Development of a Representation Technique

THROUGH A FILMIC AND SENSORY APPROACH

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This research proposes to support the reading of physical ambiences by the development of a representational technique which compiles, in a numerical interface, two types of data: sensory and filmic. These data are recorded through the use of a portable array equipped with sensors (Potvin 1997, 2002, 2004) as well as the acquisition of Video information of the moving environment. The compilation of information is carried out through a multi-media approach, by means of a program converting the environmental data into dynamic diagrams, as well as the creation of an interactive interface allowing a possible diffusion on the Web. This technique, named APMAP/Video, makes it possible to read out simultaneously spatial and environmental diversity. It is demonstrated through surveys taken at various seasons and time of the day at the new *Caisse de dépôt et de placement* headquarters in Montreal which is also the corpus for a SSHRC (Social Sciences and Humanities Research Council) research grant on Environmental Adaptability in Architecture (Potvin et al. 2003-2007). This case study shows that the technique can prove of great relevance for POEs (Post Occupancy Evaluation) as well as for assistance in a new design project.

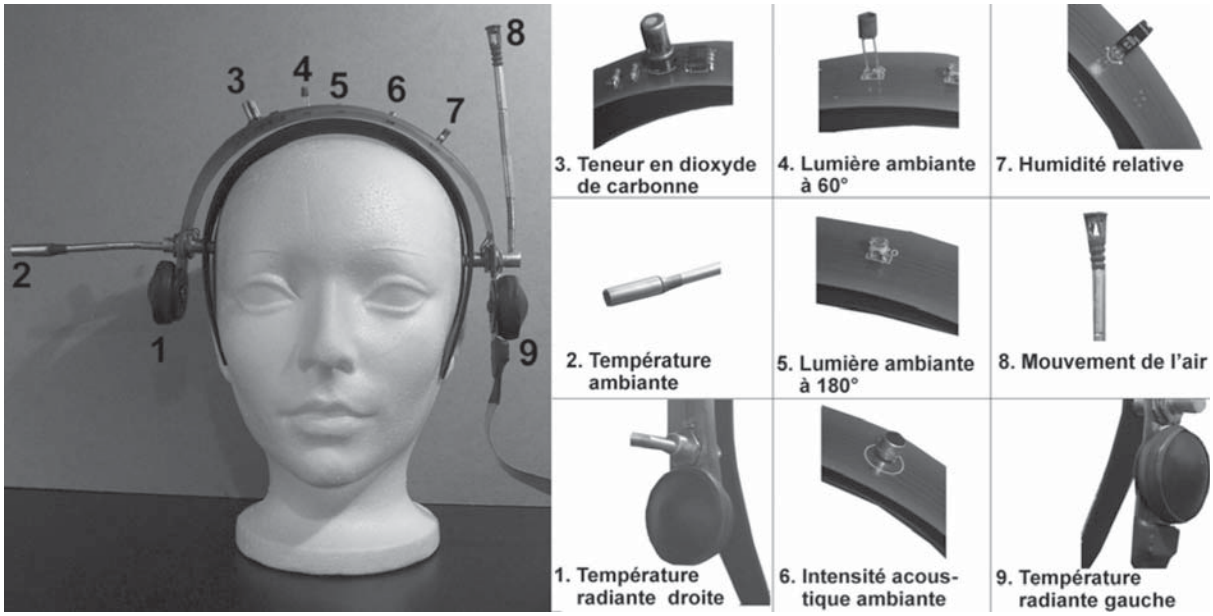

FIGURE 1 PAMPA IV and its nine probes recording environmental data

1. INTRODUCTION

1.1 PHYSICAL AMBIENCES REPRESENTATION

The various media of representation available to the architect today remain generally limited to the physical environment of a place. The visualization of the environment of a building with a plan, a section, or a perspective, is a process that often challenges the imagination of the observer. These modes of representation do not generally indicate the objective, or the quantitative values that make up the quality of a particular environment. Since the end of the Renaissance, the hegemony of the visual in architectural production became has been decisive and by heavily influencing the design of built spaces, has lasted until our days (Augoyard 1998). Space is primarily thought-of today in its visual form at the design stage, neglecting most of the time its other components: thermal, acoustic, and olfactory ambiences. Therefore, the environments of our buildings today are increasingly generated by the inception image; the objective being to have an instantaneous visual impact (Pallasmaa 1996). The representation of space also omits the expression of it as experienced in time. The traditional modes of architectural representation are indeed very limited to illustrate the spatial and temporal dimensions. According to Tchumi, these modes suggest a certain design of architecture and its use which reduces it to mere objects where the spaces are petrified for eternity in an inalterable unit (Scoffier 1994). Architecture and its representation has evolved therefore in a purely visual, static ideological order independent from time and space. This tendency influences its diffusion, which is also primarily visual. The integration of physical ambiences in the architectural design process is often neglected since it is not easily manageable by the architect who generally does not have the necessary tools of representation.

1.2 RESEARCH OBJECTIVES

The objective of this research is to develop a representation technique to promote a better comprehension of physical ambiences from a sensory and perceptual point of view in the environmental apprehension of a space. It proposes to reveal the relation between the climatic, architectural, and human components, in a dynamic technique of representation, gathering all the sensory components of the physical environment that interact in space and time. The approach proposes to exploit currently available representation media such as video, data processing, and multi-media tools to devise the technique. This technique should be readily accessible to any users willing to carry out a dynamic representation of any type of surveys.

2. METHODOLOGY

2.1 DEVELOPMENT CRITERIA

The act of representing the physical ambience of a place in space and time is a difficult task, since an ambience by definition comes about in the gathering and interaction of a multitude of complex elements. In order to gather all dimensions, it is paramount to understand

FIGURE 2 Two surveyors and their portable equipment

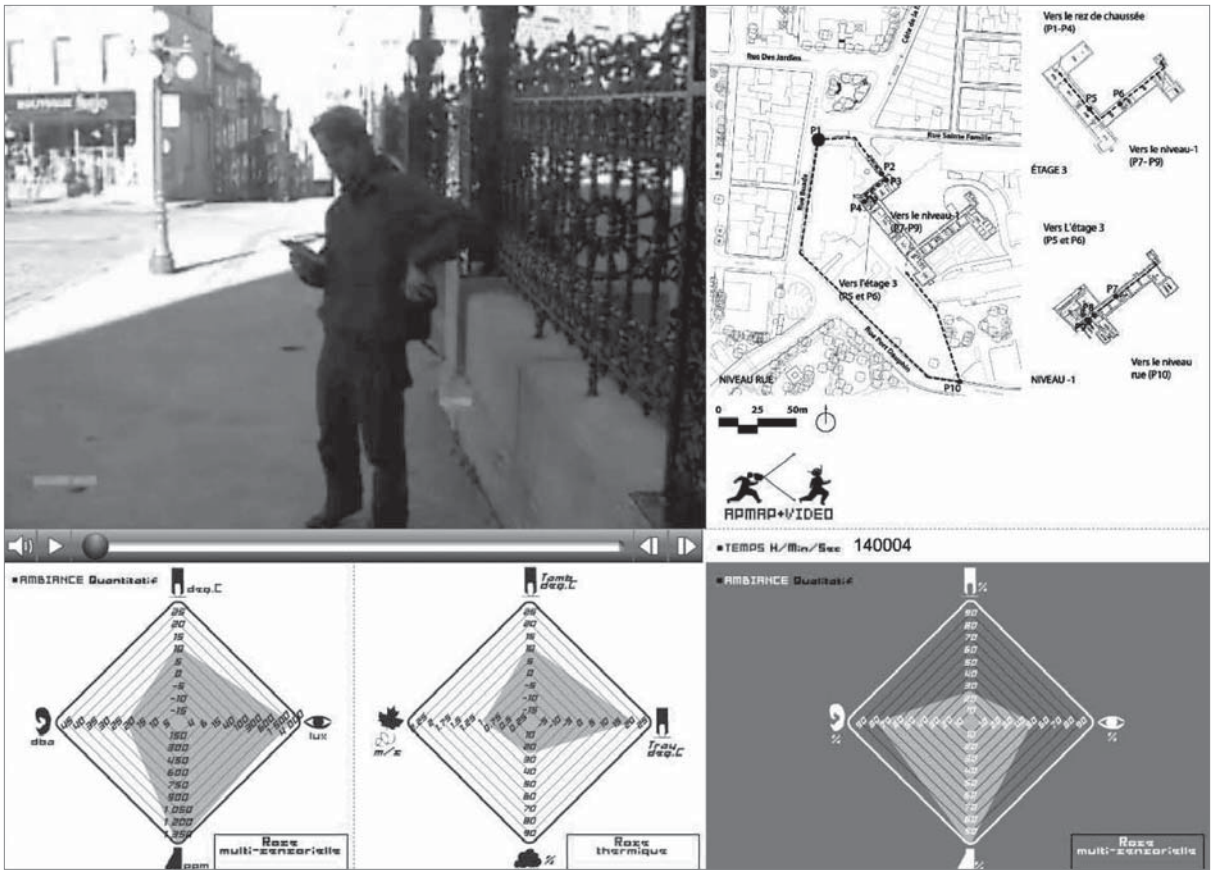

FIGURE 3 The interface of APMAP/video representation technique

what is a physical ambience, and what can be surveyed, in other words what can one effectively measure and represent? According to Augoyard an environment is a perceptive globality gathering the objective elements represented such as an atmosphere, a climate, a physical, and a human environment(Augoyard 1998). It may also refer to technical devices related to the built forms. Measuring and representing the physical ambiences of a place is therefore to reveal the multiple perceptions that its physical form generates in space and time. An architectural and urban environment results from several factors in interactions. Follut and Groleau, determine three of them: the specific built form generating the specific conditions of environments (thermal, olfactory, acoustic and visual), the variety of the specific urban factors (wind, temperature, sun exposure, acoustic propagation, dispersion of pollution), and finally the human being which determines the reception of the ambience(Follut and Groleau 2000). The concept of ambiance therefore relates to the representation of the

environment, the impact of the physical parameters on the built form (the built form acting like a filter of these parameters), and the way in which the user perceives these phenomena through multi-sensory perception. One can thus consider the particular ambience in the representation of the diversity of these sensory phenomena in interaction.

The ambience, therefore, has a profile in its particular «geometry,» a typology which makes it possible to compare it with other ambiences in time (at various moments of the day for example), and in space (of the places or a sequence of different places). Siret and Wolonszyn refer to «the ambient object»(Siret and Wolonszyn 1998). This object would be defined as a point indexed by a place, a temporal occurrence and a particular situation. Three transverse characters come to determine environment in its statement: the dimension of the ambient object (the report/ratio of scale of the interaction between space), its temporality (the interactions during the time of perception of the ambience), and finally the value of the ambience (the extent of the change that the interaction creates in the space of perception). Research on architectural and urban ambiences generally consider these three factors. The good comprehension of a physical ambience during a survey must therefore take these three factors into account for its effective measurement and representation:

- relation between the built and perceived form,
- space/time dynamics, and
- value of environment.

2.2 APPROACH AND TOOLS

The developed APMAP/video technique proposes to consider all these factors for the realization of a survey method and the dynamic representation of the physical ambiences. Starting from a spatial sequence simulating the movements of a pedestrian, the technique aims at putting in parallel:

- the recording of the environmental data through a PAMPA (Portable Array for the Measurement of Physical Ambiences) (Potvin 1997, 2001, 2004) (Figure 1);
- the representation of that dynamic space movement through a numerical video camera; and finally,
- the environmental satisfaction of the user through a subjective evaluation of physical ambiences at various strategic points in the survey sequence.

The representation technique is carried out by associating two approaches:

- the sensory approach, with the quantitative surveys of each stimulus during a sequence as well as the qualitative evaluation (perception) of the user; and
- the filmic approach, with the visual data acquisition of the spatial sequence.

The simultaneous treatment of these two types of data (filmic and sensory) will establish a direct comparison in space and the way in which it can be felt through a mode of dynamic representation.

2.3 TECHNIQUE DEVELOPMENT

The realization of the technique is carried out in four phases:

- The choice of the location of the place and the sequence to be surveyed so that the space and time of the surveys are the most representative in terms of ambiences. Location makes it possible to identify the sites to be surveyed, the sequences carried out in this site, the stops within this course necessary to the evaluation of environmental satisfaction, as well as the moments when the readings will be taken (at various seasons, at various moments of the day, etc).
- The survey or *in situ* data acquisition consists of recording simultaneously the environmental data (quantitative surveys with PAMPAs portable array and the qualitative data with the evaluation of comfort perception), as well as the spatial and human components of the sequence (audio-visual data acquisition with a numerical Video camera). Surveyors are equipped with a numerical video camera, a PAMPA array, and a notebook to evaluate the environmental satisfaction (Figure 2).
- Data processing through a custom program developed with Wolfram Mathematica 5 software. This allows the automation of numerous elaborate mathematical operations by the computer. Mathematica uses symbolic expression which allows a graphic representation of mathematics and other structures (Wolfram 1992). Environmental data are interpreted in dynamic ambience diagrams and animated in time, thus illustrating environmental variations of the surveyed sequence. This dynamic representation mode can then be superimposed on the video image to associate these environmental data with the spatial data.
- The representation consists of the superposition of the environmental and video data through a custom interface built with Flash MX Macromedia. Image files are optimized by generating vectorial graphic images that are much lighter than the bitmap images from the camera (Underdahl 2002). The interface keeps an excellent resolution quality while limiting the weight of the file.

The interface makes it possible to obtain the simultaneous readings of the information relating to a par-

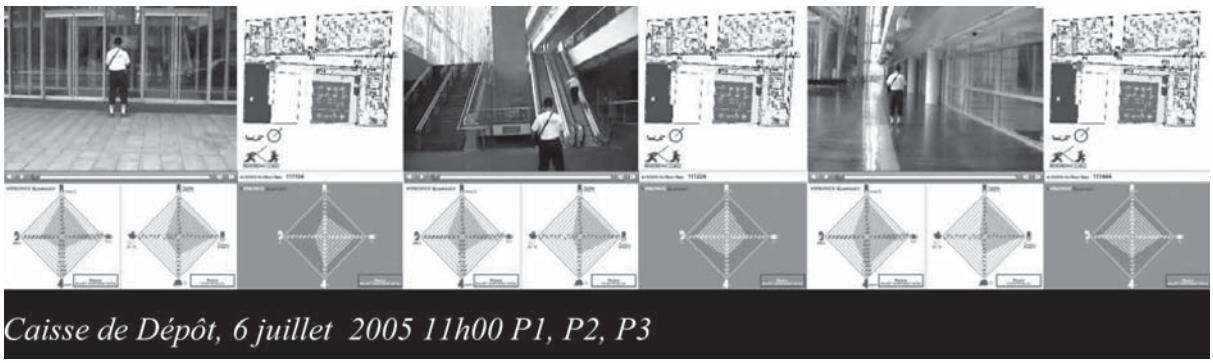

FIGURE 4 Single display showing an occupant's environmental history in space and time

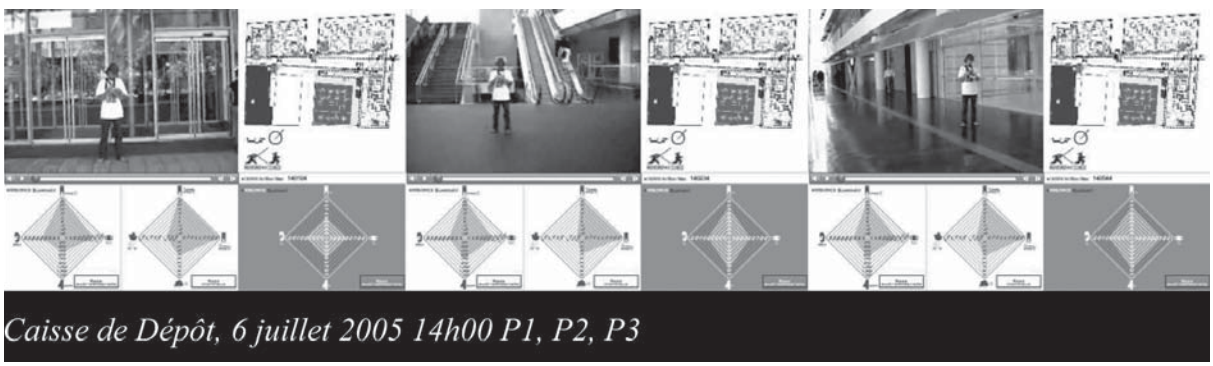

FIGURE 5 Simultaneous visualizations of the APMAP/video method: same sequence at various hours

FIGURE 6 Simultaneous visualizations of the APMAP/video method: same sequence at various seasons

ticular sequence through three types of representation (Figure 3):

- moving image in space with the video,
- position of the surveyors in the sequence, and
- diagrams of the dynamic environmental data.

Diagrams sub-divides into three so-called ambiences roses:

- a multi sensory rose indicating the ambient temperature (oC), the level of horizontal illuminance (Lux), the carbon dioxide concentration (ppm CO2), as well as the acoustic intensity (dB(A));
- a thermal rose, gathering specific thermal comfort parameters such as ambient temperature(oC), radiant temperature (oC), relative humidity (%), as well as the air movement (m/s); and
- an environmental satisfaction rose, indicating the thermal, visual, olfactory, and acoustic evaluation from the user (0=extremely disagreeable to 100=extremely agreeable).

3. CASE STUDY

3.1 CONTEXT

The APMAP/video technique is demonstrated in a case study carried out in the new *Caisse de dépot et de placement du Québec* building in Montreal. This office building located in Montreal city centre was conceived by a broad consortium of architects (Daoust, Lestage Architects and urban design, Faucher, Aubertin, Brodeur, Gauthier architects, and Lemay architects) and shows great environmental innovations such as the first double façade in a severely cold climate. The development of the APMAP/video technique is part of a *SSHRC(Social Sciences and Humanities Research Council)* research grant on Environmental Adaptability in Architecture (Potvin et al. 2003-2007). This research aims at determining, by means of multiple in situ surveys, the relativity of environmental comfort in a multi sensory approach that integrates the user-adaptive opportunities in terms of adjustment and movements through spaces of different environmental conditions (Potvin et al. 2004). Two types of surveys are carried out in this research program. Transverse surveys look at the collection of static environmental data in pre identified offices whereas longitudinal surveys look at dynamic movements of the users throughout the buildings. The APMAP/video technique was used for the longitudinal surveys according to the four stages of development: location, statement, processing data, and representation. The surveys took place during two seasons, Spring (May 4th and 11th) and Summer (July 6th and 13th). Two sequences were carried out during each day, one at 11h00 and the other at 14h00.

3.2 DATA PRESENTATION

The interface developed for the APMAP/Video technique allows for a great ease of interaction. Single longitudinal or simultaneously focused displays can be easily

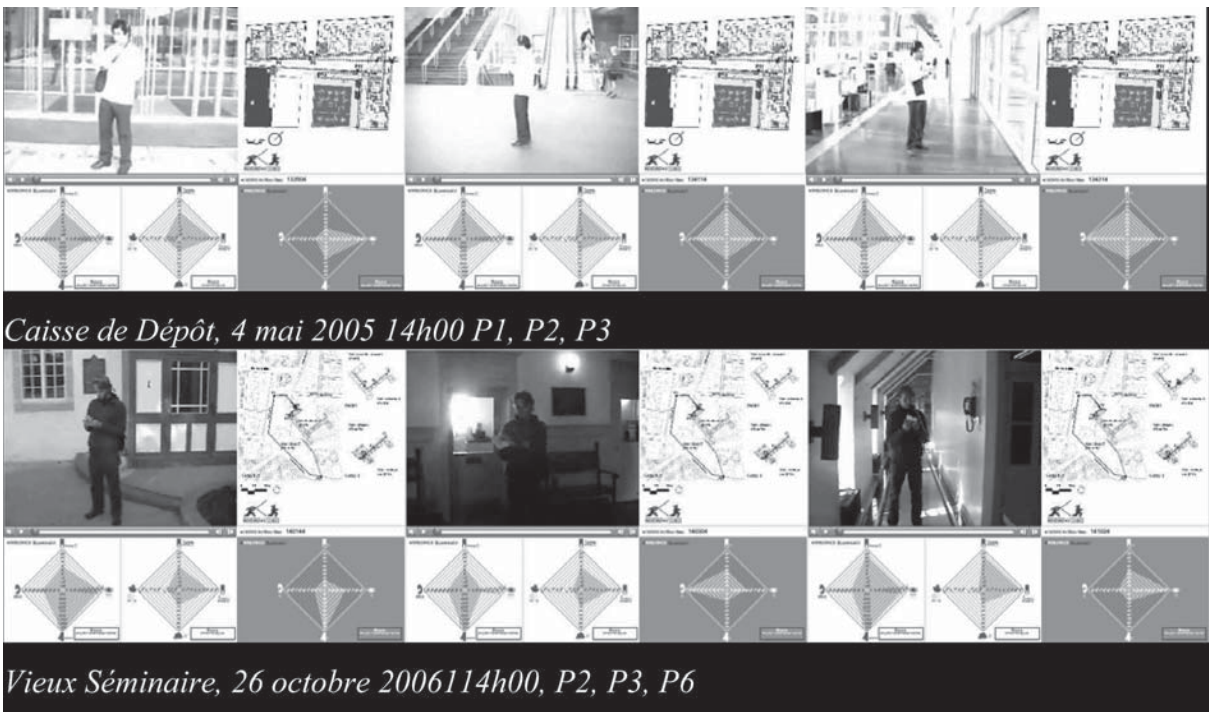

FIGURE 7 Simultaneous visualizations of the APMAP/video method: similar sequences in different buildings

performed depending on the nature of the investigation. Figure 4 shows a typical longitudinal display where the position of the observer and his/her environmental exposure are represented dynamically for an entire survey.

It is also possible for the user to open several files at the same time making simultaneous visualization possible and allowing the comparison of various more focused sequences of surveys. At any moment during a sequence, an analysis of the physical environment is readily available through the quantitative and qualitative ambience roses. Several possibilities of visualization are possible:

- The same sequence at various hours (Figure 5): Although the two sequences took place at a three-hour interval (for reasons of accessibility and safety), the sequences show interesting results. Figure 5 illustrates the increase in outdoor ambient and radiant temperatures and the decrease of outdoor relative humidity and carbon dioxide levels from the morning to the afternoon in the summer surveys. However, the indoor environment remains stable. These daily outdoor environmental variations affect the indoor/outdoor transitions and the environmental satisfaction of the users.
- The same sequence at various seasons (Figure 6): The simultaneous display of two sequences highlights the way in which environmental conditions evolve from one season to another. The sequences from May 4, 2005 at 14h00, and from July 6, 2005 at 14h00 illustrate a significant 150C outdoor thermal increase and a much higher light level in the summer season than spring. These results suggest that major seasonal shifts in thermal and visual transitions between the interior and the exterior may affect the environmental satisfaction of the users.
- A similar sequence for different buildings (Figure 7): the sequence realized at the *Caisse de depôt et de placement* building are compared with a sequence carried out in similar spaces of a historic building, the *Vieux-Séminaire de Québec.* Such comparisons allow for a clear understanding of the impact of construction techniques (modern curtain wall system with high transparency versus ancient gravity walls with minimal transparency) on environmental conditions. The two sequences show that the environmental conditions remain relatively uniform through the CDP building in comparison with the highly variable environment of the *Vieux-Séminaire* building. The historic construction techniques appears to deliver much higher environmental diversity than modern construction techniques.

4. CONCLUSION

The representation technique developed in this research opens new horizons for possible applications in architecture. The multiple means implemented in this research aimed at developing, through multi-media tools, a mode of representation which supports a better comprehension of the complexity of physical ambiences. The APMAP/video technique makes it possible to visualize the relation between the climatic, spatial, and human components of a space. This approach, based on the increased reality principle, makes it possible to enrich visual information, by the superimposition of quantitative and qualitative environmental data. Dynamic representation tools, widely accessible today, make it possible to express visually the complex apprehension of a place, through space and time. The temporal value of an ambience is therefore considered, including the moving perspective, the spatial information, and the subtle environmental transitions, gathered by the APMAP array. Finally, the APMAP/video representation technique belongs to a clear interdisciplinary approach where all dimensions of environment: quantitative, qualitative, physical, and human, are gathered in a single dynamic reading. The Macromedia Flash MX interface of the APMAP/video representation technique can be easily integrated on a Website, in order to facilitate its transfer and to allow a better diffusion of environmental knowledge. Light file size also allows for simultaneously displays on a large screen with optimal resolution quality (vectorial format of the diagrams).

The APMAP/Video representation technique allows multiple applications from the post-occupancy evaluation to the early inception of a design project. Each survey could be classified to build a complete ambience typology according to their thermal, visual, sound, and olfactory conditions. The technique being dynamic, it allows for the integration of the adaptive theory in the realm of environmental comfort and could be a major tool for post-occupancy evaluations. Successful sequences could be stored in a bank of ambiences that could become learning tools for designers and act as inductive ambiences for new designs.

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