of a biomimetic ontology to exploit the potential of thermal adaptability in nature for dynamic facade design

In respect to the level of energy efficiency of a building, the façade is highly required to achieve maximum efficiency by dynamic adaptability. By the integration of active technologies and materials, the facade shall be able to react autonomously and dynamically to changing thermal conditions. The complexity of such systems, their failure potential and reliability might be improved by investigating biological thermoregulation principles and by transferring abstracted functions and relations to new design patterns of dynamic façades.

Adaptability is one of nature’s most basic survival strategies. A very effective approach represents the thermoregulation of organisms that is optimally exploited at maximum efficiency by using both locally available resources as well as just that much energy and material as necessary. It is controlled by complex interactions of matter, energy and information between the organism and the environment. Each item is ideally adjusted to the overall function and highly flexible, which creates not only a highly efficient system, but also wide implementation variations.

The key challenge of the work is to investigate the characteristics of biological thermoregulation concepts, respectively for thermodynamically active skins and envelopes: How do thermoregulation processes in nature work? Which functions and parameters are crucial? Particular attention is given to the analysis of characteristics that are analogous to architectural design parameters, such as geometry, size, or positioning.

Thus, based on defined search criteria, principles of biological thermoregulation are investigated using the biomimetic process. The findings are transformed systematically into a classification system, which is the basis for a biomimetic ontology. The system visualizes the functional role and design patterns of constructive parameters, with each function subdivided in objects (matter, energy, information) and operations (actions, relationships). This gives insights into the interaction of "constructive parameters" for the task “thermal-dynamic adaptation to increase efficiency”.

The goal of the work is to investigate biological principles that contribute to a highly efficient thermal performance through smart constructive measures and to transfer them into functional design patterns for dynamic facades.

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PROJECT INFORMATION

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