“A Looming Cold Crunch” and the Contingencies of Transnational Air-Conditioning

Jiat-Hwee Chang

Abstract
This essay explores the technopolitical and sociotechnical contingencies of the transnational histories of air-conditioning in urban Asia. It interrogates the mainstream technocentric and technologically-determinist understanding of air-conditioning, energy use and climate change by challenging its climatic determinism, diffusionist account of globalization, and understanding of architecture as mere energy conduit. In place of these assumptions, this essay argues that thermal comfort depends on not just climatic variables but also on social practices and cultural norms. It also understands the globalization of air-conditioning technologies as consisting not of diffusionist processes that replicate universal forms but of context-specific translations whereby “universal” forms mutate. Lastly, this essay sees architecture as having material agencies that entangle with thermal comfort and energy in complex manners.

Affiliation
National University of Singapore, Department of Architecture

Contacts:
jiathwee [at] nus [dot] edu [dot] sg

Received:
21 August 2019

Accepted:
23 April 2020

DOI:
10.17454/ARDETH06.17

ARDETH#06

Contingency encourages us to understand possibilism by attending to the conditions of possibilities created by particular socio-cultural, politico-economic, techno-environmental conditions.

The concept of contingency is not exactly a new one. In some ways, it is linked to the age-old questions in the humanities and social sciences surrounding causality and the complex relationship between structure and agency. By emphasizing the multivariate uncertainties of any development, contingency cautions against attributing any outcome to a single cause. In adopting the concept of contingency, one does not necessarily need to abandon the search for primary cause. Instead one just should not see the primary cause as creating deterministic outcome. Rather than assuming any form of determinism, contingency encourages us to understand possibilism by attending to the conditions of possibilities created by particular socio-cultural, politico-economic, techno-environmental conditions. Through the framework of possibilism, agency does not necessarily reside with any single human agent. Instead, agency might be distributed among both human and non-human actants (Latour, 1987, 1993, 2005). Likewise, causes might also be dispersed among various components of a web of complex dependencies that influence the co-evolution of these components (Byrne, 2005; Urry, 2005; Waldrop, 1993).

In the interdisciplinary scholarship on architecture, the concept of contingency is perhaps best known for being deployed to interrogate the autonomy of architects and architecture. Expanding on Magali Sarfatti Larson's seminal work on the heteronomy of architectural production and reception, this scholarship revealingly shows the various dependencies and the attendant contingencies of architects and architecture (Larson, 1993; McNeill, 2009; Till, 2009). There is no doubt that this body of scholarship serves as a useful corrective against the overly-autonomous accounts of architectural history and practice. There are, however, also fields of scholarship which reduce architecture to mere neutral vessels, bypass their material and spatial agencies, in the understanding of broader social, cultural, political and environmental changes. In these cases, how do we reassert the significance of architecture while accounting for various contingencies? This abstract methodological and theoretical question is one that I would like to pose and attempt to briefly discuss in this short article on my ongoing research on the transnational histories of air-con-

ditioning in urban Asia. In answering this question, I would also like to elaborate on the ways in which architectural significance has to contend with technopolitical and sociotechnical contingencies in these transnational histories.

Behind a Technocentric and Determinist Account

Air-conditioning has been receiving quite a significant amount of media attention in recent years because of climate change and the increasing rate of adoption and usage of air-conditioning in the developing countries (e.g. Cox, 2012; Moore, 2018). A recent report by the International Energy Agency (IEA) calls the threat posed by the "rampant growth in demand for space cooling [using air-conditioning] with far-reaching implications for emissions, energy security and electricity costs" a "looming 'cold crunch'" (International Energy Agency, 2018: 57). The quantitative research in the report warns that, if unchecked, the global energy demands of air-conditioning, which currently account for nearly 20% of total electricity used in buildings around the world, will more than triple by 2050, which will strain energy infrastructures and exacerbate climate change. The report's statistical projection is based on what it sees as a convergence of three trends. The first is climate change, which will lead to an overall increase in cooling degree days (CDDs), which is used by air-conditioning engineers and energy analysts to calculate the amount of space cooling needed. Developing countries in the tropical and subtropical regions are projected to experience the greatest increase in CDDs. These countries are also those expected to have the fastest rates of growth in income and population, which leads us to the second and third trends. The second is economic development. The report claims that [t]the climate-wealth relationship is strong – especially for the countries with the hottest climates." For these developing countries, the report asserts that "[a]s household income pass a certain threshold, sales of ACs [air-conditioners] and their usage start to take off..." (International Energy Agency, 2018: 38) The third and final trend is the demographic one. Strongly connected with the second trend – countries expected to experience high economic growth rates are those projected to have fastest rates of population growth – populations are

projected to grow the most rapidly in regions with the hottest climates. The report notes that three quarters of the world's population will either be living in Africa or the Asia Pacific by 2050.

In response to this looming cold crunch, IEA's report provides a range of technocentric policy recommendations – targeted primarily at large state and corporate entities – that include funding the research and development, and encouraging the use of more energy-efficient air-conditioning technologies, and creating regulations to encourage and stipulate improved energy-performance of buildings. While I do not fundamentally disagree with any of these recommendations, I question three of the underlying assumptions in the report's statistics, namely its climatic determinism, its diffusionist account of globalization, and its understanding of architecture as mere energy conduit.

Climatic and Comfort Contingencies

The report sees climate as the "main underlying driver of demand or desire for cooling." (International Energy Agency, 2018: 37) Quantitatively, the demand is represented in the report as the number of cooling degree days (CCDs) that "measure the positive deviation of temperatures from a reference point in a given location over a specified period." (International Energy Agency, 2018: 34) At 18 degrees Celsius (or 65 degrees Fahrenheit), the reference point for CCD is similar to and probably based on the air temperature for thermal comfort zone that was first constructed by researchers closely connected to the American Society of Heating and Ventilating Engineers (ASHVE) and the air-conditioning industry in the 1920s (Chang, 2016b; Marston, 1935). However, how was the thermal comfort zone constructed and is it still a suitable basis for estimating whether cooling through air-conditioning is desired or needed? I have argued elsewhere that the thermal comfort zone constructed by ASHVE and its successor organizations (such as American Society of Heating, Refrigerating and Air-conditioning Engineers, or ASHRAE), and widely adopted internationally till today, is an overly narrow range of air temperature and relative humidity based on rather reductive and mechanical understanding of human-environmental relationship (Chang, 2016a:

165-202; 2016b). Premised on a mechanistic interpretation of the human body as a heat exchange machine, researchers isolated and rendered intelligible a narrow set of environmental attributes that affect comfort – specifically, air temperature, relative humidity and air movement – creating what Michelle Murphy calls a "regime of perceptibility." The experiments for thermal comfort were carried out by putting human subjects in a hermetically-sealed, highly-insulated and windowless room known as a psychometric chamber, and testing their responses to various permutations of air temperature, relative humidity and air movement. A psychometric chamber was essentially "an empty box... a tabula rasa into which measurable variables could be inserted under controlled circumstances and their effects untangled and extracted from the messy politics and confounding influences" of actual places (Murphy, 2006: 24).

In the name of constructing universal thermal comfort standard, the human subjects were reduced to passive recipients and mere biological sensors of environmental conditions, the cultural and spatial contexts in which comfort was understood were removed, and the contingencies of comfort practices were erased in these experiments that produced the traditional model of thermal comfort (Shove, 2003). No wonder they produced a comfort zone of around 18-22 degrees Celsius (which became the thermostat settings for most air-conditioned spaces today) that rendered most places in the tropics to be uncomfortable most of the time, thus indirectly creating a market for air-conditioning in these places (Cooper, 1998; Shove, 2004).

Researchers isolated and rendered intelligible a narrow set of environmental attributes that affect comfort.

Contingencies previously purged from the traditional comfort model were reintroduced and partly accounted for in the adaptive thermal comfort model, which has recently begun to gain wider acceptance (de Dear and Brager, 2002; Nicol, Humphreys and Roaf, 2012). Unlike the traditional model, human beings in the adaptive model were understood to be active agents who, on experiencing discomfort, would react in ways to restore their comfort. Comfort is therefore understood in the adaptive model as a dynamic socio-environmental achievement rather than a static, definable environment condition or attribute in the traditional model. Instead of relying on experiments

The human subjects were reduced to mere biological sensors of environmental conditions.

in psychometric chambers, the adaptive comfort model draws primarily on data collected from the messier realities of field investigations where dynamic relationships between occupants and different aspects of the environment with multiple, shifting variables were at play. Field data challenged the validity of the fixed concept of thermal comfort framed by narrow temperature and humidity ranges in the conventional model. It shows that occupants of different buildings around the world were comfortable at broader temperature ranges than those indicated in the traditional model, and these temperature ranges vary with the outdoor climate (de Dear, Leow, & Foo, 1991). The differences were especially pronounced in naturally-ventilated buildings (Brager & de Dear, 1998). If the findings from the adaptive thermal comfort model are incorporated into the CCD calculations in the IEA report, there is no doubt that the projected increase in CCD would change and the predicted scenarios would be different. Specifically, the adaptive thermal comfort model suggests that comfort is more than a function of climatic conditions, and human beings can be comfortable in non-air-conditioned buildings. As such, the demand for cooling might not correspond directly to CCD and need not only be fulfilled through air-conditioning.

Globalization and Modernization: Translation, not Diffusion

After climate, the IEA report deems "income and wealth" as the secondary driver for increasing usage of air-conditioning (International Energy Agency, 2018: 37). Rising income would make air-conditioning affordable for more and more of the population and increasing affluence would lead to steep rises in the ownership of air-conditioners, especially in developing countries with hot climates that include Brazil, India, Thailand, Indonesia and Egypt. Statistically, climate – as discussed above – and wealth are much more significant than other factors such as "structure of economy, the price of ACs, the cost of electricity and cultural preferences" (International Energy Agency, 2018: 39). The underlying assumption here seems to be that the spread of air-conditioning globally would follow mid-twentieth century theory of modernization – the developing countries of the world would mod-

ernize in linear stages, gradually becoming the same as the developed countries in North America and Europe (Basalla, 1967; Hodge, 2011). A related assumption is that culture does not matter and cultural differences between different parts of the world would not affect the processes in which they modernize. If cultural differences exist at the beginning, the introduction of a modern technology like air-conditioning would contribute to the overriding of these variances and contribute to a largely predictable outcome, similar to what already happened in the developed countries. In a way, this assumption approximates Kenneth Frampton's critique of air-conditioning, first articulated almost forty years ago:

> the main antagonist of rooted culture is the ubiquitous air-conditioner, applied at all times in all places, irrespective of the local climatic conditions which have a capacity to express the specific place and the seasonal variations of its climate. Wherever they occur, the fixed window and the air-conditioner are mutually indicative of domination by universal technique (Frampton, 1998 [1983]: 27).

If the primarily driver of the expansion of air-conditioning is based on climatic determinist assumptions, the secondary driver is based on the conjoining of economic determinism with technological determinism. As Frampton implies above, capitalism along with the domination of universal technique brought about placelessness. Although Reyner Banham's attitude towards high-technology is at the opposite end of the techno-optimism/pessimism spectrum of Frampton, he likewise (and unsurprisingly so) share Frampton's technologically-determinist view:

> portent in the history of architecture... it has demolished almost all environmental constraints on design... it is now possible to live in almost any type or form of house one likes to name in any region of the world that takes the fancy... All precepts for climatic compensation through structure and form are rendered obsolete (Banham, 1984: 187).

Various Science and Technology Studies (STS) scholars have, however, pointed out that technology circulates in much more complex manners. Historically, there were often two-way exchanges and "technological dialogues" between the developed

and developing countries in the geographical relocation of technology (Moon, 1998). The developing countries' encounters with modern technology typically entailed complex processes of negotiation – coercion and resistance, indiscriminate imposition and selective appropriation – that modified the original technology to form what David Edgerton calls "creole technologies." (Edgerton, 2007) Given how technologies transformed when they were transferred, many STS scholars prefer to use concepts such as travel and translation to discuss the movement of technology. Through the concept of travel, STS scholars "explore how universals – [technological] thoughts or things – fall apart, and regroup differently" (de Laet, 2002: 1) when they cross physical, social, cultural and political boundaries. Unlike the stability and certainty of technological knowledge and artifact implied in the diffusionist model of transfer, travel suggests that the movement of technological knowledge and artifact involves a great deal of contingencies and uncertainties. In conjunction with travel, translation also "brings into view... the multiplicity of add-ons that contribute, often in unpredictable and varying ways, to transportation" (Jacobs, 2010: 13).

Travel suggests that the movement of technological knowledge and artifact involves a great deal of contingencies and uncertainties.

My research on the sociotechnical and architectural histories of air-conditioning in Southeast Asian and the Persian Gulf cities shows that social, cultural and political differences introduced contingencies and uncertainties that affected how air-conditioning technologies were adopted and put to use. For instance, I have argued that, in the case of Singapore, colonial ideas on hot climate as the cause for socio-economic underdevelopment influenced the thinking of post-colonial political elites and shaped their policies promoting the widespread use of air-conditioning, turning the city-state into an "air-conditioned nation" (Chang and Winter, 2015; George, 2000). In the case of Gulf cities, where state power and political authority often resided on the state's promise to provide "physical relief from the perils of desert life," (Jones, 2010) the oil states' provision of air-conditioned comfort was an integral part of their redistribution of oil wealth and in forms of social welfare and cheap energy (with the attendant services) for their nationals (Al-Ragam, 2017; Crystal, 1990; Molotch, 2019; Nagy, 1997).

Architecture as Entangled Assembly

Architecture is treated as an afterthought in the IEA Report even though buildings consume a significant

proportion of the electricity generated globally. In the final section on recommendations, the report mentions that the performance of building envelope has to be improved to reduce the energy consumption of air-conditioning. This suggests that architecture is seen primarily as merely a conduit of transmitting energy, one that necessitates enhancement to improve energy efficiency. The sidelining of architecture in the report enables the IEA to focus on its climatic and technologically determinist narrative, which I critiqued above. What if architecture is isolated as an external and marginal entity in the whole discussion of the present and future of cooling? What if architecture – broadly understood as the built environment – is understood in the broader interactive assemblage of technology, climate, politics, culture and society that support the current air-conditioning regime?

Using the concept of thermal material culture, Elizabeth Shove and colleagues argue that things, environment, people and their social practices are entangled in a web of thermal exchanges altered by the ubiquity of air-conditioning. For instance, they show that the new indoor temperature norm of 20-22 degrees Celsius (due to the international indoor comfort standards recommended by the air-conditioning engineers) meant that more and more things – from high-tech objects like computers and medical equipment, to everyday articles of food and interior furnishing – are designed for that narrow temperature range thus altering social practices and culture of comfort globally (Hodder, 2012; Shove, Walker, & Brown, 2014).

Many built environmental assemblages today are often part of such thermal material culture. One of the best-known examples globally that entrenched the dependency on air-conditioning is the energy-profligate building type of the prismatic glass-and-metal skyscraper. It might have started out as a contingent assembly "cobbled together from off the shelf parts" (Kelley & Johnson, 1998) that let in too much solar radiation and failed to keep water out from the interior space during the 1950s (Wright, 1955; Yeomans, 2001) – as were the cases of the Lever House and the United Nations Secretariat Building respectively – it is today a stable entity widely replicated throughout the world. The prismatic skyscraper becoming ubiquitous

Architecture is treated as an afterthought in the IEA Report even though buildings consume a significant proportion of the electricity generated globally.

is not just due to a shared aesthetic vision by many different architects. It is the outcome of the convergence of different socio-economic, socio-technical, and political developments that ranged from new technologies of glass and artificial illumination to new organisation of work and the real estate forces behind urban office buildings (Leslie, 2018; Leslie, Panchaseelan, Barron and Orlando, 2018; Saval, 2015).

References

Al-Ragam, A. (2017), *Towards a critique of a Kuwaiti Nahdha: Al-'Imara al-Hadītha and the Competing Narratives on Architecture and Urban Modernity*, in R. Camacho, S. Saragoça, R. Fabbri (eds), *Modern Architecture Kuwait, Vol. 2: Essays, Arguments & Interviews*, Zurich, Niggli, pp. 47-65.

Banham, R. (1984), *The Architecture of the Well-tempered Environment* (2nd ed.), London, Architectural Press.

Basalla, G. (1967), *The Spread of Western Science*, "Science", 156 (3775), pp. 611-622.

Brager, G. S., de Dear, R. J. (1998), *Thermal adaptation in the built environment: a literature review*, "Energy and Buildings", vol. 27, n. 1, pp. 83-96.

Byrne, D. (2005), *Complexity, configurations and cases*, "Theory, Culture & Society", vol. 22, n. 5, pp. 95-111.

Chang, J.-H. (2016a), *A Genealogy of Tropical Architecture: Colonial Networks, Nature and Technoscience*, London, Routledge.

Chang, J.-H. (2016b), *Thermal comfort and climatic design in the Tropics: An historical critique*, "The Journal of Architecture", vol. 21, n. 8, pp. 1171-1202.

Chang, J.-H. and Winter, T. (2015), *Thermal Modernity and Architecture*, "The Journal of Architecture", vol. 20, n. 1, pp. 92-121.

Cooper, G. (1998), *Air-conditioning America: Engineers and the Controlled Environment, 1900-1960*, Baltimore, Johns Hopkins University Press.

Cox, S. (2012), *Air-conditioning is a luxury the world can't afford*, "New York Times", 22 June.

Crystal, J. (1990), *Oil and Politics in the Gulf: Rulers and Merchants in Kuwait and Qatar*, Cambridge, Cambridge University Press.

de Dear, R. J., and Brager, G. S. (2002), *Thermal comfort in naturally ventilated buildings: Revisions to ASHRAE standard 55*, "Energy and Buildings", n. 34, pp. 549-561.

de Dear, R. J., Leow, K. G., Foo, S. C. (1991), *Thermal comfort in the humid tropics: Field experiments in air-conditioned and naturally ventilated buildings in Singapore*, "International Journal of Biometeorology", n. 34, pp. 259-265.

de Laet, M. (2002), *Introduction: Knowledge and technology transfer or the travel of thoughts and things*, in M. de Laet (ed.), *Research in Science and Technology Studies: Knowledge and Technology Transfer*, Amsterdam-Boston, JAI.

Edgerton, D. (2007), *Creole technologies and global histories: Rethinking how things travel in space and time*, "Journal of History of Science and Technology", n. 1, pp. 75-112.

Frampton, K. (1998 [1983]), *Towards a critical regionalism: Six points for an architecture of resistance*, in H. Foster (ed.), *The Anti-Aesthetic: Essays on Postmodern Culture*, New York, New Press, pp. 16-30.

George, C. (2000), *Singapore, the Air-conditioned Nation: Essays on the Politics of Comfort and Control, 1990-2000*, Singapore, Landmark Books.

Hodder, I. (2012), *Entangled: An Archaelogy of the Relationships between Humans and Things*, Malden (MA), Wiley-Blackwell.

Hodge, J. M. (2011), *Science and Empire: An overview of the historical scholarship*, in B. M. Bennett, J. M. Hodge (eds), *Science and Empire: Knowledge and Networks of Science Across the British Empire, 1800-1970*, New York, Palgrave Macmillan.

International Energy Agency (2018), *The Future of Cooling: Opportunities for Energy-efficient air-conditioning*, Paris, IEA Publications.

Jacobs, J. M. (2010), *A geography of big things*, "Cultural Geographies", n. 13, pp. 1-27.

Jones, T. C. (2010), *Desert Kingdom: How Oil and Water Forged Modern Saudi Arabia*, Cambridge (MA), Harvard University Press.

Kelley, S. J., Johnson, D. K. (1998), *Metal and glass curtain wall: history and diagnostic*, in A. Cunningham (ed.), *Modern Movement Heritage*, London, E & FN Spon, pp. 77-87.

Larson, M. S. (1993), *Behind the Postmodern facade: Architectural Change in Late Twentieth-Century America*, Berkeley, University of California Press.

Latour, B. (1987), *Science in Action: How to Follow Scientists and Engineers through Society*, Cambridge (MA), Harvard University Press.

Latour, B. (1993), *We Have Never Been Modern*, Cambridge (MA), Harvard University Press.

Latour, B. (2005), *Reassembling the Social: An Introduction into Actor-Network-Theory*, Oxford, Oxford University Press.

Leslie, T. (2018), *"Insulation with vision": The development of insulated glazing, 1930-1980*, "APT Bulletin: The Journal of Preservation Technology", vol. 49. n. 4, pp. 23-32.

Leslie, T., Panchaseelan, S., Barron, S., Orlando, P. (2018), *Deep space, thin walls: Environmental and material precursors to the postwar skyscraper*, "Journal of the Society of Architectural Historians", n. 77, pp. 77-96.

Marston, A. D. (1935), *Degree days for cooling*, "Bulletin American Meteorological Society", n. 16, pp. 242-244.

McNeill, D. (2009), *The Global Architect: Firms, Fame and Urban Form*, London, Routledge.

Molotch, H. (2019), *Consuming Abu Dhabi*, in H. Molotch and D. Ponzini (eds), *The New Arab Urban: Gulf Cities of Wealth, Ambition, and Distress*, New York, NYU Press, pp. 256-275.

Moon, S. M. (1998), *Takeoff or self-sufficiency? Ideologies of development in Indonesia, 1957-1961*, "Technology and Culture", vol. 39, n. 2, pp. 187-212.

Moore, R. (2018), *An inversion of nature: How air conditioning created the modern city*, "The Guardian", 14 August.

Murphy, M. (2006), *Sick Building Syndrome and the Problem of Uncertainty: Environmental Politics, Technoscience, and Women Workers*, Durham, Duke University Press.

Nagy, S. (1997), *Social and spatial process: An ethnographic study of housing in Qatar* (Ph.D. Ph.D. dissertation), Philadelphia, University of Pennsylvania.

Nicol, F., Humphreys, M., Roaf, S. (2012), *Adaptive Thermal Comfort: Principles and Practices*, New York, Routledge.

Saval, N. (2015), *Cubed: A secret history of the workplace*, New York, Doubleday.

Shove, E. (2003), *Comfort, Cleanliness and Convenience: The Social Organization of Normality*, Oxford, Berg.

Shove, E. (2004), *Social, architectural and environmental convergence*, in K. Steemers, M. A. Steane (eds), *Environmental Diversity in Architecture*, London, Spon Press, pp. 19-30.

Shove, E., Walker, G., Brown, S. (2014), *Material Culture, Room Temperature and the Social Organisation of Thermal Energy*, "Journal of Material Culture", vol. 19, n. 2, pp. 113-124.

Till, J. (2009), *Architecture Depends*, Cambridge (MA), The MIT Press.

Urry, J. (2005), *The complexity turn*, "Theory, Culture & Society", vol. 22, n. 5, pp. 1-14.

Waldrop, M. M. (1993), *Complexity: The Emerging Science at the Edge of Order and Chaos*, New York, Simon & Schuster.

Wright, H. (1955), *What next for the window wall?*, "Architectural forum", July, pp. 168-177.

Yeomans, D. (2001), *The Origins of the Modern Curtain Wall*, "APT Bulletin: The Journal of Preservation Technology", vol. 32, n. 1, pp. 13-18.