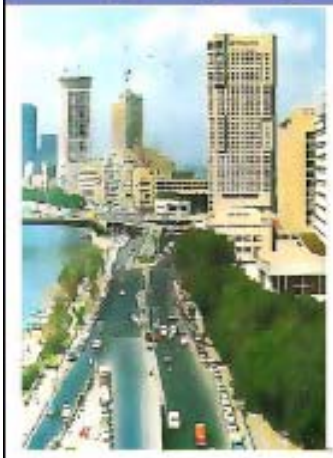
A R C H C A I R O 2 0 0 6



Department of Architecture
Faculty of Engineering - Cairo University
3rd International Conference
ARCHCAIRO 2006

APPROPRIATING ARCHITECTURE TAMING URBANISM IN THE DECADES OF TRANSFORMATION

Under the Auspices of

Prof. Dr. Aly Abdel Rahman Youssef

President, Cairo University

Grand Hyatt-Cairo Egypt
February 21-23, 2006

The use of the terms/conceptions of "Appropriate" and the underlying action "appropriating" in the realms of architecture planning and development in the sixties and seventies of the twentieth century was closely related to technology transfer. The critics questioned the validity of the notion and pointed out the shortcomings of exporting technology, tools and products to developing communities without regard to its settings, natural and manmade its ability to assimilate or benefit from. The criticism was accompanied by a positive drive calling for "Appropriate Technology", hence advocating a conscious appropriating action directed to technology: tools, process and products to suit the targeted settings/context and communities.

The controversy regarding technology transfer relatively subsided since, but the essence of the emerging conception of seeking the appropriate and appropriating the tools, processes and products continued with the evolving new directions and movements of: Post Modernism, Contextuality, Conservation and, Adaptive Reuse, Sustainability and the rest. All acknowledging, respecting, and adhering to design, planning, and development contexts; identity and features.

Appropriating design and development endeavours, its intellectual/mental framework, tools and products is becoming a challenge and an urgent need/requirement during the last two decades characterized by open doors & skies, and the free flow of information, thoughts, technology and products.

In other words "Appropriating" or addressing and manipulating of conceptions, tools and products is becoming synonymous to the ability to interact, to evaluate, read, analyze, criticize, experiment and develop; this applies to all civilizations' products including: schools, directions, and theories of architecture, planning processes and building technology, effective development control & practice and conservation of resources (natural and manmade)

From this perspective "Appropriating" architecture and urbanism is a responsibility, both the Developed and Developing communities have to undertake, as it reflects on the various aspects of its development and interaction including: building/architecture technology, identity and character, management and planning, development and conservation of resources. It also means setting and definition of references and values, evaluation criteria; all are crucial factors and challenging tasks deeply rooted in architectural and community design processes both in the academic and professional arenas.

This conference invites scholars, researchers, and professionals in the realms of: Architecture, Building Science and Technology, Environmental Design and Conservation, Community and Urban Design, Housing and Urban Planning and Management and related areas to address the to address the said issues of Appropriating Architecture and Urbanism in the past and current decades and to participate and contribute to the forthcoming discourse in one or more of the conference t themes.

Conference Themes:

- Appropriate and Appropriating architecture for existing and new settings/communities.
- Architectural criticism: appropriating current and emerging architectural and planning streams of thoughts and theory.
- Environmental systems: appropriating buildings, components and settings.
- Building technology tools and techniques, appropriate and appropriating.
- Community and Urban Design, contextuality and appropriate approaches, references, criteria and determinants.
- Appropriating planning management and development of urban settings and resources.

Additional Events:

- Architecture and products of the younger architects: 1988-2001
- The 3rd student competition.
- Architectural and art book fair.
- The construction industry exhibition.
- Architectural and Engineering design support center, selected work

DEADLINES:

Call for papers	April 15, 2005
Abstract deadline	June 15, 2005
Notification of acceptance (abstracts)	September 15, 2005
Final paper submission	October 30, 2005
Notification of acceptance (papers)	November 15, 2005
Registration	November 30, 2005
Conference	February 21-23, 2006

FEES

	Prior to 30/11/2005	After 30/11/2005
Individuals	EGP 350/100$	EGP 400/150$
Group (of 5 persons)	EGP 1400/450$	EGP 1600/550$
Graduate Students	EGP 100/50$	EGP 150/75$

Conference Directors:

Dr. Sayed M. Eltouney, Dr. Nasamat Abdel-Kade

Scientific Committee:

Prof. Colin Davidson	University of Montreal, Canada
Prof. Dr. Oktay Ural	Florida International University, USA
Prof. Dr. Nezar Alsayyad	University of Berkeley at California, USA
Prof. Dr. Mourad Abdel-Kader	Ein Shams University, Egypt
Prof. Dr. M. Tawfik Abdel-Gawad	Helwan University, Egypt
Prof. Dr. Mohsen Bayad	Alexandria University, Egypt
Prof. Dr. Zakia Shafie	Cairo University, Egypt
Prof. Dr. Nasamat Abdel-Kader	Cairo University, Egypt
Prof. Dr. Sayed Eltouney	Cairo University, Egypt

Conference Coordinator:

Dr. Hesham Khairy

Organizing Committee:

Dr. Basil Kamel	Dr. Raghad Mofeed
Dr. Emad El-Sherbini	Dr. Shereen Wahba
Dr. Ayman Hassan	Dr. Ahmed Amin
Dr. Mohamed Hilay	

CONFERENCE LANGUAGE: English & Arabic

The abstract is not to exceed 150 words, it is required to mention the sub-themes related to the subject. The final paper is presented on 6-8 A4 pages (single spacing, font size 11 TNR, left and right margins 2.5 cm, top and bottom margins 3.00 cm).

Conference Mailing Address: Department of Architecture, Faculty of Engineering, Cairo University. Tel: 00202 7791078, Fax: 00202 572 8067
email: info@archcairo.org, Abstracts: abstracts@archcairo.org, Papers: papers@archcairo.org, website: www.archcairo.org

Tamer Gado *BSc. Dip. MSc. Head and Lecture of Environmental Design of Buildings, School of Architecture, University of Dundee*
t.gado@dundee.ac.uk
Mady Mohamed *BSc. MSc. PhD student, School of Architecture, University of Dundee*
m.a.a.mohamed@dundee.ac.uk

APPLICATION OF COMPUTER BASED ENVIRONMENTAL ASSESSMENT AND OPTIMIZATION TOOLS: AN APPROACH FOR APPROPRIATING BUILDINGS

ABSTRACT

The main aim of this paper is to devise a research methodology that employs computer based environmental assessment tools, to be used to quantify the effectiveness of passive measures. The use of computer allows the visualization of the unseen environmental attributes in a three dimensional interface, permitting by such more effective understanding of the issues involved in the quantification process. This will also open up this methodology for use by researchers from different professional backgrounds. It also could prove very useful in the identification of the most efficient solutions to the upgrading of the environmental performance of existing buildings. The results of work appertaining to the proposed methodological approach are presented.

1. Introduction

The main aim of this paper is to set out a methodology that can be applied to test the effectiveness of passive measures in buildings during design process or in research projects on designs and existing building. This paper does not claim that this methodology is the sole method to be used to design passive climatic responsive architecture.

However, it can form the general framework to any investigation that aims to design an environmental building or passively improve the environmental performance of already built buildings. The proposed methodology have been developed over time by the first author [1-3] and is intended to be employed in an ongoing research project at Dundee School of Architecture that investigates the environmental performance of governmental primary schools in Egypt [3] focusing on thermal and visual comfort inside classrooms.

2. Research problem

The process of investigating the effectiveness of any environmental design control measure whither passive or active is very complicated. The number of issues related with such investigation is immense, interlinked and overlapped. The following list is an example of the tasks involved in such investigation.

1. Choosing the case study to be employed as a vehicle to test the effectiveness of the measures under investigation
2. Identifying of the environmental problems
3. Setting out the assessment criteria
4. Analyzing the climatic context including; obtaining, designing, modifying, analyzing and visualizing the climatic data
5. Identifying promising passive strategies and measures
6. Quantifying the effectiveness of the proposed passive strategies and measures
7. Results analysis and presentation

In addition, this process involves the use of large number of research tools including; computer analysis tools, manual calculation, interviews, questionnaires, physical modelling etc... The main problem is that the process is usually overwhelmed by time and manpower constrains as well as the financial limitations of any investigation. On the other hand, nothing was found in the literature that sets out a framework for a methodology that can be employed to quantify the effectiveness of passive design measures. A gap in the knowledge was identified which this paper tries to fill by devising a methodology and discussing the main issues involved.

However, the issues involved in the choice of the case study are much dependent on the circumstance of the research project as illustrated in the following examples.

Gado [2] chose to investigate the environmental performance of housing developments in Egypt due to the high demand to cope with the population growth. The author chose a design built by the government not considered to be climatically responsive as it is being repeatedly built in several locations of the country without considering the effect of climate on the internal environments. The case study was chosen from one of the new cities where all the new developments are taking place. A walk-up housing block prototype was investigated as it is the type widely built in Egypt.

Gado et. el. [3] in a recent study investigated the environmental performance of classrooms of primary schools in Egypt. Primary schools was chosen since they represent 44% of all the government schools in the country [4]. The governmental schools have been chosen over private schools since they represent 89% of the total number of schools in Egypt. Three prototypes representing 80% of all primary schools have been elected for the investigation. All the case studies have been chosen from El-Minya governorate that represents the desert climatic region of Egypt; the biggest region in the country. Eighteen case studies in seven towns out of nine were chosen; twelve were built in rural contexts (villages) and six were built in urban areas (cities). This was done to insure that the effect of the microclimate is taken in consideration.

From the above two examples it can be seen that the criteria governing the choice of the case study can be grouped under the following:

1. Demand for the building type
2. Significance of the location
3. Building technology and buildability
4. Climate of the region
5. Context of the case study
6. Microclimate of the site
7. Accessibility to the case studies

3. The proposed methodology

The proposed methodology (refer to Figure 1) is based on the simple known notation of architectural design; target identification, context analysis and design formulation and assessment. It includes three main studies; field study, theoretical study and computer based study. ***The field study*** includes two stages i) choosing an appropriate and representative case study to the research project ii) identifying the environmental problems related to the case study location and building type. ***The theoretical study*** includes two stages i) identifying the environmental design targets ii) formulating potential passive strategies and measures that can be applied to the case study. ***The computer based study*** includes two main stages i) climatic context analysis ii) computer simulation.

4. Field study

The field study is the starting point in the proposed methodology. It begins by choosing a case study. This is essential to achieve the main aim of the investigation as a vehicle is needed to test the effectiveness of the proposed passive measures for a particular building type in a particular location. This is followed by identifying the main environmental problems in terms of thermal comfort and energy performance. This is done through monitoring the subjective response of the case study's occupants using the appropriate tool such as interviews, questionnaires, observation etc. and through measuring the objective response of the interiors using monitoring equipments.

4.1. Choosing case studies

One of the most paramount and critical factor that makes a successful environmental design research project is the proper selection of the case study. Unfortunately, there is no one single definite criteria that govern this process. Choosing a case study includes specifying the building type (schools, housing development etc…), the location of the case study (effect of the microclimate and context of the case study under investigation) and finally specifying the number of cases to be investigated (effect of the sample size on the reliability of the results).

respondents in his sample where men biasing by such his results. In another case Gado et el. [3] interviewed school occupants in 18 different schools. It was not possible to balance the number of females to males and only 29% of the sample was females. This was inevitable due to the low rate of female attendance.

5. Theoretical study

The theoretical study aims to set out the environmental design targets to be used latter to assess the performance of the case study's spaces. It also aims to formulate the potential passive strategies and measures that can be used to enhance the environmental performance of the case study under investigation.

5.1. Environmental design targets identification

This methodology employs thermal comfort and energy efficiency as environmental design targets. The effectiveness of the proposed measures is determined according to its ability to passively achieve thermal comfort by using minimum amount of energy possible.

This methodology uses two ways to identify the environmental design targets i) through environmental design codes ii) through analysing the climatic context. Environmental design codes such as CIBSE environmental design guide A [8] sets out environmental design targets for the United Kingdom. For other locations the relevant codes should be consulted and if not found or one is in doubt, design targets should be identified by other means. Several empirical and analytical approaches were employed through the last decade to develop indices capable of predicting thermal comfort through analysing the climatic data. Field survey is an example of empirical studies where the physical characteristics of the environment are related to the subject's thermal sensation in order to find a relationship. Humphreys adaptive thermal model is an example of models devised empirically. On the other hand, analytical approaches are based on experiments made in controlled environments to assess thermal sensation of individuals. Fanger's Predicted Mean Vote (PMV) and Gagge's Standard Effective Temperature (SET) used by the American Society of Heating,

4.2. Identifying the environmental problems

Methods of identifying environmental problems within case studies can be classified under two categories; measuring the occupants' subjective response and measuring the objective response of the built environments. The proposed methodology suggests that measuring the subjective response should be the first step towards identifying the environmental problems. Any attempt to measure the occupant's subjective response and/or the objective response of the environments is faced by lots of obstacles. Measuring the subjective response of the occupants involves data collection, sampling and timing of the survey.

Data collection - There are different methods of data collection. Interviews, questionnaires and observation are the common methods for collecting data from buildings' occupants. Every method has different aims and is based on a different principle. Interviews are more time consuming and require more skills. However, it is very flexible and suitable for gathering information about people's opinions and motivations [5]. On the other hand, it is more suitable to use it with small samples while questionnaires are more suitable to be used with larger samples.

Sampling - In most cases, it is not possible due to time and expenses limitations to test the whole population within a single case study. Consequently, the data have to be obtained from a sample that represents the whole population of the case study. The quality of a peace of research not only stands or falls by the appropriateness of methodology and instrumentation, but also by the suitability of the sampling strategy that is adopted. There are two main methods of sampling; random sampling and a purposive sampling [6]. The main difference between these two methods is that, in the first every one in the population has the chance to be included into the sampling, however in the second the researcher has purposely selected a particular section of the wider population to include in or exclude from the sample. However, it is not possible in all cases to randomly choose the respondents in the sample. For example Al-Shibami [7] used questionnaires to collect data about the thermal conditions from 342 occupants living inside 300 houses on the same day. However, due to cultural restrict in the Yemeni community all the

Refrigerating and Air-Conditioning Engineers are good examples of the analytical approaches.

5.2. Formulating potential passive strategies and measures

The proposed methodology uses three methods to formulate potential passive strategies and measures that can be applied to the case study to improve its environmental performance. The first is part of the theoretical study and the second two are parts of the computer-based study.

Analytical investigation into methods of dealing with climatic used by vernacular and contemporary architecture within the context of the case study. This methodology adopts Hassan Fathy classification of vernacular methods of dealing with climate. Fathy classified these methods according to the main three climatic elements that affect the microclimate of buildings: sun, ventilation and humidity [9].

Weather Tool software that uses Svszokolay method of Psychrometric analysis is used to plot the hourly climatic data points on a Psychrometric chart. An overlay is drawn representing the comfort zone before and after using any of six passive strategies including passive solar heating and thermal mass. Then the number of points within each zone is counted. The results are then presented in the form of a graph showing the effect of using each strategy as a percentage of increased human comfort at each month and the overall effect for the whole year. Any number of strategies can then be combined to reach the most effective combination of passive strategies.

Computer-based version of Mahoney tables developed at the department of Housing Development & Management at the School of Architecture, Lund University [1] is used to suggest passive strategies.

6. Computer based study

This study includes two main tasks; the climatic context analysis and computer simulation. In order to analyse the climatic

[1] www.hdm.lth.se/TRAINING/Postgrad/AEE/index.htm

context a suitable set of climatic data of the location under investigation is needed. The proposed methodology employs a method of designing hourly climatic data to be used in case of actual data is not available. On obtaining the hourly climatic data, Weather Tool software is used to visualise and analyse the data in order to propose potential passive design strategies as discussed in section 5.2. Having identified the potential passive measures and strategies through the theoretical analysis and climatic context analysis, a set of computer simulation software is used to simulate the environmental performance of the case studies. Results are then analyzed using a spreadsheet to present the effectiveness of the proposed measures and strategies under investigation.

6.1 Climatic context analysis

6.1.1 Obtaining climatic data

To conduct any investigation into the environmental performance of buildings, comprehensive climatic data is needed to analysis the climatic context of the case study and to carry out the calculation. In most cases, hourly climatic data is very expensive and hard to find. Gado [2] devised a methodology for designing a comprehensive and yet representative hourly climatic data to be used in computer simulation. This methodology depends mainly on utilizing synthesised climatic data generated by Meteonorm software[2] which interpolates the climatic data needed for a certain location using the information from the nearest meteorological station to this location. Interpolated data is then rescaled using the 'Synthesis Data' feature of Weather Tool software[3]. This feature is used to superimpose accurate monthly averages on the synthesised data. This feature was developed by Dr. Andrew Marsh (author of Ecotect), and the first author in 2001.

[2] www.meteotest.ch/en/firma
[3] www.squ1.com/software/ weather-tool/features.html

thermal comfort and energy consumption.

Spatial analysis and boundary conditions

Before conducting the computer simulation, it is essential to conduct spatial analysis for the case study to identify the thermal zones, zones geometry, identify the adjacent zones to be included in the analysis etc...

Simulation

The first step towards achieving this task is to simulate the case study as built to form what is called the base case. The proposed measures are then tested by introducing each one to the base case one at a time and its impact on the internal environment is modelled. It is proposed that both free running and air-conditioned scenarios are modelled to enable quantifying the effectiveness of the tested measures in terms of both thermal comfort and energy efficiency.

The methodology proposes using whole-building analysis software such as ESP-r, IES, DesignBuilder, ArchiPHYSIK or Ecotect instead of using a combination of several simulation packages such as using Radiance, EnergyPlus and FLOVENT to conduct lighting, energy and air flow analysis. This will allow constructing and using a single building model saving time and effort and increasing by such the efficiency of the simulation process. The choice of the tool depends on the level o accuracy needed and the time limitation of the project as well as the level of user expertise. This methodology suggests to use Ecotect for several reasons. Its user-friendly interface allows constructing 3D models. It can import CAD models from AutoCAD and 3D studio. In addition, results are presented in a clear way that facilitates the communication between the researchers and between members of the design team and the clients. It can export and import data to and from more sophisticated simulation tools such as Radiance, EnergyPlus and HTB2 allowing by such conducting more in-depth analysis if needed. Ecotect has especial environmental analysis features such as solar access and exposure analysis, solar shading design, overshadowing calculation, and can assess the effect of space geometry on room acoustics etc... More importantly, Ecotect incorporates Humphreys' adaptive algorithms [10] allowing by such to take in consideration the adaptive

6.1.2. Visualization and analysis

There are several computer-based tools on the market that can be used to analyse climatic data. The majority of the available software is limited to a single function such as plotting psychometric charts. Example of such tolls is HDPsyChart [4] and CYTSoft [5]. In addition, they are not intended to architectural use but rather oriented towards thermodynamics-related industries such as HVAC to help solving problems involving moist air. Most of the metrological offices have there own computer software, which are not commercially available.

The proposed methodology utilizes Weather Tool to visualize and analysis both monthly and hourly climate data. It recognizes a wide range of international weather file formats such as fixed format weather files, separated value files, and linear row data files. In addition, it allows the user to specify customized data import formats from ASCII files allowing by such the use of a wide rang of climatic data files. Moreover, it can import energy plus climatic data files; a widely used free energy simulation software. It can visualize data in a wide range of 2D and 3D formats. It can also perform several analysis functions including assessing the relative potential of different passive design strategies and measures and accurately determining the optimum orientation for specific building design criteria.

6.2. Computer simulation

The effectiveness of the suggested passive measures and strategies obtained from the literature review and climatic data analysis is quantified in this stage. The case study is spatially analysed and all the analysis parameters are defined. Using a computer simulation tool, the temperature of the case study zones is simulated and results are analysed. Proposed measures are evaluated by comparing the environmental performance of the spaces before and after introducing the proposed measure to the case study one at a time in terms of

[4] www.chempute.com/psychro.htm
[5] www.cytsoft.com

9. Figures and graphs

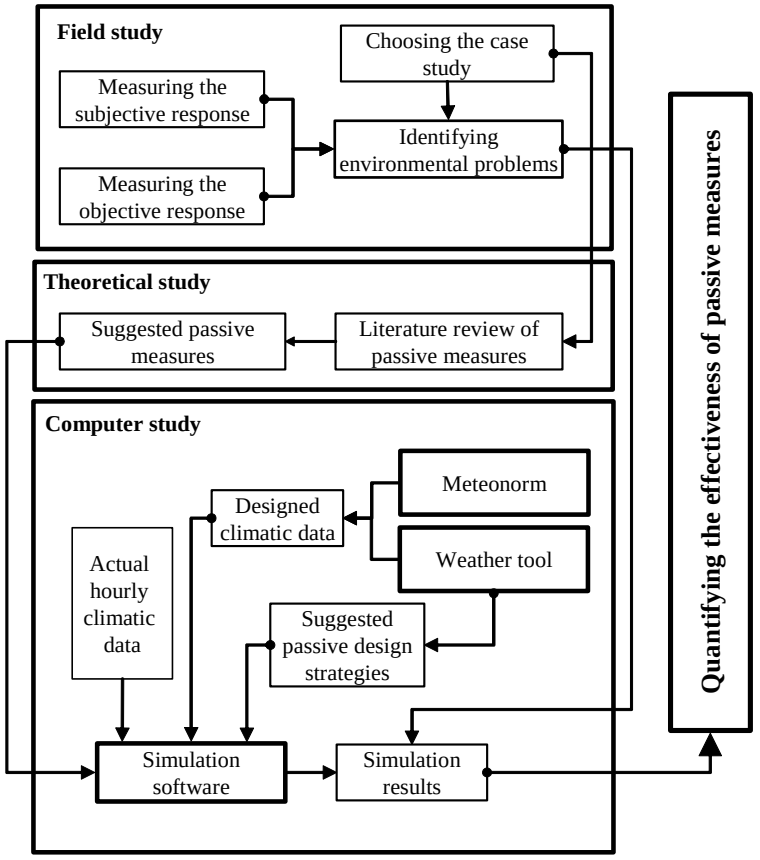


Figure 1: The proposed methodology

action taken by building occupants. This feature, were introduced to the program by Marsh the author of Ecotect and Gado the first author of this paper [2]. Ecotect is used in this methodology to calculate hourly internal temperatures and heating and cooling loads within each zone using the admittance method.

Data analysis

The simulation output is fed into a spreadsheet to calculate the percentage of benefit or loss due to the use of each measure. This is achieved by comparing the simulation results of the base case to the results of the base case with each measure introduced to it. The result of such comparison being positive means benefit and being negative means loss. In order to do so, four spreadsheets are needed; two for the base case results (one for free running and one for air-conditioned case) and two for the base case plus each measure (one for free running and one for air-conditioned case). Using the output of these analysis two sets of graphs can be plotted to illustrate the benefits and losses due to the use of each measure in the form of a percentage of change, either benefit or loss.

7. Further work

This methodology is under continuous development at Dundee School of Architecture, UK. It is planned to test this methodology in several ongoing research projects that investigate the use of passive design measures in dwellings and schools in Egypt. Further development to this methodology will be published in the Architectural Research Quarterly Journal published in the UK.

8. Acknowledgment

The authors would like to acknowledge the Egyptian Ministry of Higher Education for the scholarship given to the second author and the Egyptian Education and Culture Bureau in London for their effort in managing the scholarship.

8. References

1. Al-Shibami F, Gado T. *Formulating passive measures to achieve thermal comfort and energy efficiency in Yemen hot dry region*. In: International Conference on Future Vision and Challenges For Urban Development; 2004; Cairo; 2004. p. EE34F.
2. Gado T. *A parametric analysis of thermal comfort and cooling in walk-up housing blocks in the Arab Republic of Egypt* M.Sc. Cardiff: University of Cardiff, 2001.
3. Gado T, Mohamed M, Unwin S. *The environmental performance of classrooms in Egypt: a case study from El-Minya governorate*. In: The Second Scottish Conference for Postgraduate Researchers of the Built & Natural Environment; 2005; Glasgow Caledonian University; 2005. p. 643-651.
4. Ministry of Education. Progress in the number of schools, classes, and students in public education. WWW <www.idsc.gov.eg> 2005; (Accessed: 2005).
5. Drever E. *Using semi-structured interviews in small-scale research*. UK: SCRE publication 129; 1995.
6. Cohen L, Manion L, Morrison K. *Research methods in education*. London: Routledge Falmer; 2000.
7. Al-Shibami F. *Thermal comfort and energy efficiency in Yemeni houses* PhD. Sheffield: University of Sheffield, 2004.
8. CIBSE. *Environmental design guide A*. London: CIBSE; 1999.
9. Fathy H. *Natural energy and vernacular architecture - principles and examples with reference to hot arid climates*. Chicago and London: The university of Chicago press; 1986.
10. Humphreys M. *Understanding the adaptive approach to thermal comfort*; 1998.