The office: how standards define 'normal' office design practices and work infrastructures

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Introduction

The post-industrial city is a complex assemblage of infrastructures. Some scholars have written about the pipes and cables buried beneath the roads and pathways of the city (Graham and Marvin, 2001), whilst others note that we only become aware of many of these infrastructures when they fail (Graham and Thrift, 2007). Here, we concern ourselves with a different manifestation of infrastructure: the office building.

In its post-industrial guise, the city in the developed economies of Western Europe and North America has come to be defined by office work ranging from finance, insurance, and real estate (Sassen, 2011) to cultural industries such as advertising and architecture (Scott, 2000) and administration and sales work required by corporations (Scott, 1996). All these sectors and more call for offices. The office has consequently become a fundamental feature not only of cities, but of a vast range of working practices distributed across multiple fields and sectors. Roughly a third of workers were found in offices in 1974, and almost half in 2005 (46%), according to the Multinational Time Use Survey.

Of course, the pipes and wires that allow flows of electricity and water into and out of the office, and the roads that bring workers from their homes, are infrastructures that serve offices. In categorising office *buildings* as infrastructures, we follow Star and Lampland

(2009), who define infrastructures in two ways. First, they define infrastructure as something 'invisible, part of the background of other kinds of work'. Second, they define infrastructures as relational. As they put it, 'one person's infrastructure is another's brick wall ... the teacher considers the blackboard as working infrastructure integral to giving a lesson. For the school architect and for the janitor, it is a variable in a spatial planning process or a target for cleaning'(2009: 17). In this sense, the office itself is clearly an infrastructure for those working within it. De Wit et al. (2002) describe offices as 'space[s] in which different sets of heterogeneous technologies are mobilised in support of social and economic activities', whilst Niezabitowska and Winnicka-Jaslowska (2011) adopt a similar conceptualisation, emphasising the coevolution between technologies, work practices and offices. In such views, the office is a machine for working, an infrastructural nexus of space, technology and practices (Hui et al., 2016).

In this chapter, we ask how those developing new and refurbishing existing offices produce building infrastructures that service a particular form of 'normal' office work. In particular, we focus on how various *standards* shape the design of office infrastructures and their utilisation of infrastructures of electricity provision. By standards, we mean agreed rules which coordinate the process of designing offices and which specify acceptable levels of provision (Bowker and Star, 2000; Timmermans and Epstein, 2010). We focus on how standards represent 'normal' office infrastructure capable of servicing 'normal' work practices. Using examples from the speculatively developed office market in London, UK, in the years 2010–2015, we show then how complex interplays between different standards generate interlocking effects that tie 'normal' offices (at least in the context of an international financial centre) to specific levels of infrastructural provision which have become ubiquitous.. Underlying this are particular assumed understandings of work practices which drive understandings of what is 'needed' in a 'normal' office. This has implications for both ongoing office building design and for the potential for adaptations to changing work, technologies and environmental concerns.

Offices and standards

The office is analysed in a variety of ways. For some it is an innovation junction, where technologies facilitate work (De Wit et al., 2002). For others, it is a symbolic space, attached to the identity of the companies that occupy it (Black, 2000). It can be seen as a space defined by cultural circuits of knowledge which construct ideas about productive and desirable working environments (O'Neill and McGuirk, 2003). A political economy perspective emphasises the role of property markets (D'Arcy and Keogh, 1997), and valuation of office space in a financial investment context where ‘form follows finance’ (Willis, 1995). Yet others have explored how office forms and functions reflect the organisation both of space and of work (Burrell and Dale, 2003).

We consider instead how much of the above influences come to be represented in a series of standards that define what the ‘normal’ office should be as an infrastructure. There is an extensive literature on standards in the social sciences (e.g. Bowker and Star, 2000, Allen and Sriram, 2000, Busch, 2000, Schmidt and Werle, 1992), which provides a compelling account of their power to coordinate design processes and the incorporation of technologies into infrastructures. In particular, it is suggested that standards coordinate by homogenising: defining what is standard and conversely, nonstandard and to be avoided. There is also recognition that standards come in many forms. Timmermans and Epstein (2010: 72) differentiate between *design* standards that specify technical properties, *performance* standards that define operation, *terminological* standards that use labels and categories to classify and *procedural* standards that define steps to be taken in any process. In the case of UK offices, several of these types of standards have coordinating effects, explored below in a summary of regulatory and voluntary standards relating to office building design.

In the UK, the law governs building design primarily through building regulations which cover most aspects of a building in a prescriptive framework within which design must operate (Imrie, 2007). These regulations cover issues such as structural, safety and well-being aspects of *design* e.g. the structural loading capacities of different materials and the insulating properties of walls and windows. Others apply to the provision of ventilation/fresh air (driven by historical concerns about 'sick buildings'), lifts and stairs (particularly for emergency evacuation, based on expected occupancy of the building) and toilets (again, per occupancy). Provision cannot fall below a certain level, in the interests of health and safety.

Since 2010, the energy efficiency *performance* of new non-domestic buildings including offices has been addressed in 'Part L2A of the Building Regulations', addressing the 'conservation of fuel and power' (HM Government, 2013). Part L requirements are set in terms of CO_2 emissions reductions, with the onus on developers and their designers to demonstrate that their intended building is designed to have lower emissions than a reference model.[1] However, Part L does not mandate *how* developers and designers are to ensure that their building performs better than the similarly sized and shaped 'reference' building created for this comparison. Rather, it focuses on the modelled performance of the design. It is also important to note that Part L compliance is assessed on the modelled performance of a building's main heating, ventilation, air conditioning (HVAC), lighting and other major systems, using only standardised assumptions about building occupancy. It does not take account of anticipated patterns of occupancy and use, including the energy use associated with computers and other plug-in equipment (Van Dronkelaar et al., 2016).

Not only building regulations act as *performance* standards. New buildings require an Energy Performance Certificate (EPC) before they can be sold or let. EPCs label the energy efficiency of the building on an A–G rating scale similar to those used to indicate the energy efficiency of domestic appliances (Department of Communities and Local Government, 2012). They are calculated using a similar methodology to that used for demonstrating Part L compliance (i.e., a modelled estimate under standardised conditions, not an estimate of likely real energy consumption). This is fairly typical of the international situation, where to bring coherence to international 'energy standards' for buildings, the EU's (2003) Energy Performance of Buildings Directive only demanded building certificates be based on actual energy performance 'to the extent possible'. A more prescriptive approach based on real performance was adopted by many EU countries (Economidou, 2012), which the UK's Display Energy Certificates (DECs) also provide, but only in the public sector. These were not extended to private sector buildings under the post-2010 coalition government, although energy audits under ESOS (Energy Savings Opportunities Scheme) have similar functions (Cohen and Bordass, 2015).

Another part of the regulatory framework that applies to building design is planning law. Planning consents are granted based on numerous factors, including maximum height, visual 'bulk' and style, the 'rights to light' of surrounding properties, and more. These restrictions on design, while framed by national planning policy, are open to local interpretation and are, in part, negotiable. They are backed by legal enforcement.

There is a substantial literature on such regulatory standards and their effects on office design (Hamza and Greenwood, 2009, Imrie, 2007, Pan and Garmston, 2012, Goulden et al., 2015). Regulatory standards are, however, only the tip of the iceberg as far as the role of standards in office design is concerned. There are also voluntary standards whose use is highly expected in competitive property markets. In the UK, these include BREEAM (the Buildings Research Establishment Energy Assessment Method) and the British Council for Offices' (BCO) Guide to Specification.

The BREEAM process is an evaluation and score of the 'sustainability' or environmental *performance* of a building, with credits given for diverse features including low carbon energy, green roofs, biodiversity, building location, and links to sustainable transport. Credits for specific infrastructural aspects of a building's heating, cooling and other systems are also included. These aspects, and improvements in them during design and construction, are scored to give an overall building rating.

Compliance with BCO guidance is expected as best practice within the (particularly speculative) office development sector. The BCO Guide, updated every few years, was first published in the 1990s with the purpose of helping property developers negotiate between providing too much in expensive and wasteful specifications and conversely risking producing 'below standard' building quality and infrastructural provision (Guy, 1998). Compliance with its recommendations is now seen as *sine qua non*. BCO guidelines cover many of the features also covered by building regulations (toilets, lifts, etc.) and add guidance on levels of comfort and infrastructural capacities, e.g., for ventilation, cooling and the availability of electrical power ('small power').

A final set of 'quality standards' emerge from cultural understandings and models of what a good quality office looks and feels like. This relates to features such as the façade and the aesthetics and feel of office space, alongside services provision. Such cultural standards are somewhat hard to define and taken for granted, being shared amongst actors in office design, development and marketing, as well as their 'customers': the eventual tenants. The term 'Grade A' can be seen as shorthand for this cultural standard of quality and different interviewees in our research provided different checklists of what a 'Grade A' office ought to provide (Cass, 2017: table 2). While informal, such standards are a powerful influence on design and construction and are essential to the Grade A market.

Conceptualising the effects of standards on office infrastructures

Having described the standards that affect office design in the UK, the next task is to conceptualise their effects on the character of offices as infrastructures for work and on the technologies that are incorporated into designs and link to electricity infrastructures. We do so by drawing attention to the role of standards as structuring devices for design practices.

Different sets of office standards operate in different ways, differentiated in two dimensions. First, we can differentiate between standards dictating provision or performance. The former define the level, number or amount of facilities to provide in a building. Examples include building regulation requirements and BCO guidance on toilet provision, to cover occupation levels calculated from workplace density, gender balance and absenteeism assumptions. Performance standards instead define outcomes in terms of a standard achieved, or rather anticipated, when the building is used. An example is the temperature parameters (24°C ± 2°C in summer, 20°C ± 2°C in winter) defined by BCO guidance (Gardiner & Theobald, 2014). The numbers of days of variation allowed are also specified (e.g. 'not to exceed 25°C for more than 5% of occupied hours'), but with no restrictions on how to achieve either.

Standards often straddle the categories in Timmermans and Epstein's (2010) typology. For instance, BCO guidance relates to design and performance standards, and producing a BCO compliant office is the achievement of a terminological standard of 'Grade A'. Standards also have complex effects on agency. When imposing provision, they remove design discretion, but when focussed on performance, they provide apparent design freedom, within boundaries that are imposed by outcomes that often realistically can only be achieved in a limited number of ways.

The complex effects of standards relate to a second differentiation based on their operation and enforcement. The mechanisms of enforcement can be distinguished using Scott's (2008) 'three pillars' perspective on institutions, which also reminds us that standards can be both formal and informal (Brunsson and Jacobsson, 2000), visible and invisible (Timmermans and Epstein, 2010). The three pillars of institutions are seen as *regulatory*, *normative* and *cultural-cognitive* forms of legitimacy with corresponding threat of sanctions for nonconformity.

The most formal standards (e.g. planning agreements and building regulations) fit Scott's (2008) *regulatory* pillar, of rules imposed by the state with the threat of punitive, i.e., legal consequences. This differs from the *normative* pillar in which collectively shared understandings of what *ought* to be done lead to standards policed through social sanctions: those not following normative standards are perceived as illegitimate players. Guidance from an established and recognised institution such as the BCO fits this definition. The *cultural-cognitive* pillar is closely related to the normative, but involves institutions and standards reflecting basic beliefs about reality and understandings rooted in culture, rather than norms of behaviour. In the case of offices, this is exemplified by beliefs about what a quality, lettable building looks and feels like (i.e., bright, white, cool, with lots of glass). There is no 'hard evidence' to support these beliefs. Indeed, the concept of evidence does not apply to such cultural constructs, but in a social field, they become recognised to the degree that anyone not acknowledging or reproducing such beliefs is viewed as an outcast.

Standards, then, give structure to office infrastructures in two important ways: by defining provision and performance and by structuring the practices of designers through regulative, normative and cultural forms of policing that constitute the institutional environment in which they operate. Our next step is to show how this structuring by standards generates prescriptive ideas of office infrastructure design with implications for the possibility to respond to changing work, technologies and environmental concerns.

Commercial offices in London

The following draws on expert interviews with informants in the field of office building design and refurbishment conducted in 2014-16, including early exploratory interviews that narrowed the research questions and later interviews tied to case study buildings. These interviews were semi-structured (Fylan, 2005) and conducted using a schedule of questions designed to draw out the different factors that determined a building's form, functional and symbolic spaces, and the use of particular infrastructures of heat, cooling, light, power and information technology. We used ten buildings as case studies to provide a focus for interviews and to ground what otherwise would have been abstract discussions. Questions explored the justifications and rationales for specific decisions in design and infrastructure provision in these buildings.

The case study buildings were selected to reflect a number of different categories of office buildings. They were all in London, across a number of key office sectors and locations, varied significantly in size from 3,000 to 23,000m^2, and covered new build projects (n=6) and major structural refurbishments of 1980s (n=3) and 1960s buildings (n=1).. The spread of sizes of buildings in the sample is representative of office buildings in London – properties below 1000m^2 are too small to be covered by some guidance. All of the buildings were developed speculatively (in the years 2010–15), meaning that the identity of tenants was unknown in early design phases, although in one case an occupier was involved in design discussion from an early stage. The rationale for this was to examine the particularities of offices developed speculatively, as owner-occupation has long been known to produce a greater degree of variation in building designs and servicing (Manning, 1965). As Table 3.1 shows, different numbers of buildings fell into the categories of dominant type or alternatives depending on the factor by which they were categorised, demonstrating the diversity of the sample. The most ubiquitous characteristic was the ranking of buildings as 'BREEAM Excellent' or better (n=9), whilst the under-representation of the dominant form of HVAC system (4 pipe fan coil air conditioning: n=4) was due to our desire to also investigate alternative systems. Although interviews were designed to draw out a large number of issues for analysis, here we specifically focus on infrastructural provision for work practices, focussing on e.g. occupational densities, heating and cooling, ventilation, small power provision, glazing and shading and façade details.

[Table 3.1 here]

The next section loosely applies Scott's (2008) 'three pillars' analysis to explore how the different standards involved operate to standardise offices and their infrastructures. As Scott (2008) points out, the most powerful institutions draw legitimacy from all three forms of support and in practice it is hard to isolate the operation of different forms of legitimacy from each other. This corresponds with work on how standards form obdurate and interlocking complexes (Leigh Star and Lampland, 2009).

Forms of standardising effects

Regulative and normative standards

These two forms of standards are closely linked in practice. The regulative/coercive pillar of office design standards is mainly found in the legal requirements of building regulations and planning permissions. However the process of designing an office building typically proceeds from satisfying a combination of regulations *and* normative standards: "first of all … they need to pass the building regs and the compliance side … can we make sure that passes whether it's a BREEAM 'Excellent' or something like that?" (Building developer and manager). 'Compliance' (a shorthand for the fulfilment of standards) often involves processes of simplification, e.g. using default values when modelling. An engineer suggested that "you have to do it that way to get compliance and that's the way they tell you to do it … simplifying assumptions to make sure it's not too onerous … not an undue burden on design".

The regulated provision of adequate numbers of toilets, stairwells etc. are simple to understand as *provision* standards, while in the realms of heating, cooling and the speed of lifts, *performance* standards also apply. Regulations however set a bare minimum beyond which almost every developer will extend in (normative) practice, to achieve what is deemed in the market to be acceptable performance. For example:

> "Building regs for fresh air is 10 litres a second, but BCO recommends 12 litres to 16 litres. At [building] the client said 16 litres plus 10%. And on cooling loads it was plus 10%" (Architect).

The comparative rankings of EPC and BREEAM processes are not legally required but normatively expected in prime commercial offices. However high BREEAM scores are also included in BCO guidance as a measure of sustainability and it has become increasingly common for developers and planners to insert them into contracts with design teams, and planning permission requirements. This tightly links regulatory and normative standards:

> "Often it's a planning requirement. … the market's changed over the time … [BREEAM] was seen as very much being optional …. Whereas now … you need it for marketing and … corporate social responsibility" (Building services consultant).

> "Our market insists that we're BREEAM 'Excellent' … as a company … it's also the standard that we have set for ourselves to achieve" (Architects).

However, compliance with the BCO Guide to Specification is probably the single most powerful normative standard affecting commercial offices. Individuals involved in early design meetings stated that:

> "The BCO criteria is where we start" (Architect).

> "Design standards will be taken from … BCO guides and so forth because why would you do any different?" (Building developer and manager).

The perceived need to adhere to BCO guidelines, which again becomes regulatory-normative if written into contracts, means the design process according to our informants is becoming “too normative” (Building performance consultant); “ most commercial offices buildings would be immediately compared to the BCO specification … it’s almost like a regulatory must have” (Architect).

Even the most respected developers were said to “benchmark all their jobs based on BCO standards … just a very standard M&E specification” (Architect). Often this involved the application of an in-house set of specifications for their own developments that build on and supplement the BCO guidance: “[Developer X] in this instance have a sustainability brief and it’s very prescriptive … to prove that the building is designed within those parameters … it would start with the BCO” (Architect)

But *how* do such ‘market standards’ actually affect design? EPCs and BREEAM do not prescribe particular features of office design, but those we interviewed suggested there are standardised ways of achieving the expected scores in the two assessments. Following the BCO guidance can also lead to expectations of the inclusion of particular technologies with the most predictable performance, as the starting point for all subsequent design processes. One interviewee noted that speculative developers rely on advice from letting agents who stress “what you’ll need is BCO spec, BREEAM Excellence, other than that it’s up to you” (Building developer and manager). This quote outlines, then, the reality for many of our case buildings. The majority of design features in a building are standardised in order to meet the BCO guidelines and achieve BREEAM Excellent. This normalises and standardises the look, feel and technical design of the office spaces and the technologies within. An M&E engineer pointed out that this is particularly true of buildings developed for short-term profit: “The ability to sell … is of prime importance … a lot of it is a tick box exercise of ‘does this building comply with BCO?’” (Building services engineer).

In these senses, the BCO guidance and other 'regulatory-normative' standards operate to define the 'normal' office. The standards substitute onerous calculations, judgements and decisions with default measures of provision and performance. To some extent, they replace the expertise, judgement and autonomy of design professionals with 'off the shelf' optima. This produces spaces that are relatively predictable, uniform and comparable. Standards operate, then, as a form of nongovernmental steering of the industry through regulation, but also in ways not backed by legal coercion. Normative and cultural standards prescribe conformity to shared understandings of what a 'normal, modern, office space' looks and feels like. We now develop this point further by considering how such governance operates in the context of office markets.

Market standards and cultural norms

Commercial office buildings are more than sites for office work and such 'functional' understandings of the office may not even be the primary concern of those who design and build them. An office building is also an investment vehicle, a potentially risky capital outlay that must produce a return, provided by effective real estate management. As one interviewee summarised: "these buildings are investment vehicles. They are all about providing a return for a pension or … insurance policy" (Architect). There is a sense that understandings of offices as infrastructures that enable office work practices are subsumed under the financial imperatives of the market and the symbolic power of market-valued buildings (Cass, 2017, Guy, 1998). In a very straightforward manner, profit trumps other concerns in the case of speculatively developed buildings.

Meeting the normative standards associated with BREEAM and BCO, as discussed above, is part of this process. They can be applied without consideration for who will occupy the building and in turn what work practices the office as an infrastructure might need to enable. Designs that ensure compliance with standards are prioritised rather than bespoke designs for effective alignment with (unknown) office work practices. In terms of architecture, the 'Grade A' cultural model and its definition of a 'need' for offices to be open, light, and airy, and to provide a 'blank canvas' for occupiers, places constraints on design autonomy:

> "that's quite important … getting a more open, more airy … sense of openness" (Architect).
>
> "greater height and space … a feeling of space and volume … you're trying to maximise … floor to ceiling heights … It's a better feel within your floor plate" (Letting agent).

Developers claim that it is tenants who demand such features. They argue that these demands are conveyed through letting agents, their interactions with tenants if they are developer-managers or through the demands of tenant's representatives in letting negotiations. Demands are said to include faster lift speeds, marble toilets and larger and more impressive lobbies, in addition to provision for certain levels of occupancy, air flow, cooling, etc. However there is a question mark over whether such standards actually reflect common occupier 'needs' and/or are required to enable office work practices. Letting agents in our data were often blamed for proliferating the 'Grade A' standard, in a way some think is questionable and disconnected from what people actually do in offices. A building services engineer suggested that "they'll say to let it you've got to have all glass … you've got to have air conditioning … they say the market wants it … because it looks good … it's not what people really want, but it sells it.".

Letting agents allegedly also push for a quicker letting, 'plug-and-play', 'Cat(egory) A' fit-out, where the whole of the building is fitted out with e.g. standardised suspended ceilings, raised floors and pre-installed services, which often lock-in default systems such as the most common air conditioning types. Again, this is based on a presumption of what is ‘needed’ in the ‘normal’ office, but stifles design alternatives. An architect claimed that “a ‘Cat A’ fit out doesn’t leave you too many options if you’re going to do it efficiently … We’re very frustrated that we have to incorporate it at all but the agents want it …” (Architects). Perhaps more accurately, ‘Grade A’ and other quality standards are designed to deliver offices that will accommodate all potential tenant types and thus be flexible to changes in tenancies: they deliver a generic infrastructure designed to encompass all possible office work practices and therefore arguably not ideally suited to any. The standardised ‘normal’ office is: “standard across the board … whether you looked at a [developer A] specification or a [developer B] specification there was nothing in them … the baseline stuff was there” (Architect).

Hence, all our case study buildings detailed in Table 3.2 are to slightly varying degrees exemplars of the standardised infrastructure that is the ‘normal’ office. These offices are expected to be rated BREEAM ‘Excellent’ and to have an EPC rating of B or above. Following BCO compliance they are designed to accommodate 1 person per 8–10m^2 and to provide 16 litres of fresh air per second per person. They often have 4 pipe fan coil unit air conditioning, and they are assumed to need 25 Watts of heat-gain producing small power provision per square metre of floor, in some areas supplemented by another 10–15W. This level of provision results from assumptions embedded in the standards discussed above about what is acceptable and ‘needed’ in terms of provision and performance.

Lock in, ratcheting and standardisation

The above has shown how standards of various sorts, requiring certain levels of infrastructural provision or expected performance, and resting on different forms of institutional legitimacy, together act to structure and standardise speculatively developed office buildings in London. It has shown how compliance with regulation is a starting position regarding both provision and theoretical performance. Normative standards of provision and performance represented by the guidelines and assessment procedures of a number of professional industry groups, including the BCO and BREEAM, provide a process through which buildings are further shaped towards a standardised model of form and function. Such influences on design practices result from a desire to attain credentials from adherence to industry standards of quality, which in turn help to guarantee saleability. The highly binding demands of the market, with associated cultural-cognitive beliefs of how a 'Grade A' office building should look and feel, further lock-in standardised design. Standards thus lie behind a process which leads to uniformity and comparability (Cass, 2017).

Standards also interlock in further complex ways. In particular, assumptions built into standards impact upon the modelling processes used in designing buildings. For example, the standards of provision for occupation densities (the density at which the floor space will be occupied, measured in square metres per worker) and small power requirements (Watts per area of floor space) in the BCO Guide assume a certain uniform, spatially and temporally undifferentiated use of an office and its technologies connected to electricity infrastructure. This in turn presumes certain levels of heat gain (of the PCs, VDU screens and human bodies presumed to occupy space), the peaks of which feed into both ventilation and cooling requirements for the building. In addition, cultural models of 'Grade A' lead to high levels of glazing and suspended ceilings with further implications for heat gain and airflow. Adherence to standards thus leads to an assumed need for large capacities of cooling and ventilation. This in turn drives the incorporation of other infrastructures, which then also become 'needed': mechanical air conditioning (rather than forms of passive or mixed mode cooling and ventilation) being one of the most common examples (Shove et al., 2014).

This structuring of 'normal' office infrastructure derives, therefore, from the interlocking of standards. The apparent need for air conditioning in the 'normal' office does not result from any single standard or design decision, but rather is the result of the interlocking and cumulative effects of multiple standards on design decisions. These are difficult to unravel, as designing to avoid using air conditioning might require the transgression of multiple other standards; unlikely given the risks associated with social and cultural sanctions for noncompliance, for designers and developers.

These interlocking processes sustain the upwards ratcheting of norms, expectations and levels of provision, with implications for energy demand and carbon emissions. Such ratcheting is not new or unique to office buildings, being an identifiable process across multiple fields in the pursuit of socially valued comfort, convenience and speed (Shove, 2003). However, the modes in which building modelling, redundancy and standardisation combine give this societal trend (reflected in competitive levels of provision) an endogenous boost; an unintended consequence of the interlocking operation of technical and market standards themselves. The 'iPhone mentality' (as one interviewee put it) transforms best practice into an expected minimum, with effects such as those detailed above:

> "What was considered high-tech in one model is considered norm in the next … what was considered to be state of the art in one building, the next generation, well we've got to have it …" (Building Management Systems consultant).

Standards are, then, both productive of, and a means to achieve, standardisation. Homogeneity and uniformity of provision across offices is produced by standards, disregarding variations in work practice, as part of efforts to ensure 'normal' levels of provision are maintained and offices are saleable in competitive markets (Cass, 2017). Standards do much important work in the process of producing offices as infrastructures for work.

Conclusions

In cities around the world and particularly in their Central Business Districts where speculatively developed office buildings are chiefly located, the culturally legitimated extravagances of status-expressing, iconic and apparently unique architectural forms and façades hide a closely kept secret. Offices as infrastructures for work, and their forms, functions, spatial arrangements and levels of provisioning, reflect a homogenised model of 'normality'. We have shown here how the different types of standards that apply in office building design sustain such homogeneity. Regulations backed with coercion, normative standards and guidelines that define acceptability and cultural-cognitive shared understandings of how a high-quality, lettable office looks, feels and performs, lock together to drive design in certain directions. This means the infrastructures for work that are produced reflect reified ideas of 'normality' and are rarely tailored to any specific work practices.

In particular, we have shown that offices as infrastructures for work are structured in two ways by standards. First, standards mean the 'normal' office is structured around a common understanding of what is 'needed' in an infrastructure designed to facilitate work. Bright, white, airy, air conditioned boxes, which require certain levels of provision in terms of occupancy, small power, etc. are seen as the 'normal' infrastructure 'needed' for contemporary work. Such provision in turn requires particular systems of lighting, heating, cooling and ventilation to be connected into the wires of the electricity infrastructure within the building, all of which affects energy demand and the carbon footprint of the 'normal' office. Standards matter to discussions of infrastructure given their effects on design practices and in turn provision.

Such standardisation has its downside. Research since the 1990s (Stanhope, 1992, Cook and English, 1997, Stanhope, 1993) and more recently (BCO, 2014) has highlighted that provision, for example of small power, is often of a level far greater than that required by the majority of office work. The BCO (2013) have also produced empirical analysis of the densities at which offices are occupied in reality, which reveals that even with an unrealistically high level of employee 'utilisation'[2] of 70%, 96% of surveyed offices would be occupied at a lower density than that set out in their design guidance. This means that 'normal' office infrastructure goes far beyond the levels of provision technically required in the vast majority of cases, most of the time. This relates to standards rather than office work practices being the focus of design. The result is provision of office infrastructures that are supposed to reflect everyone's work practices, but in reality reflect no one's and which presume levels of demand that have not materialised. As such, standards and the market are delivering offices as infrastructures for work that are often unnecessarily over-specified, with both financial costs for those developing offices and environmental costs when the provision results, for instance, in air conditioning rather than less energy-intensive systems.

Can standards better reflect office work practices? The trajectory over the past twenty years suggests we should not be overly optimistic that such reorganisation will occur. Over this period, office work practices have changed dramatically. Trends include an increasing move towards home and third-space work, hot-desking in work, the domestication of office space with the addition of catering and leisure facilities and a shift in focus towards tenant well-being (Cass, 2015). All of this has coevolved with the rise of the internet (from wired to wireless forms) and related shifts from bulky desktops to laptops and most recently tablets. These developments challenge understandings of the levels of provision demanded by work practices and one assumes would also change understandings of what a 'normal' office infrastructure should provide. This raises an important question: can standards evolve and the market reorganise itself to respond to such dynamics and the potentially lower requirements for small power provision, light and thus cooling and air conditioning? However, we have witnessed a tendency for standards to change in only one direction: upwardly ratcheting to provide more of the same. Moving in the opposite direction (downward ratcheting) or evolutions to promote alternative forms of provision (diagonally shifting) may have been expected, given that new work practices use office space differently and require less bright lighting, and the fact that wireless laptops and tablets require smaller floor voids, and less cooling as they generate less heat gain. Why has this not happened? How might design better respond to such developments in office work practice? Such outstanding questions suggest that how standards come to influence the 'normal' office, and how their operation results in arguably ever-greater detachment from office work practices, are important topics worthy of continued scrutiny.

Factor/Variables	**Dominant type**	**Other types**
Age	New Build: n=6	60s: n=1 80s: n=3
Developer type	Investment: n=6	Managing developer: n=4
Location/sub/market	City (3) and West End (3): n=6	Midtown (3) and South of River (1): n=4
BREEAM ratings	Excellent: n=7	Outstanding: n=1; Excellent (older): n=1 Very Good: n=1
Occupancy density designed to	1:10m^2: n=6	1:8m^2: n=3 1:8-1:12m^2: n=1
Heating, Ventilation and Cooling system	4 pipe fan coil air conditioning: n=4	Displacement ventilation: n=3 Variable refrigerant flow: n=1 Variable air volume: n=1 Chilled ceilings and beams: n=1
Air flow rates	16l/s/person: n=4	No data
Small power base provision	25W/m^2 base: n=6	15W/m^2 base: n=3; 30W/m^2 base: n=1
Small power additional capacity	+10–15W/m^2: n=4	+20–40W/m^2: n=3; None: n=3

Table 3.1 Characteristics of case study buildings (sourced from fieldwork)

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[1] 'Energy conservation' is thus actually assessed as the CO_2 emissions arising from energy use rather than the energy use itself.

[2] Utilisation is defined and calculated as 'workplace density divided by the maximum utilisation of workplaces, expressed as a percentage' (BCO, 2013: 12).