Climate Ergonomics: Establishing the Role of Ergonomics/Human Factors in Climate Change

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ABSTRACT

The aim of this qualitative research study was to establish whether Ergonomics and Human Factors (E/HF) and its associated practices and principles could be applied to the issue of climate change. Furthermore, it aimed to explore how these professionals could help address the climate crisis through climate-conscious systems, processes, and designs and by considering human interactions with the climate as an interactive system. The following paper is therefore a first step towards establishing 'Climate Ergonomics' as a field, defining it based on expert opinions and suggesting where the E/HF professional is best situated to address climate change. The research team conducted three focus groups, with six E/HF professionals in each group, to establish how the profession could best support efforts in the climate crisis. Thematically analysed data suggested that three themes best explained the role and function of Climate Ergonomics and those working within this multi-disciplinary sphere. First, professionals must establish the position of ergonomics in the fight against climate change. Second, the appropriate methods, measures and tools must be established; be those repurposed from the E/HF toolkit or new measures which will need to be developed. Third, the inherent social inequality that is bound to matters of climate change must also be considered. E/HF professionals should work towards remedying, not reinforcing social inequalities. Future research should look to establish measures and tools to support the measurement of sustainable and socially responsible practice in the E/HF domain.

KEYWORDS

Climate Ergonomics, climate change, behaviour change, social inequality.

Introduction

Climate change can be defined as the shift in climate patterns mainly caused by greenhouse gas emissions from natural systems and human activities (Fawzy, Osman, Doran & Rooney, 2020). Natural systems may include forest fires, earthquakes, volcanoes and oceans whereas human activities predominantly relate to energy production and consumption; but may also include industrial actions, forestry, land-use and exploitation. Yue and Goa (2018) analysed greenhouse gas emissions and established that planet Earth is capable of balancing natural greenhouse gases, but anthropogenic activities disrupt and add pressure to this process of natural equilibrium. Given this, climate change is unequivocally human accelerated and now represents the most pressing global crisis humans may ever face on this planet (Intergovernmental Panel on Climate Change (IPCC), 2021), annihilating ecosystems (Doney et al., 2012) promoting ill health and cancers (Turner et al., 2020), poor psychological health (Clayton, 2020) and has even been shown to reinforce systematic inequalities (Cunsolo Wilcox et al., 2013; Sida, 2020). For example, increasing the safety risk of natural disasters to low-income labour workers on land and at sea (Islam & Winkel, 2017).

Sustainability and Ergonomics & Human Factors (E/HF)

As climate change is unequivocally human accelerated (IPCC, 2021), then logic would suggest that the solution should be human focussed. Given the active role of humankind in climate change, matters of sustainability have, unsurprisingly, caught the attention of Ergonomics and Human Factors (E/HF) professionals (see Steimle & Zink, 2006). E/HF is, in itself, a systems-oriented scientific discipline focussing on the interactions between humans and other composites of a system, in order to optimise human and system performance and capability (International Ergonomics Society, 2020). It is, therefore, easy to see how E/HF have operationalised systems, designs and workplaces that have some form of ecological impact (see Thatcher, 2013). Moray (1995) posited that "the role of ergonomics is to design a lifestyle support system that elicits behaviours required to reduce the severity of the global problems" (p.1699). Moray (1993) also suggested that E/HF should consider ecological factors such as mass scale urbanisation, water and food shortages, pollution, energy consumption, and waste in the design and implementation process. Relatedly, Helander (1997) called for E/HF to support in tackling global issues of sustainability such as the pollution of industrialised cities. However, given these calls little research has conducted in this sphere, by this community (Hanson, 2013; Thatcher, 2013).

Considerations of sustainability gained traction in E/HF when Thatcher (2013) published his seminal paper on 'Green Ergonomics', which he defined as "ergonomics interventions that have a pro-nature focus; specifically, ergonomics that focuses on human affinity with the natural world" (p.391). Since then, this term has been used to categorise any works within E/HF that have a sustainability angle or metric; for example, Hilliard and Jamieson's (2008) design of cognitive support tools for solar-powered vehicles or Sinclair, Henshaw and Henshaw's (2021) design of sustainable communities. However, the systems and interactions explored in studies of green ergonomics are often bound to the immediate environment and therefore may fail to consider human interactions with the Earth itself. As such, considerations such as the impact of extreme weather conditions on transport networks may not be considered which, from an E/HF perspective, may be extremely relevant as this may require a change to working conditions or patterns and/or require the impacts of climate change (current and future) to be considered at the design phase (see the case study presented by Network Rail 2021). Alternatively, depending on the interactive relationship between the climate and the system, there may be call for a radical transformation of current service and infrastructure (for an elegant example in rail see Golightly & Palacin, 2021). E/HF also must rely on their current tools and techniques to probe matters of sustainability (such as the task analysis, user profiles and risk assessments; Junillia, 2004); however, there is a distinct lack of not only work within this field but sparse availability of measures, tools and techniques to support such endeavours.

However, as Norton, Ayoko and Ashkansay (2021) state, what has become evident overtime is that Green Ergonomics has become inextricably bound to the workplace. Subsequent works only reinforce this connection and often consider the boundaries of the environment to be the workplace and therefore concern themselves with the environmental impact of variables within a controlled human environment system (Hanson, 2013). Although a positive step towards a more sustainable E/HF practice and workforce, this may inhibit climate-conscious efforts that fall outside of the immediate working environment, system or product. Furthermore, it may not conceptualise humankind's interactions with Earth - which may be considered a system itself. This criticism still holds true even after works have highlighted the potential benefits of a systems approach to climate change (see Berry, Waite, Dear, Capon & Murray, 2019); which the researchers from here out refer to as 'Climate Ergonomics'.

Introducing 'Climate Ergonomics'

The researchers present the term Climate Ergonomics to capture the interactive processes between humans and their immediate systems that feature sustainability. Climate Ergonomics, is also a term sensitive enough to capture the interactive processes between the human (both individual and race) and the climate. Climate Ergonomics can, therefore, be defined as the understanding of interactions among humans and their effect upon the macro-climate in which they inhabit. Underpinned by E/HF theory, Climate Ergonomics applies theory, data and methods to optimise human and climate well-being. It is the hope of the researchers that using the term Climate Ergonomics will avoid any confusion with previous nomenclature and their associations with the workplace. Though it should be noted that terms can, and have, been used interchangeably (Hanson, 2013) but previous terms may not be the most inclusive way of representing all human interactive processes with planet Earth's climate and ecosystems.

The aim of the current study

The aim of the current qualitative study was to establish if E/HF practices and principles could be applied to climate change and how E/HF professionals could help address the climate crisis through systems, processes and design. This paper is therefore a first step towards establishing Climate Ergonomics as a field, defining it based on expert opinions and suggesting where the E/HF professional is best situated to work towards sustainability to reduce the impact of the climate change.

Methods

Participants

Participants were eligible for the study if they were currently, or have been, working in the field of E/HF. Here, working refers to studying or working in academia and/or practice. This definition was used to ensure diverse representation of participants from across the career progression spectrum. Participants job titles ranged from 'full time MSc student', 'head of carbon' through to 'Professor'. Participants could typically be categorised as representatives from academia, industry or practice. Participants were recruited from advertisements by the Chartered Institute of Ergonomics and Human Factors (CIEHF) and by social media advertisements posted by the research team. Attendees were welcome to attend from any country, though the session ran in line with British Summer Time. Participants were from a range of countries including the United Kingdom, South Africa, Georgia and New Zealand. Eighteen participants took part in the study. All participants were fully informed of the nature of the round table event, and subsequent study, and all participants gave informed consent to take part. Participants gave consent verbally and all qualitive interactions were recorded digitally.

Epistemological approach

In line with many qualitative paradigms, the study took an inductive approach with a post-positivist epistemological and ontological stance (Fox, 2008). The paper is therefore positioned with the idea that, whilst reality can be investigated, any observations are only ever estimation and never represent truth; for all human observations will inherently involve some degree of error or bias (Denzin & Lincoln 2011). The explorative study collected qualitative interactions using a focus group design. The study was designed in this way to facilitate free thinking, spark new ideas interactively, and to produce more well-rounded notions (Cyr, 2017). This would also allow any ideas to be developed by numerous stakeholders and sense-checked from numerous experts and persons of interest in a way that would not have been possible using solitary interviews.

Procedure

Potential participants were invited to take part in a virtual round table event on 'Climate Ergonomics'. Participants took part in one of three focus groups each facilitated by one of the research team. All participants were welcomed together, digitally, and fully informed about the nature of the study and its motivations. All focus groups occurred at the same time using the breakout rooms function in Zoom. Participants were randomly allocated one of the three focus groups. Each focus group lasted between 1 - 1.5 hours. All participants were fully debriefed and thanked for giving their valuable insights and thoughts as to how and why E/HF should approach the climate crisis. Qualitative interactions were recorded and transcribed verbatim. Data were analysed using thematic analysis, according to the six-step process established in Braun & Clarke's (2006) seminal paper on the qualitative research method. The analysis itself was inductive in nature and fully data driven focussing on the semantic content of data whilst simultaneously exploring latent constructs underpinning participants narratives and social interactions.

Results

Three themes best explained the role and function of Climate Ergonomics. Themes included the positioning of ergonomics in climate change, identifying and establishing measures, methods and tools and considerations of social inequality.

Theme 1: Positioning ergonomics in the climate crisis: Where can EHF deliver effect?

This theme refers to identifying what E/HF can offer in the fight against climate change. If this discipline is to deliver effect to restrict climate change, then this requires E/HF professionals to establish what unique value, they and their profession can offer. "As an institute I think what we need to do is identify who the right stakeholders are for us and each of the groups that we can influence" (Focus Group 2, Participant 1). Relatedly, another participant stated: "As [In]Human Factors I think there's two things we need to prioritise with this problem. I think A) where can we add unique value that doesn't already exist from other disciplines (...) the second question which is really important is of all the potential initiatives that are out there which will really offer the greatest de-carbonisation benefits" (Focus Group 1, Participant 4). Participants also highlighted that E/HF takes a systems-thinking approach and that this is what has not been applied to the climate crisis before and that this may therefore be the unique 'thing' E/HF can offer: "We just need to focus on what it is that we can add to what is already happening. And I think one of the things we bring is systems-thinking" (Focus Group 1, Participant 5). The same participant also stated, "nobody's thought about the users for example – we can do that bit!" (Focus Group 1, Participant 5). The fact that one participant states: "The problem we are talking about is a huge problem in huge complex systems" (Focus Group 1, Participant 5), shows that these professionals are already thinking about sustainability issues in line with the systems-thinking approach.

Participants believed that E/HF professionals may be the most effective in tackling large scale industry sustainability issues. For example, "Looking at the whole rail network and how you can decarbonise that" (Focus Group 1, Participant 5). This may also be effective as E/HF often operates in areas associated with greater risk such as power, oil and gas, for example. Regardless, participants believed that their profession and skillset may lend itself best to large scale industry contributors to climate change and that this may be where they can deliver the greatest impact and effect. "Actually, the real value might be finding ways to successfully and cheaply decommission coal power, power stations to replace them with offshore power stations so actually applying Human Factors knowledge to that problem might have an order of magnitude (or several orders of magnitude!) benefit" (Focus Group 1, Participant 4).

Finally, in order to promote climate considerations into E/HF projects, processes and work, participants believed that Climate Ergonomics should occupy its own separate knowledge area. "Should we have a separate knowledge area for this? I think we should. I think in part in order to raise the profile and in part to collate all the relevant themes, even when a project is not directly about climate – every project surely now has a climate implication – we need to always be thinking about the climate implications of what we do; so, I think that's a yes." (Focus Group 1, Participant 4)

Theme 2: Establishing measures, methods and tools for the climate ergonomist

For E/HF professionals to be able to work within the climate change sphere they must be equipped with the right measures, methods and tools to implement and measure change. This is what the second theme captures. Professionals stated that there are currently available E/HF tools that have been, or can be, redeployed to assess climate systems. One participant stated: "It's a systems discipline; we have systems tools. I think it was about 3 years ago [Professor] Paul Salmon presented at the annual conference. He was using, he'd done some work, a cognitive work analysis of the entire world um in order to try and get to this kind of, you know, major, systemic at the highest level, issues and interactions. I guess things like STAMP could be used to control an environmental impact as much as it is for a safety impact (...) so I think we do have the tools and techniques that can be adapted" (Focus Group 1, Participant 4). In addition, later the same participant adds that: "We normally think about safety versus performance versus return on investment. Should we not now be thinking about this fourth thing about if you're going to introduce an intervention, a Human Factors intervention, is it gonna be safe, is it gonna give you performance but also is it gonna give you carbon" (Focus Group 1, Participant 4). This suggests that perhaps E/HF professional need to embed sustainability and carbon assessments into the everyday assessments and tools used within the profession. However, another participant suggests that this is not enough. Rather: "We need a model to be able to work with. To be able to say 'well this is what you need and that is what you need' and we haven't got it yet" (Focus Group 3, Participant 1). They go on to say: "what we really need is some handy um some fairly standardised formulas that says, well how much work were they doing before, and multiply that by a greenhouse gas factor, what sort of distance were they commuting multiplied by a greenhouse gas factor (...)We could standardise it within the CIEHF [Chartered Institute of Human Factors and Ergonomics], better still the IEA [International Ergonomics Association], and then you've got something that we can really offer industry now. That would be a real, you know, unique selling point for us" (Focus Group 3, Participant 1)

Participants also highlight that currently; practices focus on the financial consequences of climate decisions rather than their environmental impact. "We need to take the carbon emission into account. Not just money You know it's how we account for sustainability whether that's human impacts or whether that's environmental impacts" (Focus Group 1, Participant 4). Finally, participants also highlighted that using relevant historical data also be a useful tool, if this is compared against current or future practices. "We've gone back and looked at our historical data and then we've made mapped it against heat and rain and hours of sunshine [relevant climate factors] to, so going backwards we can start to see are there any correlations (...) we've used our historical data to see and run it forward and you know does that correlate?" (Focus Group 3, Participant 4).

Theme 3: Social inequality

This theme relates to the social inequalities that exist around, and because of, human-accelerated climate change. For example, in Western societies making more sustainable and/or greener behaviours often come at a greater financial cost to the individual which may not be feasible for

everyone across the socio-economic spectrum. Highlighting this, one participant stated: "In some ways it's a middle-class issue. If you're living on a tight budget; what can you do?" (Focus Group 3, Participant 3). Other participants referred to the social injustice that has come from Western societies over use of global resources and the impacts this has had on developing nations that now face the same global crisis: "The equality, diversity and inclusion thing is important because as soon as you do it [Climate Ergonomics] internationally (which you have to do) that's a problem that comes up; social justice and those things come up tremendously because people don't like having to do things as a result of us having stuffed loads of, dumped loads of, stuff and carbon, in the past, to the atmosphere" (Focus Group 1, Participant 1). Participants therefore thought it important that some consideration be given to the expectations of social change and how it may not be equitable or fair to hold all nations to the same standards. "There's a big imbalance especially in developing countries of; do we go with sustainability or do we, not necessarily, um, do we let people just starve?" (Focus Group 3, Participant 2). Thus, participants thought E/HF experts should look to help Western society change the design and implementation of products, systems and services whilst empowering developing nations to do what they can with the resources that are available to them. One participant gives an example of doing this in the field of marine rescue boats: "We get this when we work internationally (...) It's pointless us telling them, yeah a rescue boat like this, this specification – they're fifteen-hundred quid each! Y'know, how's a small community in Bangladesh gonna ever afford that?!. So, what we do is we work with them and say well what raw materials have you got, what industry, what raw materials have you got around you? How can we modify the specifications to enable you to use those materials that you can afford around to create the same effect" (Focus Group 3, Participant 3).

Discussion

This qualitative research study suggests that Climate Ergonomics may be a promising subdiscipline of E/HF that encourages the profession to consider matters of sustainability and social responsibility throughout all areas of its work. It also works to promote the active awareness and consciousness of the environmental impact of products, systems and services that the E/HF professional may encounter. It also offers a term to categorise works that are not only concerned with macro or work-based environments, but those that scale up to encompass the entire planet and human race. Qualitative findings suggested three themes best explained the role and function of Climate Ergonomics. First, professionals must establish the position of ergonomics in the fight against climate change. Second, the appropriate measures, methods and tools must be established; be those pre-existing from the E/HF toolkit that may be repurposed, or new measures which will need to be developed. Third, the inherent social inequality that is bound to matters of climate change must also be considered, and professionals should work towards remedying, not reinforcing, them.

The E/HF community must establish their position in tackling climate change, including what unique value they, and their profession, add. Findings that the unique 'thing' E/HF can bring to climate conscious endeavours is the systems-thinking approach. This is in line with the previous thoughts within the field (Berry, Waite, Dear, Capon & Murray, 2019). Researchers from across the scientific spectrum of disciplines have worked towards delivering effect or knowledge in relation to climate change including ecologists (Doney et al., 2012) healthcare professionals (Turner et al., 2020) psychologists (Clayton, 2020) and sociologists (Cunsolo Wilcox et al., 2013; Islam & Winkel, 2017; Sida, 2020). Representatives have considered sustainability in E/HF designs and processes (Hanson, 2013; Thatcher, 2012) and the data presented in this paper supports the promise of this approach. However, previous research at the intersection of sustainability and E/HF has been bound to the workplace or when expanded to the macro-environment often failed to extend to the

planet's atmosphere and to humankind as a whole unit of measurement (Norton, Ayoko & Ashkansay, 2021). Climate Ergonomics allows for such systems to be modelled, explored and promoted. Findings did, however, suggest that in order for Climate Ergonomics to be successful, impactful measures and tools will need to be formed to support its work. Traditional E/HF tools may be repurposed, such as task analysis, user profiles and risk assessments (Junillia, 2004); however, there is a need to establish measures and tools to quantify the sustainability and environmental impact of products, systems and services. Future research should look to build and validate such tools.

E/HF professionals clearly highlight the inherent social inequality intertwined with climate change. This theme captures both the inequities relating being able to afford to make a meaningful difference and the global, between-country, inequalities. These concerns are congruent with previous research such as that of Cunsolo Wilcox et al. (2013) who found that indigenous communities are often one of the most affected by climate change, even though they do the least to contribute to it. Works have also suggested that the impacts of climate change reinforce social injustice for women and perpetuate cycles of discrimination which reinforce gender roles and norms in developing countries (Sida, 2021). Similar findings are also apparent in western industrialised communities (Islam & Winkel, 2017). This theme suggests that climate conscious decisions are inextricably intertwined with matters of social justice and considerations of both factors must be embedded into the design of products, systems and services. This should be done in a way that is flexible enough for the solution to be operational across borders, where resources and socio-economic status' may differ hugely. Where this is not possible modifications to design should be available; future research should look to address this.

It is, however, important to note that participants in the study self-selected to take part in the roundtable events. Given this design, a number of valid limitations may apply to the research. First, these individuals may be more concerned with climate change and this may have influenced the discourse and themes established throughout the study. Second, these self-selected individuals may have neglected to mention some key themes (such as behaviour change) as these may be obvious to the participants and therefore may not have been directly captured by the current study.

Future Directions

E/HF professionals are encouraged to develop, repurpose and/or update appropriate measures, methods and tools for the use at the intersection of climate change and E/HF. Future works should also look to better understand how sustainability decisions can also mitigate or reinforce global social inequalities. Institutes and governing bodies should look to lead the Climate Ergonomics movement and encourage training and methodology development to support those working in practice to embed sustainability into everyday work. Finally, all interested E/HF organisations and parties should maintain the relationships established through the current research and look to support the sister-scientific disciplines in tackling climate change. An area where, to date, the E/HF professional, and associated bodies, are poorly represented.

Conclusions

This study aimed to establish if E/HF, and their associated practices and principles, could be applied to climate change. Furthermore, it aimed to explore how these professionals could help address the climate crisis through climate-conscious systems, processes and designs and by considering human interactions with the climate as an interactive system: or rather Climate Ergonomics. Qualitative data from diverse experts suggested that; first, the position of ergonomics in tackling climate

change should be established. Second, appropriate methods, measures and tools must be established. Third, the inherent social inequality that is bound to matters of climate change must also be considered. Future research should look to establish measures and tools to support the measurement of sustainable and socially responsible practice and encourage climate-based work.

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