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## Indoor Environmental Quality (IEQ)

### Title

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### Permalink

<https://escholarship.org/uc/item/6c75b8c6>

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### Publication Date

2010

Peer reviewed

## Using Text Analysis to Listen to Building Users

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**Keywords:** occupant surveys, indoor environmental quality, adaptation, sociotechnical, building performance and evaluation

### Abstract

This paper reports on analysis of open-ended survey responses in a commercial building occupant indoor environment satisfaction survey database maintained by UC Berkeley. Building on past analyses of Likert-scale satisfaction ratings and categories of dissatisfaction on acoustics, temperature, lighting and overall building and workspace, we use text analysis software to enrich understanding of occupants' perspectives on what matters about the buildings they work in, and why. These comments detail interactions between occupants and their physical environment, and reflect on expectations, stress, and concerns that lie outside dimension-by-dimension assessments of physical building characteristics. They thus speak to gaps between theories of how buildings work for their occupants and experiences of how they actually do. Together they assert the importance of user-centered views that are currently known through anecdote but poorly incorporated in more clinical or top-down views of building environments.

### Introduction

Recent studies on commercial building environments stress the importance of seeking occupant feedback as groundwork for getting new or renovated buildings to provide satisfactory indoor working environments (Bordass & Leaman 2005; Zagreus et al. 2004). Assessments of individual buildings set the stage for broader questions: identifying patterns of occupant experience and reaction that occur across buildings and using these patterns to improve building design, workplace theory, and possibly, workplaces. While it is methodologically straightforward to compare quantitative survey data on indoor environmental quality (IEQ) from building to building, the low dimensionality of IEQ satisfaction scales misses much of the richness and complexity of user experience. Better incorporating this complexity can help reorient more clinical views of indoor environmental quality to better account for users' interpretations in the context of everyday work, social relationships, adaptation, and expectations. This mission supports Vischer's call for building a user-centered theory of the built environment lying somewhere between environmental determinism and social constructivism (Vischer 2008).

This paper examines one method to improve this understanding: analysis of open-end text comments collected in the Occupant IEQ Satisfaction Survey and archived in a

database maintained at University of California Berkeley's Center for the Built Environment (CBE). On-site interviews are the traditional method for collecting "rounded" information on occupant experience. Interviews are potentially richer than survey data, but are impractical or at least unpracticed on a large scale, are less anonymous than web surveys, and are rarely linked to satisfaction ratings which provide at least a rough scale of reference. Since its inception in 2000, CBE's Occupant IEQ Satisfaction Survey collects open-ended responses for a variety of questions, in addition to more traditional closed-ended responses, resulting in an extensive data set couched in IEQ satisfaction terms but providing much more detail.

Historically open-ended text data has been difficult to analyze if collected in research surveys; and are often left untouched for lack of tools and time. Text responses may often not map well to conventional notions of the problem to be solved. Survey text data furthermore strains conventional statistical frameworks for representation and objectivity (Jackson & Trochim 2002; Geer 1991). Recent advances in natural language processing and text analysis software capabilities, prompted by the masses of text data available on the internet, have made text analysis far more accessible than even ten years ago. Much of the emphasis has been on commercial applications, especially marketing and product development, biomedicine, security, and information retrieval; but methods can also apply to survey research.

We use text analysis software to explore the archived text comments in the CBE occupant satisfaction survey, and give an overview of this exploration in this paper. We view this text data as supplemental to traditional collection of satisfaction on the indoor environment. Besides adding technical detail to data collected via closed-ended responses, these data comment on the functional importance of various IEQ problems, describe adaptation and consequences of adaptation, speak to how physical aspects of the indoor environment create workplace stress (Vischer 2007), convey emotion, and illustrate concerns that inform and lie beyond the already complicated but incompletely understood notion of "satisfaction" with physical elements. Many of the themes identified are already familiar as informal knowledge among people who work with buildings, i.e. the anecdotal understanding that occupants disable sensors, hate certain building features, tussle with building management and maintenance personnel, and so on. But much of this knowledge has not breached formal theory about how buildings work for their occupants, nor how they might be improved.

Even without major changes to buildings, occupants can often create more satisfactory work environments for themselves, given opportunities to do so (Heerwagen and Diamond 1992). Satisfaction can derive both from physical changes as well as the psychological value of having control over one's immediate environment. The idealized technological solution of giving people lots of controls and letting them find satisfactory conditions is not necessarily an effective one (Heerwagen and Diamond 1992). Adaptation can also be stressful, and the reasons adaptation is required also matter. Since current "green building" theory builds in expectations of occupants' active participation in creating satisfactory indoor environments (Brown and Cole 2009), our analysis attends especially to adaptive opportunities in all sorts of buildings, constraints to adaptation, and why this matters.

## Data and Method

Since 2000, the Center for the Built Environment (CBE) at University of California has developed and administered an Occupant IEQ Satisfaction Survey (Zagreus *et al.*2004). CBE's ongoing survey database currently includes data for over 400 buildings and 50,000 occupants, incorporating over 300,000 text responses. Information on building characteristics, including the presence of particular design features, is also collected. Half of the surveyed buildings were built after 1991. Nearly half are office buildings, a quarter are educational buildings, and most of the rest are commercial space or public buildings. Buildings in many countries are covered but most buildings are in the United States. Because of software limitations, the text analyses have been applied to only a subset of the comments, while all available records were used for the checkbox and satisfaction summaries.

Surveys are administered to building occupants over the web. They include core questions on occupant satisfaction with various dimensions of the indoor environment and physical workspace, along with questions on particular building features and other matters, depending on the building. At a minimum, respondents are asked to rate satisfaction with thermal comfort, air quality, lighting, acoustic quality, speech privacy, office furnishings, office layout, cleaning and maintenance, the workspace in general, and the building in general. Ratings are collected on a 7-point Likert scale. When respondents express dissatisfaction with one of the major dimensions, they are asked to explain by a yes/no response to a series of checkbox questions including some dozen different options for the particular IEQ dimension. The checkbox options in the CBE survey were developed by extensive testing and cognitive interviewing (Zagreus *et al.*2004), ensuring good coverage of a wide range of technical concerns. In addition to the satisfaction scale and the checkbox explanations of dissatisfaction, respondents are given the opportunity to provide a free-text response on further explanation of sources of dissatisfaction. And all respondents are asked for any general comments on building and workspace.

The text responses offered by survey respondents range in length from a few words to a half-page. For basic IEQ questions, because only dissatisfied occupants are prompted for open-end responses, text data are already structured as to main topic and overall to negative sentiment. The comments are of a mix of different types: technical descriptions of conditions and dynamics; personal descriptions of physical and general working conditions; description of adaptations with assessments of how well this has worked and what constraints and tradeoffs are encountered; functional assessments of working conditions; commentary on interactions within the workspace and organization, both technical and social; and reflections on survey questions, workspace design, and organizational politics.

We used PASW Text Analytics for Surveys for the text analyses, creating custom text analysis packages based on extracted keywords. Much of the first-order value of this data comes through with relatively simple assessments, rather than requiring sophisticated linguistic or statistical techniques. Participating in surveys, including this one, is already voluntary. Response rates for the open-ended questions in the CBE survey are lower than for scaled questions, and respondents answer questions in a variety of non-parallel ways. Though promised anonymity, the promise is not

necessarily believed, and respondents typically speak in workplace tone. There is no rigid statistical framework for interpreting this data.

Our approach is analytic, but more sociological than statistical. In this exploratory work, we rely on univariate frequencies as sufficient to raise viewpoints that might be explored by more statistical or more sociological means, with more attention to who is saying what and in which situations. The frequency of any given theme presumably says something about salience and importance to workplace experience, but imprecisely. Some ideas may be rarely stated but capture a wider sentiment. Others exist in opposite hate-love pairs. And most can be classified in a variety of ways. As primarily office workers, most survey respondents are presumed college-educated and comfortable with words. They are, overall, articulate and thoughtful about their experience in the workplace. At the same time, many comments seem beyond the direct range of building design and operations, to be trivial, one-off, venting or rambling. Precisely because of their “out of range” character, if the questions are about what makes a workspace better or worse, these comments deserve to be left in and reported on, rather than being corralled out.

### Satisfaction Ratings on Basic IEQ Dimensions

Table 1 summarizes the Likert-scale responses of survey occupants on core questions about satisfaction with basic dimensions of indoor environmental quality, workspace, and the building overall. These responses are grouped by the percentage of respondents who said that they were dissatisfied (Likert-scale rating -3, -2, or -1), neutral (rating 0), or satisfied (rating 1, 2, or 3), presented from most satisfactory to least satisfactory elements. Almost three-fourths of occupants said that they found amount of light satisfactory and two-thirds found office furniture comfort satisfactory. A casual observer might imagine that most commercial buildings function smoothly enough to satisfy most occupant expectations. But the satisfaction rates shown here tell a different story. Air quality, temperature, noise level, and speech privacy – factors most closely linked to building systems and workplace physical structure – each satisfy less than half of surveyed occupants. Despite this component-wise dissatisfaction, satisfaction rates with the building and workspace overall are among the highest of any dimension measured, with two-thirds saying that they are satisfied. The reasons for this remain a good question.

Table 1. Survey respondent satisfaction with basic IEQ and building factors, ordered from highest percentage satisfied to lowest (n=46,513).

How satisfied are you with?	Percentage of respondents		
	Dissatisfied	Neutral	Satisfied
Amount of Light	14	13	73
Workspace Overall	17	16	67
Office Furniture Comfort	19	14	67
Building Overall	18	16	66
Cleanliness of Building	22	16	63
Cleanliness of Workspace	24	17	59
Visual Privacy	32	14	54
Air Quality	32	21	47
Noise Level	36	17	46
Temperature	42	19	39
Sound/Speech Privacy	57	13	30

On the one hand, the goal of a workplace is rarely to satisfy employees. Rather, it might be to accommodate them in a way that roughly supports their work subject to considerations of cost, organizational image, the diversity of occupants and visitors, and, as Ciulla (2000) discusses, an interest in “taming the worker.” Design decisions are also much less rational than researchers assume, and space is often used for other than the original intended function (Vischer 2002), so the process of creating and maintaining workspaces is already not oriented to optimizing productivity or meeting comfort ideals. On the other hand, Table 1 suggests that there is much to learn about where and how theories of building and maintaining adequate workplaces fail from the perspective of occupants. Here is where open-ended survey responses become so valuable.

### **Themes from the Text Analysis**

The remainder of this paper summarizes some major themes present in user comments for questions about the building and workspace overall, acoustics, thermal environment, and lighting.

#### **General Building**

At the end of the CBE survey, all respondents are asked for any additional comments about the building and about the workspace. These responses thus represent what occupants find important or otherwise felt they needed to say but that was missed by the preceding survey questions, and are not necessarily negative. This openness makes the comments especially interesting. Topics cover basic IEQ and workplace functionality concerns queried elsewhere in the survey, but some also tie together physical dimensions, the workplace as a social organization, and the survey:

- “I hate to be blunt, but this office is a bit of a dump. I appreciate the chance to take this survey and express my feelings. However, the survey seems slanted towards issues of productivity. How about a question regarding how the workplace environment affects employee satisfaction?”
- “Overall the physical environment is fine. The bottom line is a good manager that maintains the good attitude and motivation of the staff irrespective of the environment. The environment matters more only where the manager is lacking.”
- “This building is a terrible place to work. I would take a 25% salary cut just to work in a different building.”
- “Management does whatever it wants. Nothing I say would make any difference.”
- “These questions are irrelevant to me. I work for the government and have to do my work, no matter what the physical conditions.”
- “Many of these questions are related to things that cannot be changed without great cost. What is the intent of these questions?”
- “Most negatives in survey reflect personal interactions and level of respect between personnel that workspace and building changes may or may not affect.”
- “Having a private office would be great, and nothing about a cube can be totally satisfactory. It is, what it is. At least the space has been renovated and the puke pink walls have been replaced by a nice soft green.”

These comments put the physical environment in its place. Abstract notions of ideal physical environments make limited sense viewed from the worker’s desk, and the question of “how could we get you to produce more” is not necessarily a welcome

one especially if the answers can only be about the physical environment and changes are viewed as unlikely. At extremes, physical qualities may overwhelm other concerns, but overall these comments transcend dimension-by-dimension assessment of physical qualities (Vischer 2008) and point to the importance of how the organization makes them feel. The survey does not try to cover all aspects of the workplace –in whose interest is it to know what occupants think about office management? But neither is interpretation of physical aspects about only the physical. Overall, the responses support Goins’ (2010) suggestion that the symbolic meaning of workplace organization and design are, overall, more important to worker performance than the physical attributes *per se*.

An environmental determinist view of occupant experience sees occupant satisfaction as an outcome of the physical functioning of the environment (Vischer 2008). An alternative view might be, “If occupants feel supported in their quest to do their work, they feel more satisfied with the physical environment.” Part of what matters to rated satisfaction with the physical environment is whether workers feel respected. Respect and disrespect can be demonstrated in a number of ways. Where does the worker fall in the hierarchy of attention to people and things? Adapting to a moderate range of thermal conditions may be fine, but when the reasons for the adaptation are management or design inattention, adaptation opportunities are blocked, or complaints about fixable problems are ignored, it sends a clear message about the worker’s importance. Users may typically set expectations not to the ideal, but to what they think can reasonably be done, and whether somebody with the power to do so has tried to do something about it. Respondent comments often interpret the physical environment in these terms – forgiving old buildings for flaws, loathing architects for self-indulgence at the apparent cost of occupants, resenting green theory that trumps usability or praising it if the effort seemed sincere, understanding the limitations of government funding, accepting that HVAC system flaws are not easily fixed, and so on.

We categorized the responses to the general satisfaction questions as to main themes and within these identified reoccurring motifs, with many responses covering multiple topics. Alternative classifications are possible. Based on our definitions, 75% of the responses were categorized. Ranked in terms of frequency, the top 15 themes, each reflecting at least 5% of responses were, in order: bathrooms, cleaning, temperature, air quality, parking, eating and restaurants; carpet, furniture and paint; acoustics, water and plumbing; lighting; windows; doors and entryways; elevators; building maintenance and management, and building security. Table 2 summarizes these themes and some of the motifs within them.<sup>1</sup> Below we discuss some of these categories, outside the traditional IEQ realm.

Basic personal comforts are near the top of the list: give me a place to park, a reasonable place to eat and somewhere to buy coffee, and above all, a clean place to retreat. These matters do not directly affect ability to perform a job, as opposed to acoustic dissatisfaction for example, which many respondents mark as the worst problem from the point of workspace functionality. However more organizational

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<sup>1</sup> Many of the basic IEQ questions (cleanliness, air quality, temperature, acoustics, building maintenance, furnishings, among the 15) appear elsewhere on the survey, so this is not an overall ranking of occupant concerns.

attention to some of these might reduce what Vischer (2007) calls “daily hassles” and would also symbolize general attention to users. The bathroom, top of the list, is mentioned in 15% of categorized responses to the general workspace and general building questions.<sup>2</sup> The bathroom is not, then, a simple functional feature, and respondents had much to say about them. Many of the comments might seem one-off or completely irrelevant in terms of design attention, from “The floors are too shiny, we can see reflections!” to “Why do the cleaning ladies insist on stuffing the paper towel dispenser so full?” Yet the toilet, that basic of comforts, becomes not only a magnet for complaints but also a nexus for judging the thoughtfulness of building design, maintenance, and colleagues, as well as resistance to sharing such private space.

Table 2. Top themes in user responses to questions on general building and general workspace.

<b>1. Bathrooms:</b> Cleanliness, odor, bad manners of colleagues, distance from workspace, low-flow toilets, issues with paper products, privacy concerns, sharing bathrooms with public.	<b>9. Water and plumbing:</b> Leaks, faucets that don’t stay on, water that looks or tastes bad.
<b>2. Cleaning:</b> Insufficient cleaning, disruptive cleaning during work hours, recycling issues.	<b>10. Lighting:</b> Insufficient light, dissatisfaction with lighting aesthetics, dislike of automated lighting systems, sunlight, maintenance issues with lighting.
<b>3. Temperature:</b> Too much air conditioning, too little heat, unpredictable and varying temperatures, limited adaptation opportunities, inappropriate building design.	<b>11. Windows:</b> “If I had a window, this would make up for a lot,” “Since I have a window, things are much better than they would be,” shading problems, issues with opening windows.
<b>4. Air quality:</b> Dust, fresh air, problems with smokers and for smokers, odor.	<b>12. Doors and entryways:</b> Disruption to those nearby; entryways that don’t protect occupants from weather
<b>5. Parking:</b> Hassles in finding parking, annoying allocation policies, expense, access from parking lot.	<b>13. Elevators:</b> Poor programming of elevators, noise, slow; stairs difficult or impossible to use.
<b>6. Eating and restaurants:</b> lack of places in the building or nearby to eat or to buy coffee, poor food selection in cafeteria or vending machines, prices, space to take a break especially outdoors, food odors.	<b>14. Building maintenance and management:</b> Some compliments, mostly complaints that problems are not fixed or fixes are inadequate, slow response, no response, broken agreements.
<b>7. Carpet, furniture, and paint:</b> Bad colors, old paint, walls not cleaned, outdated furnishing, things that are easy to fix but have not been.	<b>15. Building security:</b> Procedures that hinder employees such as security checks and card keys; feeling unsafe; security procedures that don’t work, unprofessional security guards.
<b>8. Acoustics:</b> Noise distractions, speech privacy, misfit between acoustical environment and tasks, annoyance with cubicles, annoyance at design features that exacerbate noise, good and bad white noise.	

As to fixing HVAC and other building system problems, some comments compliment building maintenance staff, but most maintenance stories are about

<sup>2</sup> The fact that comments on restrooms are easy to spot linguistically, and that other survey questions do not address restrooms, accounts for part of the popularity.



problems not fixed, inadequate fixes, lack of responsiveness and dilatory practices, roadblocks to communicating with building maintenance staff, including having nobody to communicate with and split incentives among building owners, managers, and occupants. Of course occupants are less likely to write about smooth sailing fixes. But the results do suggest that a naïve theory of complaint-based systems maintenance, where occupants call dedicated staff who subsequently follow the book to alleviate problems behind the complaint, is unfounded. In practice, how are occupant complaints managed, and how do the stories told by building occupants and those by building operators differ? And what implications do these clashes of perspectives and the swirl of physical changes they entail have on how buildings work, and on long-run building performance versus complaint avoidance.

Some building design issues drew special comment. Occupants often criticized exterior design and heavily symbolic features (e.g., atriums, grand entrances, glass buildings) that they saw as coming at the expense of functionality and occupant needs, such as adequate space, quality interiors, and general thoughtfulness about basic comforts. Comments calling out green buildings were particularly interesting, ranging from forgiveness – “I’m proud to be in a green building. This isn’t diminished by the comfort issues I have” – to extreme frustration “The green building will survive at employees’ expense so the managers can say: We are the first with a green building, and here are the savings \$\$; screw the occupants. I am resigned to that fate and will continue to keep my mouth shut at work.”

### **Acoustics**

The acoustic environment, meaning noise level and speech privacy, is among the least satisfactory dimensions of workspace quality (Table 1 above). Satisfaction is lower in cubicles than in private offices (Jensen et al.2005). In a sample of the CBE survey data, new green-intent buildings were found to perform more poorly than other buildings overall in part because of the more open office environments (Fard 2006). Opportunities for coping with acoustic problems are more limited than for lighting and temperature. Respondents mention playing music, lowering voices and taking calls elsewhere; but “psychological coping” is the main option in most cases (Heerwagen and Diamond 1992).

Figure 1 shows the distribution of complaints from survey respondents dissatisfied with the acoustic environment, as indicated by their checkbox responses.<sup>3</sup> Overhearing people talking is the most common response, at 23% of the complaints; 61% of dissatisfied respondents marked this option. Fewer (18% of complaints) marked “people overhearing my private conversations.” Telephones ringing and speakerphones make up 30% of the complaints. Text responses for acoustic dissatisfaction show the same kinds of complaints, adding detail and interpreting dynamics and coping mechanisms. The text responses, however, reveal more of the emotional background and the dilemmas created. Many expressed distress, sometimes veering on outrage, at having to do work that requires concentration in a cubicle environment where noise was noise was not sufficiently controlled:

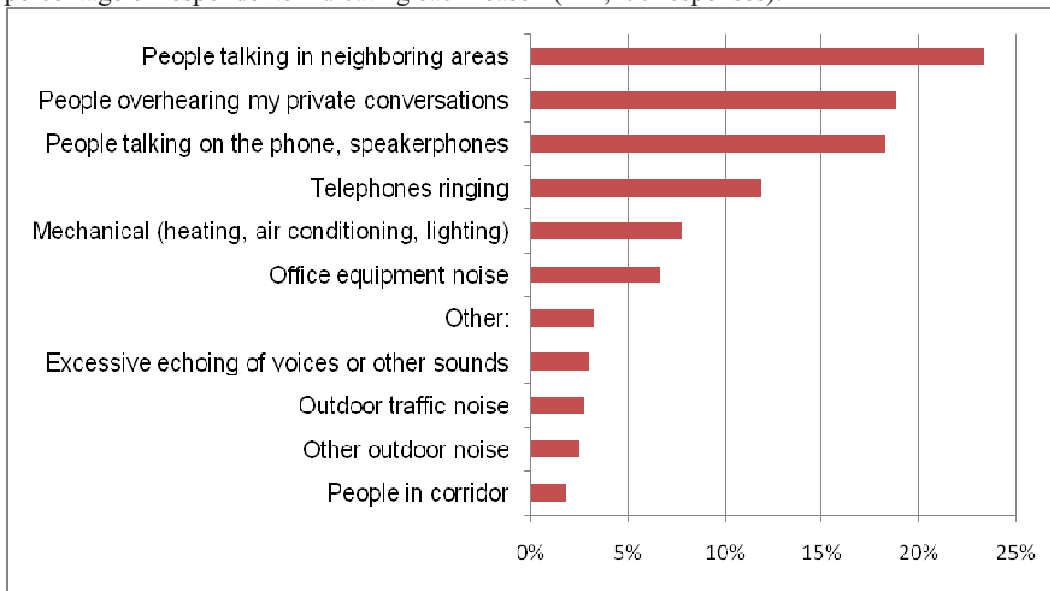
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<sup>3</sup> Respondents can indicate more than one problem. Respondents who answered this question checked an average of 2.8 reasons.

- Noise is a critical issue in the building. It is so noisy I cannot concentrate. Playing music on headphones works, when I am doing work that does not require concentration but for reading and writing technical things the noise level makes it near impossible.”

Preventable noise brought the strongest reactions, especially loud colleagues, non-work conversations and conversations that could be moved elsewhere, other people’s music, and vacuuming during work hours. Where acoustical design fails from the perspective of employees, some of these problems might be partly alleviated by social and organizational strategies, but there may rarely be an organizational process to consider such strategies – and similarly for all sorts of other issues noted in the general satisfaction questions.

Figure 1. Distribution of reasons for dissatisfaction with the acoustic environment, by percentage of respondents indicating each reason (121,478 responses).



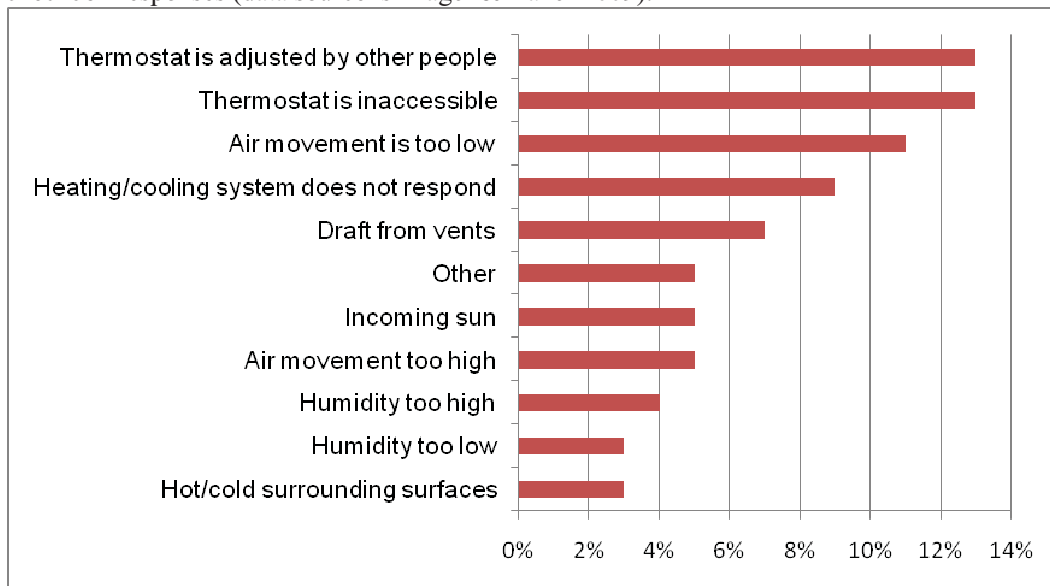
Professionalism demands control over emotions, “subordinat[ing oneself] to the job at hand,” remaining pleasant and friendly no matter what one thinks of colleagues (Ciulla 2000:122-126). This professionalism, along with standard hierarchical considerations, and low expectations that raising a problem will bring positive change, may leave occupants reluctant to confront problems. For example, some play music to cope with noise or as territorial marking, and the music in turn annoys others. This is one of many examples of cascading problems. Adaptation by one occupant to one environmental condition causes problems in other dimensions or to other users. Overhearing other people’s music was a common complaint, with “music” or “radio” present in 8% of categorized comments on acoustic dissatisfaction. Technically this problem seems easy to rectify – disallow radios, ask users to turn them off or to use headphones. But this pair of comments from the same building and possibly neighboring cubes hints that this is not easy: “I like that my radio doesn’t bother my neighbors” *versus* “I would love to crush, with my bare hands, any radio brought into this workplace. What are people thinking?????” The first comment may be facetious, but as general office folklore suggests, apparently simple noise problems fester.

Occupants also commented on discomfort with their own speech, both others overhearing private conversations (work-related or not) as well as not wanting to bother colleagues. They often mention that they make effort to keep their voice low, change what they say and when, again at effort. Depending on the local acoustics, occupants may feel forced to deal with sensitive issues in email, changing the nature of the intended conversation, and possibly the amount of time taken to deal with it. Occupants with private offices mention closing the door, but also that this itself has reverberations in communications, relations with colleagues, and the thermal environment.

### Thermal Environment

Figure 2 shows the top twelve check-box responses from survey respondents who offered explanations for their dissatisfaction with temperature (Brager & Baker 2009). Open-text responses reflect similar concerns, but overlay “standard” dissatisfaction about temperature as a physical condition with reactions to the causes of this dissatisfaction, description of adaptation strategies and barriers, and a broader assessment of relationships among thermal conditions, satisfaction, and work.

Figure 2. Top twelve reasons for dissatisfaction with temperature, compiled from survey checkbox responses (data source is Brager & Baker 2009).



Adaptive comfort research argues that most people can adjust to a range of temperatures considerably broader than standard, that doing so especially in conformity with weather is natural and even pleasurable (e.g., Baker 2001; deDear and Brager 2001). To do this people need adaptation opportunities. Heerwagen and Diamond (1992) outline common adaptation strategies for various kinds of discomfort with workplace physical environment, and the open-ended survey responses reflect these strategies very well. Some with windows have the ability to open them or at least access to shades, fewer have operable windows that might either reduce or increase heat, and fewer still have access to thermostats that effectively control temperature in line with expectations. Many keep extra clothing, dress in layers, take walks, etc. Occupants often point to difficulty in dressing to accommodate both outdoor weather and indoor thermal conditions, and comment on the wastefulness of

overcooling and overheating, especially when it contrasts with other forms of economy in the organization.

It is well known that people actively cope with indoor thermal conditions, less so how often, with what consequences, and in which buildings. The reasons for thermal discomfort also matter. Occupants themselves are not directly determining the level of air conditioning in large buildings, or at least not in anything resembling democratic vote. Is the problem poorly balanced systems, the effects of complaint reduction forcing high cooling or heating levels, an unexpectedly wide range of temperature preferences, or fussy employees? While most modern buildings, in theory, are capable of maintaining temperature in a fairly restricted range, many may not perform that way. Previous analysis of the CBE survey data base reveals that only 11% of buildings met the ASHRAE target of keeping 80% of occupants comfortable (Abbaszadeh et al.2006; Brager and Baker 2009). In the summer, survey checkbox responses show more complaints about being too cold (56%) than being too hot (53%). The sum is greater than 100% since occupants can indicate both problems. There were also many complaints about being too hot in the winter (38%) rather than just being too cold (69%). Resentment around “too much air conditioning” shows up vividly in text comments, and some describe the dilemmas created:

- “I would like more natural temperatures, without all the damn heating and air conditioning. I'd usually like it warmer, because all the air conditioning makes it too cold, but not at the expense of using the heater. Opening the window is not enough to compensate for all the air conditioning and it makes it less safe, and the window is difficult to access.”

Second, the degree of temperature and ventilation problems and the frequency with which occupants feel they must adapt also matter. Dissatisfied occupants sometimes cite temperatures in the low 60s°F and upper 80s°F, and complain about ill-placed or poorly-adjusted vents blowing intermittently on their heads or at their feet. Vents may often be easy to block, and open-text responses describe some of these strategies, often with an air of triumph. The vent-blocking in turn, has implications for others in the same zone.

Third, perception of what solutions are available matters. Occupants accept and may forgive comfort problems in old buildings, especially ones with other charms, as opposed to where they perceive intentional disregard for occupants, e.g., “Why would anybody build a glass building in [a hot sunny city] without air conditioning, why??” But many responses criticized automation that turns off air conditioning and heating at set hours (6 pm) or on weekends, adding insult to working overtime in the name of saving money for somebody else. Rules that require occupants to purchase their own portable heaters or coolers, or worse yet, that prohibit the use of any portable heating device, came out as especially irritating. Here adaptive practices are blocked, perhaps often without readily apparent rationale, or comfort concerns are made to be personal problems to be managed on one’s own.

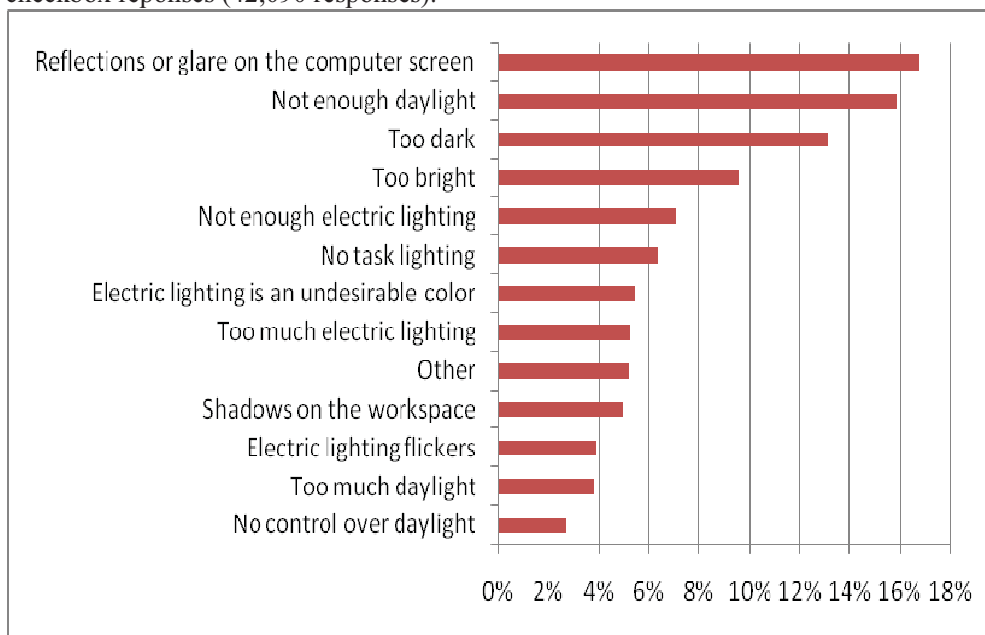
Finally, some responses mention appealing to building operations to fix problems, but not expecting much change. In contrast, at least from an occupant perspective, many other partial solutions (e.g., supplying portable heaters and fans, adding shades or window treatment, changing the hours of vacuuming, changing automated lighting and HVAC so that they better fit occupant needs, allowing personalization of

offices—that this is against policy is not an uncommon complaint) are easier to change; the fact that they are often not may send the message that basic occupant needs are systematically ignored or are trumped by theory, cost or energy savings, or obliviousness.

## Lighting

Overall, lighting quantity has high satisfaction levels, with only one in seven rating themselves as dissatisfied with amount of light. Figure 4 shows the results of the checkbox responses for reasons for dissatisfaction with lighting in general. Reflections or glare on the computer screen (17%) and not enough daylight (16%) are the most common responses. Lighting is too bright, too dim, glaring, the fluorescent lights are disliked, and so on.

Figure 4. Distribution of reasons for dissatisfaction with lighting, compiled from survey checkbox responses (42,090 responses).



Among lighting issues, besides desire for natural lighting, trouble with automatic lighting systems stands out. Lights turn off when the space is occupied, forcing the occupant to deliberately activate the sensor or accept the dark; occupants dislike sensors; systems are not designed for or adjusted for actual occupancy patterns or schedules; skepticism about energy savings; annoyance about being subjected to something or somebody else's will; and a general desire to control lighting on one's own. None of these are likely to have a huge impact on productivity but all have phenomenological implications.

In theory, system commissioning and improved technology can overcome some problems with automated systems, but this is not the end of the story. Commissioning and adjustments are not necessarily done, and even when they are, may not solve what occupants see as problems. As Edge (1974) argues, technological devices fill consciousness and create strong metaphors, reflecting their importance in shaping social relationships and our attitudes about them. And so then does their control and the perceived reasons for their control (e.g., energy savings, subjugation). Here the

multiple stories about jury-rigging to fix problems that building management does not or has not been asked to repair, and on disabling automated systems told in survey comments and known in building folklore (Embrechts & van Bellegen 1997; Vaidya et al.2004) speak to more than just fixing physical problems.

## **Discussion**

The analyses above provide a short overview of user comments collected by the CBE occupant satisfaction surveys. More extensive linguistic interpretation and more targeted analyses on subsets of buildings, particular features, and relationships among ratings and comments would also be supported. From a statistical point of view the data is partial. Only dissatisfied occupants answer most questions, and it is unclear how much any one comment represents. But the data, if heeded, does a good job at creating space to remember much of what is often forgotten about building occupant experience, couched in terms that help translate technical points of view to more user-centered ones, and raise a number of questions needing more investigation: How much are occupants already adapting and what are the consequences of this adaptation? Why are satisfaction rates for temperature so poor? How are complaints managed? Are there organizational strategies that can successfully improve some environmental satisfaction problems? Are acoustical problems driving workers to despair?

While traditional occupant satisfaction assessment tries to purify experience into physical and particularly design components and to assess how well each component satisfies expectations or supports job functioning, users have a different view and different criteria. They read organizational values into physical systems and care not only about doing their work but about how they are treated, and whether the building helps makes life pleasant or makes it harder. How much of this is incorporated in the notion of “satisfaction” is unclear. The mission of improving physical environments, whether this means spaces that increase employee productivity, improve employee health, or reduce energy and environmental impact of buildings, cannot be won on engineering criteria alone.

Presently, various environment- and energy-oriented initiatives – green buildings, zero net energy buildings, demand response tariffs for electricity, and employee-centered conservation campaigns – all make strong assumptions about the participation of building occupants in creating or defining environments that meet other goals while, it is assumed, maintaining adequate environments for occupants. So these initiatives, where more is asked or assumed of the occupant, should be planned with a firm base in understanding what occupants already experience and already do, what they care more about and what they care less about, told from an occupant rather than theoretical perspective.

## **Conclusions**

Though technical, methodological, and interpretative challenges remain, our analysis of the open-ended responses given by survey respondents shows that this data supplies information that helps interpret and goes beyond what is conveyed in single-dimension satisfaction ratings and other closed-ended forms of survey data. Surveys could even be extended, on an experimental basis, to request further open-ended input from respondents.

User comments also draw attention to the importance of basic comforts that are not directly linked with producing work, but rather to well-being, pleasure, and with reading support rather than antagonism from the organizations they work for. This is not to diminish the importance of the purely physical interpretation of IEQ and the physical workspace's fit or misfit with what workers feel they need to do (Vischer 2007), but rather to draw the lens wider with greater depth of field. This wider view is important because such a large proportion of occupants find that their workspaces come up short, even with modest expectations of what an office should be like.

## References

- Abbaszadeh, S., L. Zagreus, D. Lehrer, and C. Huizenga (2006), Occupant Satisfaction with Indoor Environmental Quality in Green Buildings. *Proceedings of the Healthy Buildings Conference*, Lisbon.
- Baker, N. (2001), Designing for Comfort. Recognising the Adaptive Urge, Keynote Paper. *Proceedings of the Cooling Frontiers Conference*, Arizona State University.
- Bordass, W. and A. Leaman (2005), Making Feedback and Post-Occupancy Evaluation Routine: a Portfolio of Feedback Techniques. *Building Research & Information* 33(4):347-352.
- Brager, G. and L. Baker (2009), Occupant Satisfaction in Mixed-Mode Buildings, *Building Research and Information* 37(4):369-380.
- Cole, R.J., J. Robinson, Z. Brown, and M. O'Shea (2008), Re-Contextualizing the Notion of Comfort, *Building Research & Information* 36(4):323-336.
- Ciulla, J. B (2000), *The Working Life*, New York, Times Books.
- de Dear, R., and G. Brager (2001), The Adaptive Model of Thermal Comfort and Energy Conservation in the Built Environment, *International Journal of Biometeorology* 45:100-108.
- Edge, D. (1974), Technological Metaphor and Social Control, *New Literary History* 6(1):135-147.
- Embrechts, R. and C. Van Bellegem (1997), Increased Energy Savings by Individual Light Control, *Proceedings of Right Light 4*.
- Fard, S.A. (2006), Post Occupancy Evaluation of Indoor Environmental Quality: Do Green Buildings Have More Satisfied Occupants?, M.S. University of California Berkeley.
- Geer, J. G. (1991), Do Open-ended Questions Measure 'Salient' Issues?, *Public Opinion Quarterly* 55(3):360-370.
- Goins, J., J. Jellema, and H. Zhang (2010), Architectural Enclosure's Effect on Office Worker Performance: A Comparison of the Physical and Symbolic Attributes of Workspace Dividers, *Building and Environment* 45:944-948.
- Heerwagen, J. and R. C. Diamond (1992), Adaptations and Coping: Occupant Response to Discomfort in Energy Efficient Buildings, *Proceedings of the 1992 Summer Study on Energy Efficiency in Buildings*, Washington, D.C., American Council for an Energy Efficient Economy.
- Huizenga, C, S. Abbaszadeh, L. Zagreus, and E.Arens (2006), Air Quality and Thermal Comfort in Office Buildings: Results of a Large Indoor Environmental Quality Survey, *Proceedings of Healthy Buildings 2006*, Lisbon. Vol. 3: 393-397.

- Jackson, Kristen M. and William M. K. Trochim (2002), Concept Mapping as an Alternative Approach for the Analysis of Open-Ended Survey Responses, *Organizational Research Methods* 5(4):307-336.
- Jensen, K.L., Arens, E., and Zagreus, L. (2005), Acoustical Quality in Office Workstations, as Assessed by Occupant Surveys, *Proceedings of Indoor Air*.
- Nicol, J. F., and M. A. Humphreys (2002), Adaptive Thermal Comfort and Sustainable Thermal Standards for Buildings, *Energy and Buildings* 34(6):563-572.
- Vaidya, P., T. McDougall, D. Eijadi, J. Douglas, and J. Steinbock (2004), What's Wrong with Daylighting. Where it Goes Wrong and How Users Respond to Failure, pp. 7.342-7.357, *Proceedings of the 2004 ACEEE Summer Study on Energy Efficiency in Buildings*, Washington DC, American Council for an Energy Efficient Economy.
- Vischer, J. (2002), Post-Occupancy Evaluation: A Multifaceted Tool for Building Improvement, Chapter 3 in *Learning from Our Buildings*, Federal Facilities Council Technical Report No. 145, Washington DC, National Academies Press.
- Vischer, J. (2007), The Effects of the Physical Environment on Job Performance: Towards a Theoretical Model of Workplace Stress, *Stress and Health* 23:175-184.
- Vischer, Jacqueline (2008), Towards a User-Centred Theory of the Built Environment, *Building Research & Information* 36(3):231-240.
- Zagreus, L., C. Huizenga, E. Arens, and D. Lehrer (2004), Listening to Occupants: a Web-Based Indoor Environmental Quality Survey, *Indoor Air* 14(Suppl 8):65-74.