
CHI 2020: Right Here, Right Now?

A bottom-up approach to estimating the carbon emissions from more than twenty years of CHI conference travel.

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Abstract

Over the last twenty years the CHI conference has grown substantially. However, with the reframing of climate change as a *climate crisis*, environmental concerns have become increasingly pervasive in the community. In 2019 CHI introduced a sustainability role and set a goal to make CHI more sustainable. In 2020 CHI is in Hawaii. This work looks back over the last two decades and estimates what are substantial and growing CO₂ emissions from conference travel. First, it posits how, in the short term, potential environmental damage can be minimised. Second, and longer-term, it invites the community to reflect on research dissemination and how the conference experience may need to change.

Author Keywords

Conference attendance; CO₂ emissions; sustainability

CCS Concepts

•Applied computing → Environmental sciences;

Introduction

The closing years of the last decade have been a hallmark period for environmental awareness. From increasing public concern about plastic pollution, the spotlight shone on the IPCC SR15 [9] by the skyrocketing profile of Greta Thunberg, and the reframing of climate change as a *climate crisis* and *climate emergency* (even by western governments) has raised conservationist concerns to new heights.

Social concerns have long been a feature of CHI, with themes including “changing the world” (2002) and “#chi4good” (2016). Environmental considerations are no exception. In 2008 a session dedicated to these concerns was featured. Entitled *Green Day*¹, the session showcased three papers focusing on environmental considerations around technology: creation, use, and disposal. Sessions in this vein continue to feature throughout the proceedings.

In 2019, CHI set an explicit goal to become more sustainable [6]. In a blog post, on the conference website, the authors of the entry highlight the carbon intensity of air travel, and consider this in the context of moving to a virtual program committee. The authors set goals to locally source

¹ <https://dl.acm.org/doi/10.1145/3256546>

food, to reduce food miles, reduce waste, and encourage shared transportation. Importantly, to quantify and measure the impact of future actions, the authors commit to “benchmark the overall carbon footprint” of the event and report on these findings in future posts.

In the absence of any reported findings this work attempts to provide one piece of this puzzle.

Background

Held periodically from 1982 and annually since 1985, CHI is the premier conference in the field of human-computer interaction and is the flagship of the Association for Computing Machinery’s Special Interest Group on Computer Human Interaction (ACM SIGCHI) [16]. From fewer than 1,000 attendees and just 72 papers CHI has grown to its current multi-track program with 703 papers and an estimated 3,800 attendees at the 2019 event.

CHI offers an environment where research is disseminated, connections made, ideas shared, and attendees mingle. In light of the recent focus brought on sustainability [6] and a renewed global interest in limiting global temperature rise, this work offers a data-driven perspective on the potential environmental impact on one aspect of attendance: travel.

Conference Attendance

Since at least 2002 CHI has, with increasing vigour, called on authors of accepted papers to present their work at the conference: 2002–2008, “authors of accepted papers will present”; 2009–2012, “authors must present”; 2013–2017, “authors are required to present”. Further, since 2018 CHI has required authors to accept a submission agreement explicitly including an attendance provision.

Authors and attendees will travel to and from the conferences via a variety of means. However, personal vehicles

and air transport together represent the overwhelming majority of all journeys, with a combined share in excess of 95% [19]. Air travel is one of the most significant causes of global CO₂ emissions from long-distance transportation, second only to global shipping [4]. As journey length increases air transport becomes increasingly prevalent. For journeys of 750 miles (1,200 km) or more air travel represents the majority choice [19].

Methodology

To determine the environmental impact of conference travel this work considers two parts of the attendance profile: a) paper authors and b) an approximation of the estimated total attendance, based on prior surveys and a model of attendee make up.

Main Proceedings Authors

Using an approach similar to that of Bartneck and Hu [1] and Sakamoto [15], the list of authors was compiled from the available proceedings on the ACM Digital Library (ACM DL) for each year of the conference between 2000 and 2019. The DOI for each of the 6,223 papers² was extracted, and the article citation page was collected. The ACM DL has both policy-based access restrictions³ and technical measures which preclude automatic data collection. As such, manual acquisition techniques were required. Data was collected, in order of preference, from a) the Internet Archive⁴, b) the Microsoft Bing cache⁵, and, only where necessary, c) directly from the ACM DL⁶.

For the purposes of this work, it is assumed that the authors of the relevant publications travelled both to and from

² See Table 1

³ <https://libraries.acm.org/digital-library/policies>

⁴ <https://archive.org/web/>

⁵ <https://help.bing.microsoft.com/#apex/18/en-us/10016/0>

⁶ <https://dl.acm.org>

the conference from the conference from their then affiliated institutions. This provides an approximation of each author's probable start and end location. For a more nuanced discussion of this assumption, please refer to *Limitations*. Each collected page was processed to extract the list of authors and their institutional affiliation, for a total of 24,569 records. For each institution the city or administrative unit, region (e.g. state), and country was manually tagged. In the limited number of cases where authors listed multiple institutions, the most completely addressed was adopted, or where ambiguous the first listed was used.

To ascertain the distance between the conference and the author, the latitude and longitude of each tagged location was identified using the OpenStreetMap Nominatim service⁷. Aircraft are typically assumed to follow the shortest distance between points, known as the orthodromic or great-circle distance. The distance between the location of each institution and the conference, in kilometres, was calculated using the Great Circle Calculator⁸ with the WGS 84 geodetic model, the reference coordinate system for GPS.

Estimating Total Attendance

SIGCHI publishes the attendance figures for each CHI conference. For the years 2004–15 the summary responses to the post-conference survey were also made available. In addition, starting in 2008, this data includes the work location of respondents offering insights into the travel country of origin for the broader group of CHI attendees.

There are many factors that may influence an individual's decision to attend a conference. One of the most cited, as identified by the CHI surveys, is having an accepted work [16]. The published survey data indicates that more

than 50% of all attendees are authors, and survey responses indicated that this proportion was growing. A second important factor is the distance to the conference location. While, on its own, distance may not directly impact an attendance decision, it potentially offers a way to flatten a number of complex factors into a uniform metric. Such factors may include available travel modes (e.g. road, air), likelihood of requiring travel documentation (e.g. none, passport, waiver, visa), cost of transit, and the required duration of the trip.

Based on published survey data, a model of attendance was generated using regression analysis on a per country basis. Using a country-based model provides a more nuanced estimate of attendance, accounting for factors including affordability concerns and travel considerations such as freedom of movement or conversely exit and entry restrictions. To estimate the likely makeup for attendee origin, the author composition for the given year is used. To localise survey attendees travelling from countries where no authors are reported to be based, the capital city is used. Further, as discussed above, the distance between the attendee and the conference location is incorporated.

This model provides estimated attendance makeup for each of the countries from which authors and attendees were identified as travelling over the 20 year period. Combined with the reported attendance figures this provides an estimate for attendance from each country in the dataset. To provide forecasts for future conferences where the attendance and authorship data is unavailable (2020 and 2021 at the time of writing), the typical authorship for the analysed period and projected total attendance figures were used.

Estimating CO₂ Emissions

While attendees may travel to conference destinations by a number of different modes, personal vehicle and air travel represent over 95% of all journeys, irrespective of

⁷ <https://nominatim.openstreetmap.org>

⁸ <https://edwilliams.org/gccalc.htm>

distance [19]. Air is the predominant mode of travel for distances in excess of 1,200 km.

Aircraft CO₂ emissions are dependent on a large number of variables including, type, load, distance, speed, and altitude. Per passenger calculations must also consider factors including the number of seats, load factor, luggage, and class of travel. Notably, for otherwise constant values it is important to note that per kilometre emissions typically *reduce* as distance increases. This inverse relationship is partly the result of amortisation of fixed emissions such as those from taxiing, take-off, stacking, and landing.

To provide representative real-world estimates, this work uses the ICCT emissions figures which are derived from a bottom-up model of the global emissions characteristics of the 38 million passenger-carrying flights taken in 2018 [7]. The consolidated figures are stratified by stage length in 500 km increments and indicate the typical value for grams of CO₂ per passenger km for each stage length.

For regional and local attendees, alternative transport is increasingly likely to be used. For journeys between 50 and 499 miles (80–800 km), personal vehicles represent over 95% of all trips [19]. Based on EPA figures, the average passenger vehicle emits 404 g CO₂ per mile [18] (251 g CO₂ per km). Considering typical vehicle occupancy of 1.67 (2009, 2017) [12], this suggests an estimated value of 150 g CO₂ per passenger km. For journeys in excess of 500 km aircraft emit 109 g CO₂ or less per passenger km [7]. The relatively high level of emissions from passenger vehicles means that these journeys are only competitive with aircraft for distances shorter than 500 km and when transporting at least two individuals.

In accounting for the two predominant transport modes, the presented CO₂ estimates assume the most efficient op-

tion was selected: air transport for journeys in excess of 500 km, passenger vehicle for journeys between 80 and 500 km. Finally, to avoid overstating emissions for hyper-local attendees, the presented estimates zero-rate emissions for journeys of less than 80 km.

To allow further analysis, the complete dataset and calculations can be found in the accompanying data file available from: <https://doi.org/10.17863/CAM.48681>

Data Analysis

Conference impact can be measured in a number of ways. It is important to remember that CHI has a purpose: the dissemination of research, the connecting of people, the sharing of ideas. And here CHI has been an unmitigated success, demonstrating decades of year-on-year growth.

Papers, as a *unit of research*, offer an interesting lens with which to consider the impact of a conference and are one way we can think about and weigh the social good of our work against any ecological concerns. Per-attendee estimates offer a scaled metric and an alternative perspective on the potential environmental implications of conference travel. These estimates, presented below, however, do not exist only as analytical tools or statistical curiosities; but rather an aggregate total with potential real world impact. An impact that can be measured in metric tons of CO₂.

Growth

Since the turn of the millennium, the growth of the CHI conference has been remarkable. As seen in Table 1, from lows of just 61 papers (and a 15% acceptance rate) in 2002, and 1,435 attendees in 2003, CHI 2019 was the biggest year to date with 703 papers in the main proceedings alone and an estimated attendance of 3,800 [16]. This represents more than 1,000% growth in accepted submissions and well in excess of a doubling of attendance over

the intervening 16–17 year period. Anecdotally, this growth is seen highlighted in the closing plenary: growth is considered a measure of success.

As CHI has grown, both in size and influence, the imperative to publish at the conference has become insatiable. With the notable exception of the 2002–03 conferences, the acceptance rate has held steady around 25% yet the number of papers published has ballooned. While the number of authors has similarly scaled, the number of papers per author has shown a creeping trajectory from just over one per author to as high as 1.25 in more recent years. Simi-

Table 1: Papers, unique authors, and attendance in the compiled dataset, with mean values for authors per paper and papers per author, along with overall attendees per paper.

Paper numbers reflect the number of papers and notes listed on the ACM DL proceedings page and may differ from officially reported figures. Italicized text indicates forecasts or estimates.

Year	Location	Papers	Authors	Attendees	Au on P	P by Au	At / P
2000	The Hague, NL	72	221	2628	3.29	1.07	36.50
2001	Seattle, WA, US	69	218	2832	3.43	1.09	41.04
2002	Minneapolis, MN, US	61	216	1726	3.74	1.06	28.30
2003	Fort Lauderdale, FL, US	75	244	1435	3.55	1.09	19.13
2004	Vienna, AT	93	296	1815	3.33	1.05	19.52
2005	Portland, OR, US	93	285	1947	3.28	1.07	20.94
2006	Montreal, QC, CA	151	477	2250	3.54	1.12	14.90
2007	San Jose, CA, US	182	523	2620	3.43	1.19	14.40
2008	Florence, IT	218	697	2361	3.64	1.14	10.83
2009	Boston, MA, US	277	814	2358	3.48	1.19	8.51
2010	Atlanta, GA, US	302	937	2384	3.64	1.17	7.89
2011	Vancouver, BC, CA	409	1286	2861	3.71	1.18	7.00
2012	Austin, TX, US	369	1128	2616	3.71	1.21	7.09
2013	Paris, FR	391	1285	3443	3.89	1.18	8.81
2014	Toronto, ON, CA	465	1487	3001	3.87	1.21	6.45
2015	Seoul, KR	484	1628	2896	4.08	1.21	5.98
2016	San Jose, CA, US	545	1841	3624	4.10	1.21	6.65
2017	Denver, CO, USA	600	2043	2939	4.22	1.24	4.90
2018	Montreal, QC, CA	665	2336	3182	4.39	1.25	4.78
2019	Glasgow, SCT, GB	702	2561	<i>3800</i>	4.42	1.21	<i>5.41</i>
2020	Honolulu, HI, US	<i>760</i>	<i>2617</i>	<i>3474</i>	<i>4.29</i>	<i>1.26</i>	<i>4.57</i>
2021	Yokohama, JP	<i>713</i>	<i>2453</i>	<i>3553</i>	<i>4.34</i>	<i>1.27</i>	<i>4.98</i>

larly, the conference has seen an increase in the number of authors contributing to each paper, from an average of 3.29 in 2000 to a high of 4.42 by 2019.

Historically, conferences have provided an important opportunity for the research community to come together and exchange ideas. However, the significance of this aspect of conferences is starting to be called into question [20]. At the turn of the millennium CHI attracted around 40 attendees per published paper, disseminating our work. By 2018 that had dropped to 4.78. Combined with an increasingly author heavy attendance [16], despite expansion, the conference may actually be becoming more insular.

Total Travel Impact

To estimate the overall CO₂ emissions from attendee travel, a three stage approach was used. First, the developed attendance model was provided with both the collected author makeup, or where unknown the typical makeup for the 20-year period, and the distance between each origin and the conference location. The resulting make up was applied to the known, or projected, attendance. As an example of this step, Figure 1 shows these estimates for the US origin attendees. Additionally, it allows for comparison of these estimates with the reported survey data for the 2008–15 period, where 27–61% of attendance was of US origin.

Second, using the lower of the ICCT air travel figures or EPA vehicle emissions (or zero for distances below 80 km), the nominal CO₂ emission figure is calculated for one-way travel between the conference location and the nominal location of the attendees, as described earlier. Finally, the attendance figures are multiplied by the nominal CO₂ emissions figures, providing an overall one-way estimate.

As seen in Figure 1, as attendance has grown so have emissions. The lowest estimated travel emissions for the

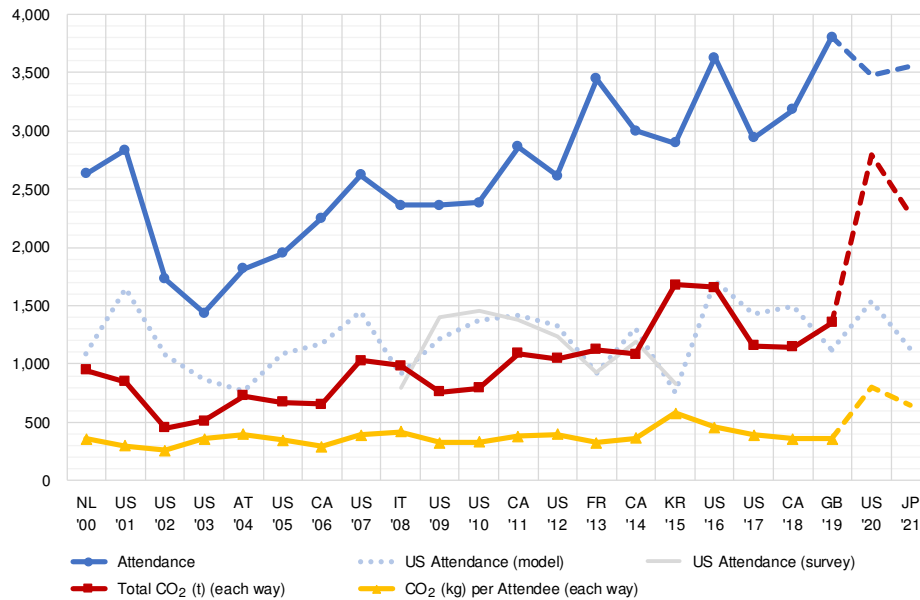


Figure 1: Conference attendance; estimated US attendance, based on the attendance model; estimated actual US attendance, based on survey responses; total estimated travel emissions in metric tons, each way; and estimated travel emissions in kg per attendee, each way.

twenty-year period occurred for the 2002 and 2003 conferences, at 451 and 512 metric tons, one-way, respectively. This coincided with the lowest attendance in the dataset, 1,726 in 2002 and 1,435 in 2003. Interestingly, this remarkably low attendance is coincident with record low acceptance rates for papers submitted to the main proceedings: 15% and 16%. While it may be unpopular with authors, and seemingly attendees, exceptionally restrictive acceptance criteria may represent a mechanism to lower emissions.

Attendance is not the only possible causal factor driving emissions detectable in the data. Despite higher atten-

dance in every year since, CHI 2015, held in Seoul, South Korea, retains the dubious honour of the record for highest total estimated travel emissions: 1,678 metric tons, one way for just 2,896 attendees. A round-trip estimate for travel emissions of 3,355 metric tons (0.003 Mt) for this single 6-day conference is greater than the entire annual CO₂ emissions of the Faroe Islands (0.002 Mt [13]), the Danish archipelago with a population of over 49,000 people.

The reason for such high estimates is that emissions are a function of distance. As the cumulative distance between individual attendees and the conference location increases, so do the attributable travel emissions. As indicated by the per attendee CO₂ emissions, in Figure 1, and found in the underlying distance calculations, Seoul required the longest average per attendee travel in the conference's history.

There are, of course, rational reasons for arranging conferences in locations inconvenient for the typical attendee profile. Attempts to increase the diversity of the author and attendee make up is one such rationale. It was expected that hosting CHI in Asia would positively influence contributions from that region of the globe [15].

The dataset shows that in 2015, 1.69% of authors indicated an institutional affiliation in Korea, more than double the 2014 figure of 0.83%. Further, based on SIGCHI's published survey data, 11.65% of attendees indicated their main working location being in Korea, and 25.4% of attendees reported an origin within a 4,000 km⁹ radius of the conference, far higher than the 7.28% combined average from those counties for the 2008–15 period covered by the surveys. By this measure, CHI 2015 was a great success.

Depending on the conference location, overall per-attendee

⁹ Approximate distance after which a flight is considered "long haul."

emissions, each way, vary from a low of 261 kg to 579 kg, with an overall mean of 374 kg. Authors, as a sub-population, have slightly different emissions characteristics with each-way figures ranging from 238 kg to 731 kg, though they are generally slightly higher with a mean of 453 kg. These figures are in line with the work of Spinelis and Louridas [17], who, from a sample of authors and conferences between 1997 and 2009, estimated the overall global round trip average to be 801 kg (401 kg, each way).

While location clearly impacts attendee make up, due to the persistent attendance of US- and European-based attendees, emissions for such distant locations will be higher. To reduce CO₂ emissions, without limiting attendance, therefore requires minimising the distance travelled for these perennial attendees. A weighted average of the origin locations for the full twenty years suggest that the attendee centre of population is in the region of 41.8, -36.0. A location in the middle of the North Atlantic, and approximately 990 km North West of Ponta Delgada, Azores.

Despite the almost convenient location of the Azores, a part of Portugal and subject to the EU Schengen Agreement (allowing visa free travel for around 400 million people), the small size of the archipelago makes it unsuitable as a conference venue. To support conference attendance, even the largest city would add more than 5% to its resident population. In addition, the small size and remote location means that any conference would have limited scope to attract local or regional attendees, therefore ensuring that essentially all attendees must travel large distances. A problem common to mid-oceanic island locations.

Discussion

Environmental impact is an acknowledged concern of the community. The ACM have recently begun to make moves

to reduce the carbon footprint of their conferences, offering an opt-in carbon offsetting program¹⁰. Further, CHI organisers have made explicit their interest in improving the sustainability of the conference, creating a sustainability role, for the first time, for the 2019 conference [6].

CHI 2020: Honolulu, HI, USA

The CHI 2020 conference is being held in Honolulu, HI, USA at the Hawaii Convention Center. Of the 58 awards the centre lists¹¹, 9 are for “green” initiatives of which 3 were grants to pay for renovations. Hawaii is approximately 4,000 km from the nearest land-mass: the continental United States. As a US state Hawaii affords “domestic” travel status for an American audience, and is a popular travel destination. The attendance model, as seen in Figure 1, predicts an increased US attendance compared with 2019.

Future attendance estimates are forecast using a simple linear regression and, for 2020, this predicts a slight drop in overall attendance. Despite this, as shown in Figure 1, travel related CO₂ emissions are forecast to be the highest ever. At an estimated 2,791 metric tons, each way, this is a 66% increase on the current record holder, 2015. This should not be surprising, Hawaii has long been noted as a particularly high carbon intensity location [17]. While this estimate is a forecast, due to the island’s remote location, to avoid becoming the most carbon intensive conference in CHI’s history it would need to see non-local attendance drop to fewer than 2,000, a level not seen since 2005.

CHI 2021: Yokohama, Japan

Due to the advanced forward planning required for a conference of its size [6], the location for CHI 2021 has already

¹⁰ <https://www.acm.org/special-interest-groups/volunteer-resources/conference-planning/conference-registration#carbon>

¹¹ <https://www.meethawaii.com/convention-center/about/hawaii-convention-center-awards-accolades/>

Carbon Offsets

Very simply, the UN Clean Development Mechanism (CDM), defined in the Kyoto Protocol, creates a global market for carbon emissions. Credits are generated for not emitting CO₂ in hypothetical future activities. As this future activity is coupled to an economic incentive, this mechanism may be abused by those claiming for reductions on emissions that would never have actually occurred [2, 21]. Additionally, credits may be accumulated for activities undertaken to sequester carbon from the atmosphere. The most popular of which, tree planting, stretches the definition of “long-term” sequestration, particularly for trees which may later be felled or burned [5]. Further, subsequent negative emissions have been found to be less impactful than the initial positive emissions, making effective offsetting even more of a challenge [22]. Even when effective, carbon offsets present an ethical quandary: is emitting and offsetting morally acceptable if it is morally worse than not emitting at all? [8]

been determined. In 2021, CHI will make a return to Asia and, for the first time, it will be located in Yokohama, Japan. Local attendance is forecast to be 11.5%, much higher than the more typical value of around 2% for attendees that travel from Japan. This boost in local attendance is similar to that of other recent conference locations outside of North America e.g. Paris, France (2013), 8.6%; Seoul, Korea (2015), 11.7%; and Glasgow, UK (2019), 13.9%.

Despite the high levels forecast for local attendance, like Hawaii and Korea, Japan actually represents a substantial travel commitment for the typical CHI attendee. The forecast, shown in Figure 1, estimates a total of 2,285 metric tons of CO₂ emitted by travel, each way. This forecast assumes a continued upwards trend in total attendees, however, even if attendance dropped to 2,896, the 2015 level when the conference was last held in Asia, the model predicts emissions 11% higher than for the Korean conference. To drop below Korea for total carbon intensity from travel, attendance would need to fall below 2,500. From an exclusively carbon focused point of view, Japan represents the second worst planned location for CHI since its inception.

Low Carbon Alternatives

If the ACM, and the community, are serious about sustainability and reducing how carbon intensive our premier conference has become, we must face some uncomfortable practical limitations. In closed systems, sustainable growth is an oxymoron [3]. Aircraft are, essentially, as efficient as they are likely to become [11]. While attractive, carbon offsets (*see sidebar*) are of debatable effectiveness [2, 5, 21], and raise troublesome ethical questions [8].

To effectively reduce emissions, failing an enormous and unexpected improvement in the emissions characteristics of intercontinental transport, we must minimise the movement of people. We can most easily do this through two

mechanisms: reduce attendance, or reduce the distance attendees travel. While these mechanisms are not mutually exclusive, it is acknowledged that the former is unlikely to be popular with authors, attendees, the committee, or conference sponsors. Therefore, in the short term, we must settle for minimising attendee travel, and we can achieve this by optimising the location of these conferences.

As with 2021, the planning for 2022 and 2023 is already underway¹². CHI 2021 is to be located in North America, and 2022 in Europe. As noted in the results, the estimated centre of population for CHI attendees is located in the mid-North Atlantic. Choosing locations on either side of this divide will, likely, reduce the total travel of CHI attendees without negatively affecting attendance. In fact over the last decade the lowest travel emissions, on a per-attendee basis, have been Paris, France (2013), Atlanta, USA (2010), and Glasgow, UK (2019)¹³. Each of these conferences demonstrated growth in year-on-year attendance. With this in mind, this paper calls on the committee to preferentially consider locations on the East-coast of North America for 2022 and in Western Europe for 2023.

Going forward, more radical solutions may be required. While the aforementioned conference locations produced the lowest per-attendee travel emissions of the previous ten years, along with attendance, each represented year-on-year growth in total CO₂ attributed to travel. Carefully selecting venues can only be one part of the solution to the challenge of reducing the carbon intensity of CHI.

Experimental remote presence technologies, such as *Beam*, have been trialed at some previous CHI conferences including CHI 2017 and 2018. Remote presence devices

¹² <https://chi.acm.org/chi-series/>

¹³ Closely followed by Montreal (2018) and Toronto (2014), Canada

are challenging to implement and physically limited, both in scope and number [14]. These limitations precluded their use at CHI 2019, and, due to their physical nature, they still require massive infrastructure and continue to consolidate the idea and ideal of large, centralised conference venues.

Expansion of video-based experiences, such as streaming and on-demand access, is already endorsed by the committee¹⁴ and offers much more broadly accessible options for remote attendees. Further, supporting low-cost, local events, such as the ACM SIGCHI Asian Development Committee's *Best of CHI2019* event at IIT Bombay, India¹⁵, can replicate much of the conference experience, foster collaboration, and disseminate ideas with much lower overheads.

In the future, the application of augmented- and virtual-reality may offer huge opportunities for bringing people together, replicating much of the traditional conference experience without the physical requirements and limitations of the current real-world approach. Such radical proposals may finally fulfil the promises of platforms such as *Second Life*, once hailed as the future of business and industry [10].

Limitations

This work presents reasoned estimates for the magnitude of travel emissions directly attributable to CHI conference travel. Its purpose is to surface discussions and consider the impact of conference location as a potential environmental concern for SIGCHI, the ACM, and the broader conference community. However, the accuracy of the estimates presented in this work suffer from a number of limitations inherent in the data, and lack thereof, discussed here.

¹⁴ <https://chi.acm.org/policies-processes/chi-live-and-recorded-video-policy/>

¹⁵ <https://www.indiahci.org/best-of-chi2019/>

Point of Origin

As stated earlier, for the purposes of this work, it is assumed that authors travelled both to and from the conference from their affiliated institution. While for many travellers this may be a reasonable assertion, there are a multitude of reasons why this may not be true. Mundane reasons may include misidentified institutions, errors in tagging, and authors located away from their affiliated location either permanently or at time of travel.

For frequent travellers, including those “out of place” or already travelling for other reasons, it may be possible for them to combine trips. For these individuals travel to and from the conference may be shorter than calculated, or conversely further. In complex cases, even with accurate travel documentation, the contributing impact of the conference location cannot be precisely determined. Factors such as reducing total journeys, or making additional detours, and the relative weighting of consequential travel plans may impact the total distance and how much of the total journey should be apportioned to a particular event.

CO₂ Emissions

The CO₂ emissions presented in this work considers only the two major forms of transportation: personal vehicle, and air. While these make up over 95% of all journeys, where possible attendees may choose to use alternative travel modes such as buses and trains which typically have lower emissions. Local journeys also represent a gap in the NTS data used, and these journeys may reasonably be taken by zero-emission modes of transport. Due to this gap and the precise point of origin being unavailable, journeys below 80 km are zero-rated, as would be typical for bicycle or foot. Conversely, local attendees may equally chose public transport which would typically have higher emissions than the zero-rating applied in these estimates.

Further, while the ICCT aircraft emissions model provides a comprehensive overview of typical CO₂ emissions, these figures may not necessarily be representative of actual attendee emissions. For example, attendees may transport atypical luggage or have a different travel-class make up than the global population. This limitation also applies to typical personal vehicle CO₂ emissions. Individual conference attendees may have differing passenger or vehicle characteristics (e.g. electric, hybrid, gasoline, or diesel). As such it is important to consider these estimates in aggregate. While some attendees will be responsible for greater emissions, others may be responsible for fewer.

Total Attendance

Over the period this work covers, unique authors have increased from 216 (2002) to over 2,500. However, total attendance is 1.5–13× higher than author attendance. To determine the attendance make up, this work includes consideration of the authors overall travel characteristics, which may or may not be representative of the broader CHI attendees. However, as indicated by the published survey data, a large and growing proportion of attendees are authors.

Further, the survey data, used in calculating the coefficients for attendance, is not available after 2015, impacting potential accuracy. Finally, while the attendance model builds upon statistically significant regressions and provides robust estimates for the best represented origin countries, estimates for origins less well represented in the survey data may be less reflective of actual attendance. For origins that are poorly represented, discrepancies may suggest additional, or alternative, causal factors which drive attendance.

Conclusion

This work highlights the scale of emissions attributable, at least in part, to the travel undertaken to attend the CHI

conference. Unfortunately, for those with a view to reduce CO₂ emissions, the immediate future looks troubling.

The limitations discussed should not negate the importance of considering the potential environmental impact of conference travel. Whether convinced by the analysis herein, or not, attendees do travel to conferences. The distance travelled is determined by location. And, be they minuscule or mammoth, travel results in emissions.

As a community we are uniquely placed to walk the walk, not just talk the talk. We are HCI¹⁶. While remote presence devices have been trialed at some previous conferences, they remain challenging to implement and physically limited [14]. However, augmented- and virtual-reality, technologies familiar to CHI attendees and prevalent in CHI papers, may offer alternative approaches in the future.

The purpose of this work is not to guilt-trip or moralise. To be explicit, the message is not “don’t travel.” Rather, these findings should prompt us to ask ourselves, both as individuals and a community, when, where, and why?

If we are comfortable with the trade-off, convinced the social good outweighs the potential harm, then we should feel comfortable continuing as we are, pursuing our gradual moves towards improving sustainability. If not, together, we should consider whether current growth and practices are sustainable and ethical, and how we can apply our own experience and expertise to the challenges that changing research communications would entail.

Acknowledgements

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¹⁶ This was the theme of [CHI 2010](#).

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