Contextual thermography: Understanding energy and comfort in society

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Who we are

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What will I cover

- **Background** what is the problem/opportunity
 - Standard approaches to 'energy research'
- Case study: 'thermal comfort' research
- New socio-technical research method: contextual thermography
 - Issues and future steps



Background

- The climate emergency stems mainly from energy use
- Domestic energy use in UK accounts for 30% of all energy use
- 70 % of domestic energy use is for **heating**
- Heat provides the **energy service** of (thermal)comfort
- Goal is to understand how energy and comfort relate



Standard studies in this area

- Typically research on thermal comfort is 'technical'
 - **Small** scale research (n=10-20)
 - Multiple technical measures (u-values, air temperature, CO2 levels, humidity, window opening, radiator sensors etc)
 - Simple self-report in Likert-style scale of thermal comfort
 - Very limited, simplistic social data



See: Love, Jenny, and Adam C. G. Cooper. 'From Social and Technical to Socio-Technical: Designing Integrated Research on Domestic Energy Use'. *Indoor and Built Environment* 24, no. 7 (1 November 2015): 986–98. <u>https://doi.org/10.1177/1420326X15601722</u>.

Research needed in this area

- At scale understanding energy use in diverse homes requires large samples (n=10K+)
- Longitudinal data is essential to unpack the homeenergy relationships over time
- Socio-technical methods are needed to better understand the relationship between the technical and social parts of the system
- Significant qualitative inquiry necessary first step to identify important objects for capturing in larger studies



Technical data capture: Co-heating test





Source: Samual Stamp, LoLo EPSRC CDT: http://www.lolo.ac.uk/w2up3/ **Source**: Oswald Consultancy: https://oswaldconsultancy.wordpress.com/2012/07/13/coheating-taming-the-test/

Technical data capture: Thermal Imaging



Fig. 6- (a) Thermograph showing thermal anomalies (thermal bridging), in purple cold steel studs temperature reading sp3 15.8 C (b) investigated wall, internally looking at a classroom

From: Taileb, Ali, and Hamoud Dekkiche. 'Infrared Imaging as a Means of Analyzing and Improving Energy Efficiency of Building Envelopes: The Case of a LEED Gold Building'. *Procedia Engineering* 118 (2015): 639–46. <u>https://doi.org/10.1016/j.proeng.2015.08.497</u>.



Technical data capture: Thermal comfort



Strips out spatial dynamics, context and meaning



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Technical data capture misses these effects:



Fig. 2. Predicted change in temperature over time, for each participant (dots) and for the two groups (lines). Green dots indicate participants in the exclusion condition, black dots participants in the inclusion condition. The green line indicates average predicted values in the excluded condition, black line indicates averages for included condition.

Social exclusion makes you cold

From: IJzerman, H, Gallucci M., et al . (2012) 'Cold-Blooded Loneliness: Social Exclusion Leads to Lower Skin Temperatures'. *Acta Psychologica* 140, no. 3 : 283–88. <u>https://doi.org/10.1016/j.actpsy.2012.05.002</u>.

AND

Being warm leads to prosocial/trusting behaviour

From: Williams, Lawrence E., and John A. Bargh. 'Experiencing Physical Warmth Promotes Interpersonal Warmth'. *Science* 322, no. 5901 (24 October 2008): 606–7. <u>https://doi.org/10.1126/science.1162548</u>.



A new method to address this: contextual thermography

An interdisciplinary **socio-technical research method** to:

- Capture **physical parameters** on a human, social scale
- Enable interpretation of **context** and **behaviour**

All within the same **frame of reference**.

Combines video ethnography and thermal imaging



Differences vs video ethnography and thermography

Video ethnography

Patterns of daily life Significant social events

Capturing thermal spectrum data

Understanding relationship between patters of social life and thermal events

Thermography

Thermal characteristics of buildings Skin temperature Multiple frame capture (video) Capturing whole rooms, with people Identification of new 'thermal objects' e.g. 'thermal landscape'







Demonstrating contextual thermography in UCL's climate chamber





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Emerging advantages of contextual thermography

- **Observational** assessment of thermal comfort in context
- Capture of **dynamics of temperature and changes to thermal elements** of setting (e.g. window open, radiator on) over time
- Capture of **dynamics of social settings** over time
- Automatic capture of a range of useful data which can be deployed at scale via a small, **single unit installation**
- Ability to anonymously identify individuals to track over time (longitudinal)
- Can combine with UCL Smart Energy Research Lab smart meter data for large scale survey data collection



Issues and limitations

Currently **very little testing** and pilot data: initial tests are promising

IR Cameras are **not optimized** for this use (narrow focal range requires)

Need to develop **new image processing algorithms** to classify 'thermal landscapes'

To address **ethics/privacy/security**, in-unit processing is needed: only anonymous data transferred out of unit

Energy use of camera units: biggest challenge to overcome



Contextual thermography: summary

Contextual thermography is a new socio-technical method for understanding how **heat** and **people** interact in context

Very early stages of testing and validating

Thermal imaging cameras **not optimized** for this use

Requires technical innovation to develop new camera units

Potential for small-scale mixed method and large-N survey use



Thanks for listening!

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