

Personal control over indoor climate disentangled, Part 2



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Many non-residential buildings that were built or retrofitted in the last 20 years use a Building Automation System (BAS). BASs are installed to achieve efficient operated buildings and a reduction of their energy use and operating costs. At the same time BASs allow tight control of the indoor climate in line with requirements as defined in guidelines, standards and building decrees. But this tight control does not necessarily lead to higher occupant satisfaction or lower complaint rates. In Part 1* of this article, published in REHVA Journal in June 2017, we discussed importance of control, effects of control and mechanisms involved (Hellwig & Boerstra, 2017).

Keywords: Perceived Control, Occupant Behaviour, Indoor Environment Quality (IEQ), Integrated Design, Energy Efficiency, Smart Buildings, Building Automation System (BAS), Building Management System (BMS)

Introduction

In this follow-up article Part 2 we answered 10 frequently-asked-questions about control, as an addition to the first 10 questions answered already in Part 1. We explained more about the factors influencing personal control of the indoor climate and discussed the design implications. The examples presented mainly focus on control and control effects in office buildings. We conclude Part 2 with suggestions for the future indoor climate guidelines and some general thoughts on further control studies. The answers presented in this article are based upon our own research (as described in e.g. Boerstra, 2016, Hellwig, 2005 and Hellwig, 2015), the work of other researchers and the feedback from participants during workshops at the Clima 2013 conference and the Indoor Air 2016 conference (reported in: Boerstra & Simone, 2013 and Hellwig & Boerstra, 2016).

The 10 questions as answered in Part 1

- Q1:** What do we mean with personal control?
- Q2:** Is control over indoor climate really an issue for the modern office worker?
- Q3:** What are the main problems with control over indoor climate in existing buildings?
- Q4:** How does control over indoor climate affect comfort and satisfaction in offices?
- Q5:** Is there an impact of installation type?
- Q6:** How about the effect of control on Sick Building Symptoms?
- Q7:** How does control over indoor climate affect productivity?
- Q8:** How about sick leave effects?
- Q9:** What do we know about the mechanism involved?
- Q10:** How about the difference between available, exercised and perceived control?

* <https://www.rehva.eu/publications-and-resources/rehva-journal/2017/032017/personal-control-over-indoor-climate-disentangled-part-1.html>

Q11: What are the factors influencing the perceived level of control?

How the level of personal control is perceived (perceived control) depends on many factors. First: the access to wall thermostats, operable windows, fans and other controls and effectivity of these controls. Furthermore: a person's actual physiological state, his/her expectations and actual preferences, a person's personality and experiences, his/her beliefs how successfully he/she can cause changes, a person's competences or skills, knowledge of the building and its technical systems as well as success or failure in previous behavioural control actions in the actual or other buildings. Finally, it is important that a person can sense whether the actual control action exercised generally is successful (**Figure 1**, from Hellwig, 2015).

Q12: Is there an impact of building facade on the level of control?

Yes, there is. The building's facades design, insulation, thermal mass and the interrelation with the HVAC and BAS system drive a building's responsiveness under changing external and internal loads. More importantly, the responsiveness of the building towards a control action initiated by an occupant needs to be perceptible for the occupant. Otherwise the occupant may experience that his/her control action generally is not successful (Hellwig, 2015). On the other hand, traditionally heavy to medium thermal mass buildings with a low to moderate window-to-wall ratio equipped with operable windows and thermostats for heating only are often perceived as offering sufficient control

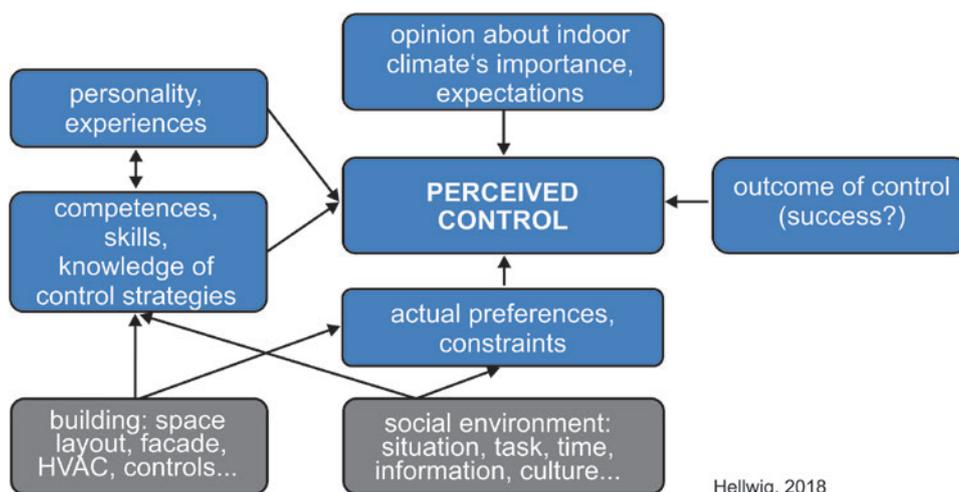
(see e.g. Boerstra, 2016). We assume that it is important to occupants that – based on the experiences from the past - they can (unconsciously) foresee a building's thermal behaviour. Predictability of thermal performance would be higher in the above described building type, compared to a highly glazed light-weight building immediately responding to changes in solar loads.

Q13: What are other constraints from the built environment?

One important example is space layout. An open-plan office tends to reduce the availability of the window access for the occupants, affects whether the windows are operable or not and determines the heating or cooling system for such space – most often via mechanical ventilation which normally provides less personal control but zonal control. Furthermore, the office plan layout can also result in constraints for the social environment (see next question). Constraints of the building could also be windows which can be opened only with a small gap of few centimetres or fixed thermostats which cannot be adjusted. In other word: all control opportunities which look as they could be adjusted but in fact they cannot, are likely to be perceived as a constraint.

Q14: What are constraints from the social environment?

A social constraint is, for instance when there is a need to negotiate with others before taking a control action, as in group or open-plan office layouts (Leaman &



Hellwig, 2018

Figure 1. Factors influencing the level of personal control perceived (condensed conceptual model of perceived control from Hellwig, 2015).

Bordass 1999). A social constraint is also when behavioural instructions are implemented by the company or the facility management. Think e.g. of organisation constraints in relation to the use of operable windows or restricted clothing protocols. These kinds of instructions ‘from above’ will reduce individual freedom to adjust one’s local indoor climate and hence limits the perceived level of control.

Q15: Is having more control options always better?

No, not necessarily. There is a finding called the jam paradox or paradox of choice (Iyengar & Lepper, 2000). Jam paradox refers to an experiment about jam buying decisions (choose from a collection of jars with different marmalades, with varying choice options) could also be applied to control in buildings (Hellwig, 2015). The experiment showed that generally speaking people enjoy extensive choice options. But when people have too many choice options this leads to information overload, i.e. too many distinctive features between the options, resulting in a stressful and demotivating situation because it’s so hard to evaluate variables when these become too abundant. Subsequently people take fewer choices and if they choose they will be more dissatisfied with the choices taken. Therefore, it is better to offer an appropriate amount of control options. In order words: too little choice options is a problem, but too many choice options is so too.

Q16: How about just putting a dummy thermostat on the wall?

Dummy thermostats are non-connected, fake temperature knobs that promise some level of control over the thermal environment but in fact are non-functional. Although often proposed when HVAC technicians are confronted with indoor climate problems, on the long term the introduction of dummy stats is one of the worst things to realise! Sooner or later, users will find out that their usage of the dummy control device does not have any effect. This can result firstly in a loss of confidence in their own capabilities or in a loss of trust in building systems or the facility manager. Users then may conclude that the building operates by chance or that the facility manager did not treat their complaints seriously. This will make them more critical of the functioning of the building (Hellwig, 2015). In Dutch offices it was found that effective personal control options in offices can decrease the amount of complaints when compared to none or ineffective personal control. If controls are ineffective, like

dummy controls, the potential for complaints can be even higher compared to the case with no control at all (Boerstra & Beuker, 2011).

Q17: When designing a new building or retrofitting an existing building, what measures should one take in order to boost personal control?

In both cases it pays off not to just provide in an HVAC system that has the right amount of heating, cooling and ventilation capacity but also to (re)design for adequate indoor climate adjustability. Depending upon the situation one can use low tech or high-tech controls. In case of a retrofitting project, it is advisable to find out what are the most liked (control) features in the old building and keep them in the new building. Think e.g. of existing operable windows. Also, finding out what controls the occupants miss in the old building and add them in the new building can help for higher satisfaction in the new building. In newly designed buildings one can decide to introduce more innovative control solutions like micro-climatisation systems (HVAC integrated in work tables and/or chairs). General strategies for high perceived control over indoor climate are: to reduce the number of persons sharing one office, to ensure the accessibility of control devices for the occupants, and to rely on user-friendly interfaces, and to aim for control over temperature, fresh air supply and lighting (**Figure 2**).

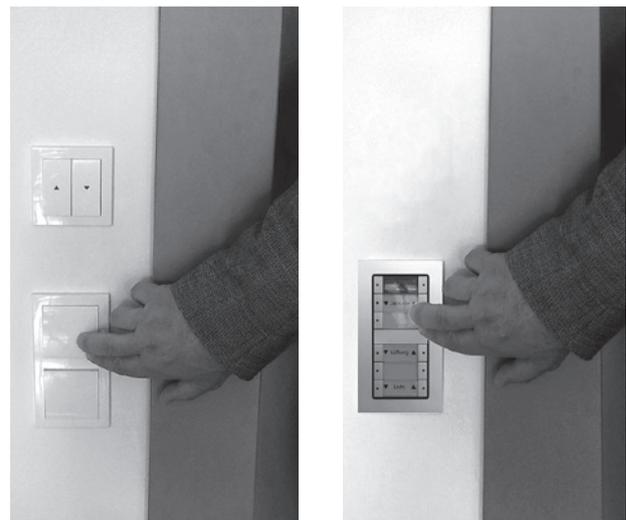


Figure 2. User-friendliness considers common routines of occupants or mounting requirements for new control devices; left: using a light switch when entering a room, right: a traditional mounting height as shown is inappropriate for new control devices (photos/montage: R.T.Hellwig).

Q18: Are there guidelines explaining how a good control device should be designed?

There is an excellent guide by Bordass, Leaman & Bunn (2007) on good design for controls for end-users and their implementation. There is also an international standard ISO 9241 on human-computer-interaction which describes principles of usability: effectiveness in solving a task or problem (successful task completion by users), efficiency in handling the system (task in time), and satisfaction of the user. Very useful additional information about controls and usability can also be found in Karjalainen, 2007.

Q19: What about expectation management in relation to controls and control effectiveness?

When new control-technologies are suggested for implementation, a building system designer has to explain why the new technology provides benefits. The person suggesting the new technology tends to be very enthusiastic about it (otherwise he/she wouldn't propose it). This enthusiastic attitude will raise the user expectation sometimes to the skies! But raised expectations could lead to disappointment later, even if the overall indoor climate has improved objectively. Therefore, it is important that the owner or user has realistic expectations which are consistent with the performance of the system after the building is commissioned. Furthermore, it is important for a building system designer not to discourage the prospective user from taking control actions. For overall satisfaction it is supportive if an occupant feels responsible for the indoor climate at his workplaces to a certain degree. Otherwise, the occupant has to rely too much on a building's autonomic behaviour or changes to be implemented by the facility manager.

Q20: What are suggestions for future work and needs?

Providing the indoor climate exactly according to the standards is probably not enough. As one and the same person might have different needs at different times due to day to day or hour to hour differences in tasks, metabolism, season, actual or previous activity, mood, health status, personal control opportunities are a key element for the future buildings. We see the need for design guides on personal control in indoor environments for planners and we see a need to expand the scope of the standards which so far aim at thermal comfort by incorporating the objective of providing appropriate effective controls. We also see that advanced knowledge

on constraints and on effectiveness of control actions is required. Furthermore, we still lack sufficient knowledge on what would be an appropriate and sufficient amount of personal control in different contexts. ■

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