

Short Term Scientific Mission (STSM) Report for COST ACTION TU1403: Adaptive Facade Network

TOPIC: Kick-off for investigation and publication on functional and architectural characteristics of adaptive facades targeting at the term “intelligence”

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| Submission date: | 16/01/05 |
| Beneficiary: | Susanne Gosztonyi (Lund University) |
| STSM Period: | 15/11/26 – 15/12/05 |
| Host: | Dr. Uta Pottgiesser, Jens Böke (Hochschule Ostwestfalen-Lippe) |

1. Summary

This report describes the activities carried out by Susanne Gosztonyi, researcher at Lund University, during her Short Term Scientific Mission (STSM) stay at Hochschule Ostwestfalen-Lippe, Detmolder Schule für Architektur und Innenarchitektur, ConstructionLab (HS-OWL), hosted by Dr. Uta Pottgiesser and Jens Böke. The STSM activity is affiliated to the work group 1 (WG1) in the COST Action TU1403 Adaptive Façade Network, with specific focus on the definition of criteria for adaptive facades. The STSM focused on the initiation of a joint investigation in regards to “intelligent” measures and architectural criteria for adaptive facades, which shall result in contributions to the WG1 database and a scientific publication. A manuscript focusing on architectural criteria for adaptive facades has preliminarily been elaborated for the STSM and presented at the international conference facade2015 at Detmold. The results of the STSM are key search criteria to identify case studies and concepts for the specific research focus in various fields (ICT, biomimetics, architectural design and engineering), and a draft of the “extended architectural criteria” as a first version.

2. Purpose of the STSM

The activities carried out in this STSM are affiliated to work group 1 (WG1) in the COST Action TU1403, particularly to the task of developing a database that displays technological solutions and applications for adaptive facades. To collect this data, key criteria that describe the adaptive functionality in facades must be identified and systematically arranged. Since there is no definition yet existing on “adaptive facades”, the initial step of WG1 was to define key characteristics for adaptive facades and develop a matrix. The STSM intended to contribute to this ongoing task.

Since both, the beneficiary and the host are currently elaborating key characteristics for adaptive facades in their Ph.D works, based on different knowledge domains (Biomimetics, ICT) and research questions (thermal adaptation, smart devices), the intention was to further develop this towards an **joint investigation on the terminus “intelligence” in the adaptation function of facades from the perspective of architectural design and system engineering**. The investigation targets at a **common view of criteria** and an **meaningful description of the function “intelligence” and “adaptive facades”** that considers different needs from architectural engineering, system engineering and, as

most often neglected, the architectural design. In this process, a taxonomy shall be developed that contributes to the development of the database in WG1. The STSM served as a kick-off for this elaboration, which shall result in a scientific publication.

The objective for the STSM period was to screen literature, case studies, and research work from both institutions, as well as available publications from the WG1, and discuss “adaptive” and “intelligent” façade measures to define tasks needed for the elaboration of the investigation. The STSM was also dedicated to a knowledge exchange about methodological approaches (ontologies, parametric systems) in the two domains “computational design” and “biomimetics”. The participation at the international conference facade2015 in Detmold at the beginning of the STSM was therefore a great opportunity. Finally, the development of a work plan for a joint publication dealing with the topic described above was intended. The publication shall add to the existing publications done already on the WG1.

3. Description of work carried out during the STSM

For the STSM, following activities have been carried out:

- a. Manuscript elaboration (preliminary work) for “architectural design criteria of adaptive facades” and presentation at the international conference “facade2015 - Computational Optimisation” on 27th November 2016 in Detmold, Germany

As a preliminary work to the STSM, the beneficiary developed a concept draft for an integrated design approach to functional and formal requirements for adaptation of facades, merging technological (functional) and architectural (formal) measures [1]. The concept targets at the incorporation of architectural criteria in the discussion about “adaptive facades”, which seems to be neglected in the current discussions. The concept has been presented at the conference facade2015 in Detmold at the beginning of the STSM. It also served as the basis for feedback discussions at the conference and later, and for the literature survey.

- b. Mapping case studies, technological and architectural concepts of facades indicating “intelligence” and “adaptation” in the various fields to identify a common basis

The identification of key words for a meta-search has been done in various work sessions. This served to identify publications about façade solutions that incorporate the criteria “adaptation”, “architectural quality” and “intelligence” in the field of architecture, façade engineering, biomimetics and ICT. Due to the short period, the literature search, especially in non-related fields, such as in the communication or natural sciences will continue after the STSM. The goal is to establish use cases based on collected concepts, technological examples, and cases studies. The use cases shall describe, in an abstracted form, “intelligent” approaches to adaptation measures of facades and link these to architectural design tasks. A literature list will be provided to the WG1.

- c. Kick-off for joint scientific publication

The results of the interdisciplinary investigation shall be elaborated in a scientific publication. Hence, the STSM also served for the definition of an outline of the needed work for the publication.

4. Description of results obtained

The results of STSM are (a) an established joint research basis, (b) a first listing of key criteria for term ‘intelligence’ in connection with adaptive facades in order to formulate a taxonomy, (c) reviewed

descriptions and examples for (b) in the fields architectural engineering, computational sciences and biomimetics, and (d) a drafted concept of extended architectural criteria for adaptive facades.

- ad (b): Discussing and mapping existing and possible key criteria for ‘intelligent’ measures that can be deployed in adaptive façades, collecting data from interviews at the conference and literature review

Descriptions of adaptive façades that incorporate criteria targeting at “adaptation”, “architectural quality” and “intelligence” are rarely found. It is more likely to find separate descriptions: Most frequently, “adaptation” and “intelligence” are addressed in the system engineering field (use of sensors, actuators and processors for activation). Another identified approach is the description of kinetic structures, without details about the activation concept. However, a clear definition that combines both is still open for development: Questions to identify key criteria have been identified, such as: What is an intelligent control in the architectural context? Digital vs analogue solutions? Which key criteria are needed to describe controlled central intelligence concepts (e.g. human mobility skills) and local intuitive intelligence concepts (e.g. skin hair)? Can they be abstracted to allow more solutions, combined solutions? Which are the system boundary criteria that must be considered (functionality, production, etc)?

For the mapping of key criteria, existing collections of case studies and concepts have been reviewed and will be further elaborated. The current collection is available online on Pinterest [1, p.4] and as a literature collection (Mind map). It shall be added to the collection of the WG1.

- ad (c): Collecting examples and concepts for the definition of intelligent adaptive facades in the context of architectural design criteria

The term ‘intelligence’ is applied in architecture with varying intentions and meanings. This can lead to misunderstanding, particularly when used as criterion for defining adaptive functions. ‘Intelligence’ from the perspective of the system engineering is most likely linked to the integration of computing and sensor technology. Herein, static physical components and/or material properties are turned into dynamic responsive systems by adding automated controls to the system. This approach has been investigated in publications by the WG1 and also in the conference paper that is linked to this STSM [1].

‘Intelligence’ is also used in context with sustainable building design to describe integral design methodologies or passive design concepts. Herein, intelligent measures refer to the application of processing knowledge of designer(s) tools and methods than to technologic solutions. The host institution has a main focus in the digital design and manufacturing processes, which contributed largely to the selection of possible key search criteria for intelligent measures, from the perspective of system engineering but also from digital design developments.

In nature, ‘intelligence’ is an embedded function of the composition of an organism. Intelligence is herein not necessarily an actively controlling feature, but can also respond e.g. via complex material compositions on various levels and scales of its structural system, which makes it capable to react “passively” on dynamic performance needs. An incorporation of this knowledge to the identification of possible search criteria is provided by the beneficiary who is conducting research in the biomimetic field.

- ad (d) a criteria concept of “extended architectural criteria” for adaptive facades

Some of the identified criteria in biology have been used for the development of a simple criteria list (draft version) displaying “extended architectural criteria” for adaptive façades [1, p. 6]. This list has been developed for discussion in the STSM and later on in WG1 of COST TU1403. “Extended architectural criteria” shall combine adaptive functionalities, which are mainly targeting technical domains, with architectural aspects including spatial, formal and visual criteria for some states of the adaptation.

- ad (a): Provide an outline for the development of a joint scientific publication

The planned publication targets at a taxonomy for “intelligent measures for adaptive facades considering architectural criteria” (working title). For the taxonomy, ontologies and the theory of technical systems design as well as the application of system engineering in ICT and digital processes are considered. The possible application of these methods needs further discussion in WG1 to define a contribution to the taxonomy of the database.

5. Future collaboration and contributions to COST TUD1403

As the STSM was planned as a kick-off for a joint investigation and later publication, a further collaboration with the host institution and also with the members of WG1 in COST TU1403 is intended. The brainstorming on the differing use of the terminus “intelligence” in various knowledge domains revealed the need for an in-depth literature survey and further discussion on the topic. This is currently ongoing. It is planned to discuss this in a WG1 meeting. All results shall be contributed to the development of the database.

6. Foreseen publications/articles resulting from the STSM

A scientific article in the fields of biomimetics or computational engineering/building automation is in planning: elaboration in 2016 and submission late 2016/2017. The elaboration of the publication shall be closely linked to the activities in WG1, particularly in regards to the database structure.

7. Confirmation by the host institution of the successful execution of the STSM

Please refer to the attached letter.

8. Additional documents / references

[1] Gosztonyi, S., “Adaptive Façade – which design criteria are needed?”, facade2015, conference paper, Conference Façade 2015 – computational optimisation, 27.11.2015.