Facade-User Archetypes

Exploring the potential of self designed facade-user Archetypes in personalisation of external shading systems in office buildings.

Reflection
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Part 1: Graduation Process

A. How are research and design related?

The research topic addresses the design of building envelope components and how the same can be personalised for users. Building envelopes have long been designed and optimised for performance. The research observes that design of building facade components can have an impact on the users in two fold ways: firstly, building envelopes directly impact occupants by regulating the indoor environment by protecting the occupants from thermal, visual, acoustical and IAQ stressors. Secondly, occupants in a building have shown to be more comfortables if they enjoy the building envelope design. Abundant existing research has shown that occupants percieved comfort is dependent on multiple environmental and non environmental factors and a higher liking towards building envelopes has shown higher tolerance towards IEQ stressors. Hence, the design of facade components have a high influence on the percieved comfort of occupants.

The research takes the example of building shading systems that are commonly used as facade components to protect the occupants from glare and thermal discomfort while providing privacy and view to the outside. The multi-domain influence of building shading systems offers opportunities to personalise shading systems for individual occupents.

By using Archetypes, the research proposes a new design strategy to integrate various user types into the design process to evaluate the requirements and biases of users and how this can influence the optimal design for that specific user group. The archetypes are not designed as absolute user groups to test the personalisation of all facade components. Here, the facade user archetypes are only intended for use to personalise building shade system design. The two fold aspects of the thesis firstly explores a design framework for user oriented design through the use of Archetypes and secondly, presents design recommendations for users on the basis of the designed framework.

B. How is the graduation topic positioned in the studio? What is the relationship between the methodical line of approach of the graduation studio (related research program of the department) and your chosen method?

The Facade Design and Engineering group deals with building envelopes in all domains ranging from sustainability, energy efficiency, aesthetics and occupant comfort. Well designed building envelopes are conducive to a comfortable indoor environment. The research attempts to not design new products but to rather evaluate existing products from the market and assess the impact of the indoor environment, energy demand and occupant comfort by the implementation of these products. The personalisation of the products for various users is then executed by integrating objective performance and subjective user rating of building components to finally give scores to the shading systems.

With respect to the mehodical line of approach, the research uses a multi-faceted approach. The factors that influence the user preferences with respect to building envelopes are explored through a literature review. A shortlisted set of building shade systems are rated against one another by means of building physics simulation tools. A survey is floated to understand their basic demographic data, contextual background, perceived importance of environmental features and preferences with respect to shading systems. Finally, a machine learning approach is used to cluster users into Archetypes to personalise shading systems for individual occupants. This multi-faceted method of design evaluates building shade systems on the basis of their multi-domain performance, evaluates the user preferences and demands for existing facade products and finally makes use of computational tools to recommend shade systems.

C. How did the research approach work out & did it lead to the results you aimed for?

The inisitally established research approach assumed a linear design method for personalisation of shading systems. Once the process was started, it was soon realised that research just like design is not a linear process and involves a lot of back and forth between various stages of initial execution. Hence, the research approach did work out at the end, but the process had to be adjusted to allow more time for the building shade simulations, survey analysis and clustering of users.

The initial aim of the research was to establish Archetypes for personalising shading systems, but soon through the process of clustering it was realised that user responses are not fixed and clustering of users is not merely a grouping task. This part of the process involved some back and forth but with some time and analysis of the survey response, a reliable clustering of users was achieved. This added value to the existing research of building facade design as the research clearly establishes the factors that affect occupant preferences and the factors that affect the way users could be clustered into Archetypes to be used in evaluating building facade components.

D. Did you encounter moral/ethical issues or dilemmas during the process & how did you deal with these?

Since the research primarily exists within the domain of occupant comfort and building facade design, it strongly addresses the comfort metrics that must be accounted for when designing for occupants. The implementation of facade-user archetypes as a tool for personalisation of facades aims to not only imrove energy performance and environmental performance of building envelopes as a whole but to also improve the occupant comfort.

The research inititally makes use of a survey to infer personal, contextual and environmental factors of respondents to evaluate if any of these has an influence on their preferences. This part of the thesis involves gathering a lot of personal data with consent of the users. In order to remove any similarity to individuals, the anonymous user response were encoded and scaled leaving no possibility of identification. This made sure that the personal, health related, contextual and other information of the survey respondents is not misused in any way. It was also made sure that the data is not shared with anyone outside of the student and supervisor team. All data presented in the volume was limited to demographic data and no specific survey samples were singled out. This helped maintain anonymity and made sure that the responses received were not misused in any way.

Part 2: Societal impact

A. To what extent are the results applicable in practice?

The implementation of simulation in order to evaluate the performance of building facade components is already implemented in practice. The evaluation of building facade performance with respect to energy performance is already a point of concern. The implementation of facade-user archetypes in design can be executed in design scenario where the users that are being designed for are known within refurbishment / new projects. Evaluating user needs from their workplace environment and their visual preferences can be implemented with the use of a brief survey that can help form archetypes and better understand the types of occupants.

The research implements basic machine learning tools to cluster and classify occupants into archetypes that can be implemented easily. Alternatively, a further designed tool can help cluster users in any scenario to infer design preferences. The true challenge within this research outline is the final product as the process assigns shading systems on the basis of environmental importance and visual preference and is not based as a design recommendation tool on visual preference alone. Hence, the process needs to be further refined to be implemented in practice.

B. To what extent has the projected innovation been achieved?

The multi-faceted design process originally aimed to recommend shading systems to users on the basis of their internal and external factors. The final outcome of the research shows that it is possible to cluster users into Archetypes and recommend personalised shading system solutions to them. As this process is purely executed through clustering and weighted average, it puts forth a creative yet simple process that can be used to evaluate shades for individual users. Even though the research successfully assigns shading systems to individual users, it does not account for change in preference of users. This requires

a longitudinal analysis over a time period before design can be implemented for them. The use of machine learning in recommendor systems is most commonly associated in social media and online streaming websites. The innovation here lies within integration of the same recommendation system for the built environment. The use of the same tools for recommending design to users paves a way for optimisation for not just performance but also multi-domain occupant comfort and personalisation of building envelopes.

C. Does the project contribute to sustainable development?

Yes, the project contributes greatly to sustainable development. The IEA in its recommendations for higher energy efficiency of buildings recommends passive energy houses and zero energy buildings, energy efficient improvement in glazed areas and better polocies to promote energy efficiency in existing buildings. The research pushes for higher efficiency of building shading systems in terms of energy and in providing occupant comfort. Buildings often underperform in terms of energy efficiency due to a lack of consideration for user behavior and preferences. By incorporating user preferences into the design and decision-making process using archetypes, the research aims to bridge this gap and contribute to higher energy efficiency in buildings.

The implementation of higher energy efficiency in glazed areas is as important considering the current climate trends. Shading systems have proven to assist in reducing stressors and increasing efficicency. In addition to implementation in design, the method of evaluating user preferences can also help manufacturers design for the market trends. With the development of user Archetypes and evaluation of user preferences based on the same, product manufacturers can design shading systems that not only perform well in terms of energy efficiency but are also preferred by users.

D. What is the impact of your project on sustainability (people, planet, profit/prosperity)?

People - The research has a positive impact on occupants as it prioritizes their comfort and well being. By critically evaluating the performance of existing shading systems, the research promotes productivity, health and overall satisfaction. By integrating users into the design process, the research also makes sure that new and refurbished buildings meet user requirements.

Planet - The research contributes to environmental sustainability by focusing on energy performance as an important factor within the design process and hence reducing the environmental impact of buildings on the planet. Well designed shades can help reduce heating, cooling and lighting demands in both heating and cooling dominated climate. Finally, by critically evaluating existing shading systems, the research does not require new shading systems to provide occupant comfort and energy efficiency thereby promoting resource conservation.

Profit/prosperity - The research's emphasis on using existing shading systems has economic benefits as by using commonly available and cost effective shading systems the research enables energy savings and potentially reduced energy bills. Additionally, the user centered design process can add a check for manufacturer and designers before releasing products into the market to prevent the mass manufacturing of redundant products that are not preferred by end-users.

E. What is the socio-cultural and ethical impact?

The socio-cultural impact of this project lies in the implementation of low-cost and easily accessible shading technologies that can be implemented in various contexts.This enhances adaptability by allowing for personalized solutions that meet the needs of diverse users.

Additionally, by putting the user at the center of the design process, the research aims to increase user satisfaction and well-being within office buildings. Ill designed building envelopes that do not consider the multi-domain influence of their design on the environment can have an adverse impact onoccupants in the form of sick building syndrome causing discomfort and health issues to users on a weekly basis. Building envelope design that considers well the impact of design on occupants can have a positive impact by creating a healthy environment conducive to less health related issues and discomfort. A well designed building envelope that takes into account the needs of the end users also has a impact on the reported productivity and performance.

F. What is the relation between the project and the wider social context?

Personalization of design is not a novel concept in design and technology-related domains, but it is just recently being applied to building envelope components, automation and other design aspects. The research creates opportunities for extending comparable techniques to other building envelope elements and components by effectively executing and demonstrating the scope of design personalization in the context of building shading systems.

Additionally, a thorough grasp of the role of the user and how design affects their well-being is necessary to advance the global movement towards net zero energy buildings. The research aids in the transition to a more energy-efficient future by taking into consideration user preferences in component design. The research executes the same without demanding advanced tools and overly-complex processes. The ease of implementation makes this method of user centered design more accessible and applicables in a wider social context.

G. How does the project affects architecture and the built environment?

The way we design influences not only the way the space looks now but also the way it performs. Design must follow principles of simplicity, being long lasting but must also be user friendly. This approach recognizes the importance of designing spaces that are not only visually appealing but also functional and conducive to the well-being of users. This way of design demands that we detach ourselves from the top down building design approach but rather design for occupants and consider their comfort as an equal part to the evaluating factor of building envelopes along with performance and energy efficiency. By incorporating user feedback and preferences into the design process, architects and designers can create spaces that better meet the needs and expectations of occupants.

The project bridges the gap between energy efficiency and user comfort. By demonstrating that user preferences and occupant comfort can be integrated into the design of building shading systems, the research highlights the importance of considering both energy performance and user satisfaction. This integration is crucial in the context of sustainable architecture and the transition towards net-zero energy buildings.