

Taking Comfort to the Extreme

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Indoor thermal comfort can impact occupant health and productivity in both residential and commercial spaces.



Source: https://www.armstrongceilings.com/content/dam/armstrongceilings/commercial/north-america/images/roomscenes/office-metalworks-torsion-spring-cummins-e.jpg











Indoor heat exposure is related to **hundreds of deaths** in Houston, TX which has a hot humid climate.



https://basc.pnnl.gov/images/climate-zone-map-iecc-2021



Cassandra R. O'Lenick et al., "A Case-Crossover Analysis of Indoor Heat Exposure on Mortality and Hospitalizations among the Elderly in Houston, Texas," Environmental Health Perspectives 128, no. 12 (December 2020): 127007, https://doi.org/10.1289/EHP6340.











Thermal comfort affects **job productivity** which drops by ~1.25% per degree away from optimum conditions.



O Seppänen, W.J. Fisk, and Q.H. Lei, "Room Temperature and Productivity in Office Work," 2006, https://indoor.lbl.gov/publications/room-temperature-and-productivity.











"...buildings are built for their occupants, and if a building is not able to provide its occupants with acceptable thermal comfort, then it has basically failed as a building, no matter how little energy it consumes."

- D.H.C Chow (2024)











What Can We Do?



Enabling high indoor thermal comfort across the residential and commercial building sectors will require innovative solutions and implementation of new and existing approaches.



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Site-Specific Design





David H. C. Chow, "Indoor Environmental Quality: Thermal Comfort," in Encyclopedia of Sustainable Technologies (Second Edition), ed. Martin A. Abraham (Oxford: Elsevier, 2024), 283–95, https://doi.org/10.1016/B978-0-323-90386-8.00006-1.









Thermal Storage Walls

jump_{into} STEM

- Lower temperature swings in rooms
- Addition of vents allows partition of energy between daytime or nighttime heating
- Capable of giving off 10-12 hours of radiant heat*.



*https://www.finehomebuilding.com/project-guides/energy-retrofit/trombe-wall-solution









Radiant Heating/Cooling Slabs

- Supply or absorb heat directly to or from floors, or panels in the wall or ceiling
- More efficient than baseboard and forced-air heating^{*}
- Quick response time enables faster occupant comfort



Radiant Floor Heating

Radiant Panels



*https://www.energy.gov/energysaver/radiant-

 $heating \#: \cite{tart} = Radiant \% 20 heating \% 20 systems \% 20 supply \% 20 heat, the \% 20 room \% 20 via \% 20 infrared \% 20 radiation.$

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The Challenge

This challenge asks students to improve occupant indoor thermal comfort in U.S. buildings (residential, commercial, new, or existing) located in extreme climates or locations prone to extreme weather events by focusing on the environmental factors that determine individual satisfaction within indoor atmospheres.











Additional Resources



Climate Zones

• https://basc.pnnl.gov/images/climate-zone-map-iecc-2021

Measuring Thermal Comfort

• <u>https://www.buildingsiot.com/blog/how-to-perform-a-thermal-comfort-analysis-bd</u>

Passive and Low-Energy Systems

- <u>https://www.slideshare.net/slideshow/55passivesolardesignppt/257828201</u>
- <u>https://basc.pnnl.gov/resource-guides/passive-and-low-energy-cooling#edit-group-scope</u>









Additional Resources (cont'd)



Best Practices

- David H. C. Chow, "Indoor Environmental Quality: Thermal Comfort," in Encyclopedia of Sustainable Technologies (Second Edition), ed. Martin A. Abraham (Oxford: Elsevier, 2024), 283–95, <u>https://doi.org/10.1016/B978-0-323-90386-8.00006-1</u>.
- Emily C. Winfield et al., "HVAC Best Practices in Arctic Climates," E3S Web of Conferences 246 (2021): 08004, <u>https://doi.org/10.1051/e3sconf/202124608004</u>.











Thank You!

www.jumpintostem.org







