Smart living building

Living the Future

EPFL / Building 2050 Research Group
Thomas Jusselme
Didier Vuarnoz

Date
02 mars 2016

1 The challenges

The smart living lab brings together a **group of institutions** – the Ecole Polytechnique Fédérale de Lausanne (EPFL), the University of Fribourg (UNIFR) and the School of Engineering and Architecture of Fribourg (HEIA-FR) – actively involved in fundamental and applied research and social sciences. The goal of the smart living lab is to build an **internationally renowned** interdisciplinary competence center in the field of the built environment of the future. The focus of its research is described in the academic plan [1] and briefly explained in Figure 1 below:

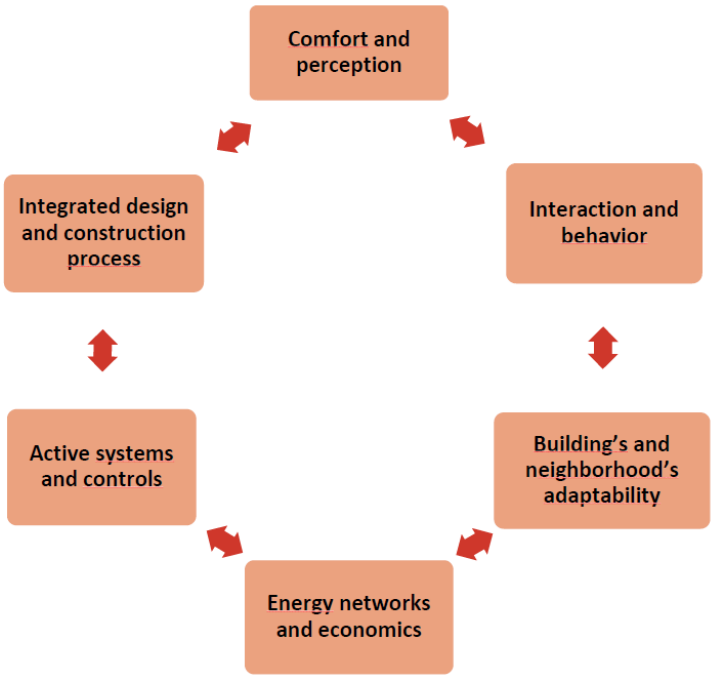

Figure 1: the smart living lab research areas [1]

Since 2016, the premises of the smart living lab are temporarily located in the Blue Hall on the blueFACTORY site, in Fribourg. In the future, the smart living lab will be housed in the **smart living building** which will be completed by 2020 on the same site. Given its research areas, the smart living building must be an example in terms of its life-cycle and environmental **performances**, as well as its **usability** (effectiveness, efficiency and satisfaction [4]) over time.

A two-year research program called « *smart living building research program* » has enabled the necessary knowledge in terms of objectives and solutions for the construction of this innovative building.

2 Architectural identity

While reaching its sustainability objectives, the building's architectural identity will have to be carefully designed in order to clearly reflect its **innovative** and **avant-garde** nature. Moreover, this identity will have to be maintained over time, in spite of the experimental and evolutionary character of the building.

This building will be a tool (living lab) intended for applying the academic plan of the smart living lab [1]. Beyond its experimental nature, the fact of being able to **live out its own research** will

make this building a unique, attractive place to develop the **international outreach** of the smart living lab.

The building will have to serve the values of the smart living lab in the first place [3], through the four clusters mentioned in Figure 2**Erreur ! Source du renvoi introuvable.**. The **outreach** cluster deals with the image and identity of the smart living lab. The **emulation** cluster relates to the gathering of the three institutions on a unique site. The **creativity** cluster implies the best possible conditions for knowledge generation. Finally, the **human ecology** cluster brings broadly summarizes the spirit of the work environment the smart living lab will offer.

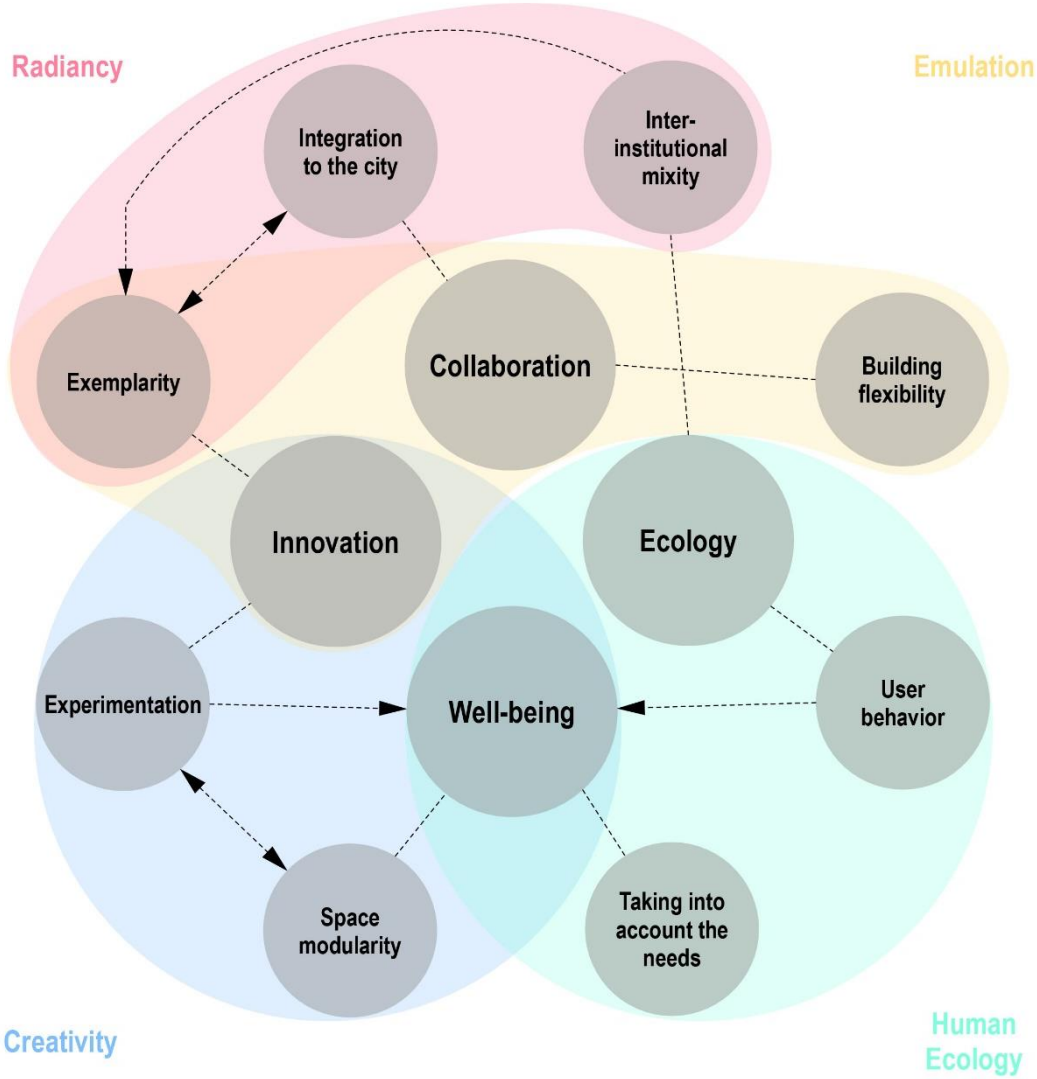

Figure 2: The four value clusters of the smart living lab [3]

As an iconic building on innovation, research and applied technologies, the smart living building will be open to different partners and professionals in the field, but will not be a public space.

The building's flexibility will be based on the *vital organs* concept [4] represented by the building components which are the major contributors to the expected performances (energy storage and production, building's envelope, etc.). **They will be staged** in order to assert the experimental identity of the building and allow their renewal.

3 Futur users

Even though the three partner institutions are characterized by a strong **interdisciplinarity**, their desire to stay independent and gain individual recognition on an international level is also strong. As stated on the report resulting from the social design approach [3]*: « It is also necessary that the design of the building, while encouraging mixing and collaboration, allows the three institutions to keep their identity. As a common space for academic collaboration, the smart living lab, should not, however, prevail over the three institutions »*.

The wealth of sociological studies that will be produced under the research program, will allow a deep understanding of the use and expectations of the future occupants of the building.

4 Features

4.1 Neighbourhood features

The smart living building will be built on the site of the former Cardinal brewery in Fribourg, which will be transformed into an innovation quarter called blueFACTORY, as planned by the Canton and the City of Fribourg [2]. Since they wish to obtain a « zero-carbon label» and to become known as an innovation quarter, blueFACTORY will have to offer many services to the occupants of the smart living lab. These services, in cooperation with the other inhabitants of the site, will have to respond to a certain level of excellence, and will include restaurants, mobility, sport and cultural facilities and the provision of infrastructure for conferences able to host around 300 people. These services should contribute to the attractiveness of the smart living lab. Easy access to the city and the integration of blueFACTORY to the local economic fabric is also expected.

4.2 Building features

The building will be a mixed architectural program consisting of offices, experimentation halls and housing.

The offices will house 80 to 90 researchers - 40 to 50 from the EPFL, 20 from HEIA-FR and 20 from UNI-FR [2]. The work spaces will be designed to foster creativity by providing both, intimate and common spaces. These spaces will provide the possibility of setting up offices of different sizes, meeting rooms and varied spaces encouraging either exchange or withdrawal [3].

An adjustable 1000m² surface for varied housing types will be designed to meet different research and market needs.

5 Flexibility

5.1 Flexibility of use

Flexibility, reinforced by the evolution of research activities, must be already integrated in the design stage. Over equipment will not be the appropriate answer in order to achieve this flexibility. It will have to be achieved by a better knowledge of its occupants, and by adapting the design and construction process according to the level of understating of these uses [4]. Technology obsolescence will have to be prevented as much as possible by making intemporal design choices. The building will allow the renewal of interiors encouraging creativity and synergy among the different parties involved [3].

5.2 Technological flexibility

The smart living building is meant to be both, the work place and the experimental tool for researchers, by providing them with the opportunity to not only test new technologies in real-life scale 1:1 but also test their interactions with the building's occupants. In order to do this, the

integration of future technologies will be facilitated through the 5 vital organs mentioned previously in paragraph 2. Likewise, the building operation conditions will describe more precisely the renewal conditions of its components.

5.3 Potential for extension

The project will have to offer the potential for extension (**of 50% at the beginning**) in order to plan the future growth of the smart living lab in the short or medium term. As a consequence, either some space will have to be adjoined to the building, or an oversized building will have to be partially occupied. Leaving this practical consideration behind, it's mainly the fact of pre-determining financial engineering aspects that will allow to carry out this extension.

6 Performance goals

The environmental performances of the smart living building will have to achieve at least the intermediate goals fixed by the **2000-Watt society for 2050**, i.e., 2 t CO_2eq/capita and 3500W/capita in the current climatic, technological, social and economic context. The greenhouse gas emissions indicators, the energy demand and the primary energy and its non-renewable share are the environmental impacts used for obtaining these goals. In order to emphasize its experimental, innovative and performant nature, these impacts will be quantified as **real occupancy conditions** throughout the building's **life-cycle**, from its implementation to its end-of-life as well as its operation and maintenance [4].

A smart, efficient management and a promotion of renewable resources will be combined with energy storage technologies leading to **the autonomy of the building** [4]. The goals of visual, thermal and acoustic comfort will be adapted according to the typology of use and will respect the objectives resulting from the scientific program [4].

The smart living building will house comfortable living and work spaces, as defined by the scientific program [4].

The building will have to respond to an **environmental certification** to be defined which will guarantee the general quality of issues not addressed on the specifications.

7 Construction means and methods

The result of the scientific work resulting from the research program smart living building [4] will be enhanced through the construction of the smart living lab. These results will be organized according to the following deliverables:

- An appropriate design and construction process will be proposed in order to ensure performance and flexibility. As a matter of fact, even the processes used during the design and construction of the building will have to be as innovative as the building itself in terms of governance, methods, iteration among actors, etc.
- A decision support tool to contribute to the integration of environmental performance criteria to the design process will be developed. Based on the sensitivity analysis, data mining and data visualization, this tool will be used by both the project owner and the contractor and will allow to show the different architectural and technological possibilities on a given performance grid, and to justify the proposed design choices. This will allow to encourage iterations among stakeholders from early design stages.

- Low environmental impact energies will be chosen. This energy concept will specify in particular the implementation of new photovoltaics and energy storage to improve the autonomy of the building, as well as a better correlation between the building energy demand and the access to low carbon energies.
- A façade concept combining low grey energy natural materials, using natural lighting and preventing glare, integrating solar panels and other technologies.
- An interior design concept focusing on the user comfort will be proposed.

References

[1] A-C. Cosandey. Smart living lab – Academic plan, 2015.

[2] Conseil d'Etat CE, Etat de Fribourg. Message 2014-DEE-22, 2014.

[3] T. Maeder, V. Kaufmann, L. Pattaroni, D. Christie, E. Ravalet, S. Munafò, V. Baranger. Smart living lab - démarche de design social, Rapport de synthèse et recommandations, 2015.

[4] T. Jusselme, A. Brambilla, E. Hoxha, Y. Jiang and D. Vuarnoz Building 2050 - Scientific concept and transition to the experimental phase, 2015.