

Rose, G. ; Degen, M & Melhuish, G. (2014) Networks, interfaces and computer-generated images: learning from digital visualisations of urban redevelopment projects. *Environment and Planning D: Society & Space*, 32 (3) 386-403.

abstract

Over the past five years, computer-generated images (CGIs) have become commonplace as a means to market urban redevelopments. To date, however, they have been given relatively little attention as a new form of visualising the urban. This paper argues that these CGIs deserve more attention, and attention of a particular kind. It argues that, instead of approaching them as *images* situated in urban space, their digitality invites us to understand them as *interfaces* circulating through a software-supported network space. The paper uses an Actor-Network-Theory understanding of 'network' as a set of relations created by the distribution of action, and argues that the action done on and with CGIs as they are created takes place at a series of interfaces. These interfaces – between and among humans, software and hardware – are where work is done both to create the CGI and to create the conditions for their circulation. These claims are explored in relation to the CGIs made for a large urban redevelopment project in Doha, Qatar. The paper concludes by suggesting that geographers need to reconsider their understanding of digital images and be as attentive to the interfaces embedded in the image as to the CGI's visual content; and that this is especially necessary given the proliferation of digital visualisations of spaces and places across many fields of contemporary visual culture.

keywords Computer Generated Image; digital visualisation; Actor Network Theory; network; interface; software-supported spatiality; visual culture; Doha

1 introduction

It is a rare urban redevelopment project that does not now use computer-generated images (CGIs) to visualise what the project will look like when complete. Over the past five years, CGIs have become commonplace as a means to market urban redevelopments. From advertisements found on bus stops and on building site hoardings (figure 1), to elaborate websites and exhibitions at global real estate fairs, digital visualisations of developments not-yet-built are ubiquitous. Indeed, it could be argued that they are now one of the most pervasive ways in which visions of future urban space are expressed.

To date however, they have been given relatively little attention as a new form of visualising the urban. When they have been examined, their digitality has been understood only as enhancing images' ability to represent places – in this case, places not yet built – in ever more seductive and persuasive ways. This type of digital image is understood as no more (though no less) than a "a key marketing strategy" (Kaika, 2011, page 985), whose role, like any other advertising imagery, is to "affectively allure" investors into buying property (Jackson and della Dora, 2011a, page 295). Scholarly literatures exploring place marketing are thus uninterested in the distinctiveness of this kind of image.

While it is without doubt the case that these digital visualisations have some similarities with non-digital marketing images – and indeed with much longer traditions of representing designs for urban spaces – this paper will nonetheless

argue that these CGIs are distinctive. They thus deserve more attention, and attention of a particular kind. Sheller's (2009) discussion of the CGIs used to sell a new development in the Turks and Caicos Islands is suggestive here. Much of her analysis of the CGIs is focused on how those images represent that development "in a global infosphere" (page 1397) – that is, her analysis, like those just mentioned, attends to what the marketing images show. However, she also places them in the context of what she calls "software-supported spatiality" (page 386). 'Software-supported spatiality' is her term for the spaces structured by the software codes that, she argues, are increasingly shaping places, territories and mobilities both in the Caribbean and globally. Her essay is thus part of what is now an extensive body of work that considers software as an infrastructure for the production of space. From Graham and Marvin's pathbreaking book *Splintering Urbanism* (2001) to Kitchin and Dodge's *Code/Space* (2011) and beyond, over a decade of scholarship has explored diverse relationships between digital technologies and urban spaces (for reviews see Burrows and Beer, 2013; Dodge et al., 2009; Kinsley, 2013).

Much of this work has examined the role of software code in creating or mediating urban spaces. Work has focussed in particular on the ways in which software can control urban infrastructure by gathering data and structuring automated decision-making systems (Crang and Graham, 2007; Thrift and French, 2002); on the way everyday experiences of urban spaces are now often inflected by the 'augmented reality' of mobile social networking and Google Maps (Brighenti, 2010; Gordon, 2010; Graham et al., 2013; de Souza e Silva and Frith, 2012); on forms of digital surveillance (Amoore, 2009) and ubiquitous computing (Kinsley, 2010; Kinsley, 2012); and on user-generated 'neo-geography' (Dodge and Kitchin, 2013). This rich literature has paid little attention to digital visualisations of urban space,

however, and this paper thus contributes by focussing in detail on the CGIs that picture unbuilt urban developments. It does not do so, though, by exploring the 'effect' of these images as they appear on temporary hoardings around building sites or on billboards advertising new developments. Material urban objects and sites are not our starting point, as they are for so much of the literature on software-supported urbanism. Rather, we deploy another methodology, in an attempt to embed 'software-supported space' into the CGIs themselves. Rather than approach these images from their materialisation in *cities*, we instead approach them from their circulation through *networks*; and as a consequence, we no longer want to call these CGIs 'images' but rather 'interfaces'.

By starting with their *network*, this paper engages with the appearance of these visualisations by focusing less on what they show and more on how they are made to show it. For they are made (to show it) as they circulate around a network of offices and computer screens; they are worked on by architects, visualisers, project managers, the client, advertising executives and others; and the visualisation's digital file thus constantly encounters various software programmes, hardware devices and human bodies. It is the importance of these encounters that makes us think of these CGIs less as images and more as interfaces, and the following section of the paper details this conceptual claim.

The arguments presented here are based on a case study of a large-scale urban redevelopment project which has taken the production of CGIs very seriously indeed. The €4.18 billion project covers a 31ha site in Doha, Qatar, and is currently called Downtown Doha. The design of Downtown Doha began in 2008; construction started in 2010 and is scheduled to finish in 2016. The developer – the architects' client – is Msheireb Properties, a company owned by the Qatar Foundation. The

concept master plan was produced by AECOM, and AECOM, with Arup and London architects Allies and Morrison, drew up the detailed master plan. There are a further range of sitewide and executive consultants with specific responsibilities, coordinated by the Master Development Consultants (MDC) team, and including Executive Consultants (EC), Executive Architects (EA) and landscape architects among others. Nine design architects (DAs) were chosen to design the hundred or so buildings on the site. A partner at Allies and Morrison was appointed as the Architectural Language Advisor (ALA) to the project, and has been a particularly enthusiastic advocate of the project's CGIs as a means of cohering the project's different components into, as he said, "something one wants on the cover of a magazine".

Here, then, we have a developer of a large-scale urban redevelopment project investing significant time and money in creating a suite of CGIs that will picture "how that place will look and feel" (MDC manager) when it is finished. The investment in CGIs as part of this project is at an unusually high level; but their evident importance to this project makes it a valuable case study for thinking about how to conceptualise them (and for understanding why they have become so common in contemporary urban development). Drawing on existing workplace ethnographies of design professionals (Gunn and Donovan, 2012; Houdart, 2008; McDonnell and Lloyd, 2009; Vinck, 2003; Yaneva, 2009), our methods were to observe the creation of these images by both architects and visualisers, and to observe their discussion at two Design Review meetings in Doha; to interview architects, visualisers and representatives of the client about their use of CGIs; and to gather examples of where CGIs were used as part of the project.

The aim of this paper is to conceptualise these CGIs as interfaces, and it will draw on evidence from our ethnography to substantiate its claims. The next section begins this task by examining the concepts of *network* and *interface*. The third section explores four interfaces that we argue are particularly significant for understanding the nature of these CGIs. The final section will argue that, given the sort of images they are, critical urban scholarship should understand these CGIs not only as persuasive marketing *images*, but also as problematic *interfacial sites* created by many different kinds of work. It will also briefly consider some of the implications of that claim for a contemporary visual culture in which more and more images are digital.

2 conceptualising CGIs: network and interface

As the introduction to this paper noted, the CGIs that visualise new urban development projects have received little scholarly attention. The few studies that do address them concentrate on their affective power as visual images. Jackson and Delladora (2011a, 2011b) are not alone in emphasising the way in which digital images of places can be affective. Digital videogame images have also been approached as above all affective, and, again like Jackson and Delladora, affective through their visual composition in particular. In a series of papers, Ash (2010a, 2010b, 2012) has explored both the importance of the affective allure of videogames and how the games' visual images can work to create that affect. Like the marketing images discussed by Jackson and Delladora, Ash points out that videogames' affect is in large part responding to a commercial imperative to sell: in this case, to sell videogames that capture the attention of gamers through their affective regimes.

It is certainly the case that the CGIs created for Downtown Doha were concerned to create a seductive 'affect'. In the first instance, CGIs were developed by the master planners as means of persuading Msheireb Properties and the Qatar Foundation to invest in the redevelopment project. As the MDC manager described them, initially there were "around twenty images... more describing the mood of the whole development. So it was not about 'that's the building, that's this building', they were showing more 'that's the life on the street, this is what you'll feel by taking the journey through the development'". A Special Design Review meeting in 2012 finalised forty-two such images, and they have been appearing at real estate fairs and on the developer's website and promotional literature since then, as well as on hoardings surrounding the building site that is currently Downtown Doha (see Figure 1).

However, as one of us sat down with architects and visualisers at their office computer screens and asked them to tell us about these forty-two images, it became apparent that those forty-two were just a tiny fraction of the total number of images made as part of this project. Not only had the production of those forty-two entailed the creation of vast numbers of earlier versions both of the forty-two and of other CGIs that might have become one of the forty-two, but all sorts of other digital visualisations of Downtown Doha had also been created as part of the design process (which the paper will detail in section 3).

The creation of all these CGIs had involved a large number of people in many different places. A CGI of a new urban development like Downtown Doha usually starts life as a file generated by the Computer Assisted Design (CAD) software used by a team of architects to design a building (Microstation is a particularly popular package). That file is then sent to a visualiser and imported into a visualisation

software package such as, in this case, 3DS Max.¹ The architect and the visualiser may be part of the same architectural firm, in which case the file's journey from an architect's computer to the visualiser's is a short one, via their shared office server; or the visualiser may work for a separate company specialising in visualisation, in which case the journey will be longer (in this case, to elsewhere in the UK, Europe or the US). The visualiser begins work on the CAD file by stripping out a lot of the architects' design details, which leaves something on his screen that looks like a wire-frame model. He then specifies the precise location of the building and a date and time, both of which dictate the direction and angle of sunlight in the eventual CGI,² and starts to add layers of colours, materials and textures to the model (which can still be manipulated in three dimensions on the visualiser's screen). To check on the results of this work, the file is sent to be 'rendered': that is, to be converted from a working image to something that looks more like a 'picture'. Again, that journey can be long or short. Rendering requires large amounts of computer processing power, so while small files can be rendered by the visualiser 'in-house', very large files are sometimes sent to so-called 'render farms' in China, where massive servers powered by cheap electricity can render images in hours rather than days. The file then returns to the visualiser for more work. Once the building itself is looking good in 3DS Max, the file is then imported into another software package, usually Photoshop, to be worked up still further as 2D image (Figure 2; and see Houdart, 2008).³ At appropriate points in this process, the visualiser will have sent the file back to the architect for viewing and feedback on their work; this may happen

¹ Some CAD packages – Rhino in particular – allow architects to work in 3D from the start of the design process. In this case, there is no transition between the design and visualisation software.

² The use of 'he' is deliberate here. All the visualisers we interviewed in this project were male.

³ It could also be exported into other software to be made into an animation or 'fly-through'.

several times. In our case study, the ALA also commented on the CGIs. When the ALA was satisfied, the CGI would be taken to Design Review meetings in Doha, where (along with many other images, material samples and models) it would have been discussed with the client, the MDC, the EC, the ALA, other consultants and (sometimes) the DAs, as part of the ongoing process of designing the development. This iterative process accounts for the huge numbers of CGIs created; a printout of the file names of all the CGIs generated for just one building in Downtown Doha by Allies and Morrison ran to sixty pages.

As well as the sheer numbers of CGIs generated, it should also be evident from the above account that the CGIs are highly mobile. And their mobility continues even after 'final' versions have been agreed (the forty-two agreed in November 2012 were being revised a year later to reflect design changes). The 'finished' CGI as a digital file goes to all sorts of other places and in the process it gets converted into different media. So, it appears on the pages of promotional books and on the websites of the the developer, to advertise their project (Msheireb Properties has a website, a YouTube channel and a Facebook page). The developer has also used the image in other promotional media: on billboards, as smaller posters and part of interactive models at real estate fairs, and as framed prints in their offices. It may also travel to the websites of the architect and the visualiser and in order to advertise their skills. Already it is obvious why CGIs are popular with developers: they are seductive images; their content can be easily altered; and they can be displayed in many ways via various media.

As they are created, then, these CGIs travel extensively through a *network* of different offices, servers and screens. As many commentators have remarked, 'network' is a term with multiple meanings (Gane and, Beer 2008). Here, we follow

an Actor Network Theory (ANT) approach. Latour (2011, page 797) notes that "the notion of network is of use *whenever action is to be redistributed*". And indeed, as we have just described, the CGIs of Downtown Doha move because work needs to be done on them: they have to look more accurate, or more attractive, for example. Thus they move in order to be acted upon, to be modified. And as they move, they constitute two specific forms of network spatiality (Law, 2002).

The first is the circulation of these CGIs through a network in what Law (2002) describes as Euclidean space. In this network, these images move in physical space, as digital files, through the the material infrastructure of the internet and a wide range of associated technologies such as cables, computers, servers, printers and screens. This movement is crucial to track, as it speaks directly to the skewed global distribution of this kind of creative expertise; as others have also pointed out, creative expertise is located in specific cities of the global North (McNeill, 2008; Ren, 2011), and, bar trips to render farms, until they were taken to the client in Doha the images we studied circulated only between Europe and the USA.

This paper pays particular attention to the second sort of network space identified by Law (2002), however, which is less an effect of the CGIs' mobility and more of the action needed to maintain their integrity as an object. The claim that "objects are an effect of stable arrays of networks or relations" (Law, 2002, page 91) is conventional in ANT; "an object... remains an object while everything stays in place and the relations between it and its neighbouring objects remain steady" (page 93). Although this paper has so far suggested that the object that moves is 'the CGI', in fact the object that held steady was not 'the CGI', or its software code. As the paper has already implied, code was constantly changed as a CGI was worked on; and the media through which the code generated a visible image were also

multiple (other softwares, various display screens, printers, inks, projectors, papers, frames, books...). To be precise, what held steady was the *view* that a CGI was to visualise. All of the forty-two CGIs which won the client's approval were views of streets and public places. The ALA initiated their creation by specifying on a plan of the development which 'views' he wanted to see visualised in a CGI; the visualisers then went to work combining CAD models of the relevant individual buildings. The CGIs were versions of the views, and as such they were highly *mutable* mobiles as they travelled through their network, their code and the media which visualised them constantly changing. Hence this paper's attentiveness, less to what a CGI looks like at any one of its many stages, and more to what it "needs to *subsist* through a complex ecology of tributaries, allies, accomplices, and helpers" (Latour, 2011, page 799).

What also became evident early on in our fieldwork was that this 'ecology' was not only complex but also somewhat unstable. Relations among various 'allies, accomplices, and helpers' were not always 'steady', and this also contributed to the mutability of the CGIs. Latour suggests that those 'allies, accomplices, and helpers' become particularly noticeable in moments of crisis:

"Take any object: At first, it looks contained within itself with well-delineated edges and limits; then something happens, a strike, an accident, a catastrophe, and suddenly you discover swarms of entities that seem to have been there all along but were not visible before and that appear in retrospect necessary for its sustenance." (Latour, 2011, page 797)

Our research did not encounter any 'strikes, accidents or catastrophes' (though several of our interviewees recalled working through the night to complete CGIs for

Special Design Review meetings). The specific concept this paper uses to examine the 'ecology' of the CGIs' 'swarms of entities', therefore, is the *interface*. An 'interface' is the intersection between two objects or systems. In digital studies, use of the term is often restricted to the relation between a human and a digital device, or, to be more specific, to contact between eyes, hands, screens, mice (or graphics tablets), keyboards (or gaming control pads) and the software driving the hardware. An interface is thus "a point of contact at which different bodily or machinic systems meet" (Gane and Beer, 2008, page 53). We draw on Galloway's (2012) elaboration of the term here. Galloway (page vii) describes interfaces as "zones of activity", which can be "manifest (as screens or keyboards), but also latent within software as the mediation between internal and external levels" (page 74). Interfaces, then, are where the action happens in a CGI's network. Importantly though – and this addresses both Law's (2002) concern that ANT approaches to networks pay too much attention to things being made stable, as well as avoiding Latour's need for catastrophe to make an object's allies visible – Galloway insists that interfaces are never quite as smooth as they so often look and feel. An interface, he insists, is "an autonomous zone of interaction, orthogonal to the human sensorium, concerned as much with unworkability and obfuscation as with connectivity and transparency" (Galloway, 2012, page 120). Rather than events such as accidents or catastrophes, then, in this paper frictional *interfaces* are the sites where the CGIs' 'allies, accomplices, and helpers' become evident.

The paper now turns to four such sites.

3 the interfaciality of the CGI

Thus far, this paper has argued that digital visualisations of new urban developments should be understood as objects (views-to-be-visualised) circulating through a *network*; and that the actions that perform the network and that constitute the view as a CGI should be understood as a series of *interfaces*. This section discusses four of the most significant interfaces that constitute the CGIs of Downtown Doha. The activity in these interface zone does not always have the effect of holding things together: sometimes, following Galloway (2012), some sort of glitch, misunderstanding or disagreement will happen. And then more work has to happen to resolve such 'unworkability'. This section thus emphasises not only the work being done to create the CGIs at each interface by specific humans, softwares and hardwares, but also different kinds and degrees of unworkability and the actions taken to mitigate that friction.

3.1 intrafacial

One of the most fundamental interfaces in the Downtown Doha project was that between different software packages and different software files. Galloway's (2012) term for the interface where different software components interact is the *intraface*. As Galloway (2010) points out, software consists of three kinds of programmed code: the source code written in programming language which contains commands, an executable application which turns the source code commands into instructions for the computer, and the runtime experience which is what the computer shows to its user. He uses the interface between these different software components as exemplar *intrafaces*. We have already noted that the CGI file is based on a digital 3D model imported from CAD software, and that it also migrates from a visualisation software into Photoshop: the points of contact where

these different softwares interact with each other and with other softwares (for example, a computer's operating system) are all intrafaces.

Intrafaciality *within* a software package usually runs smoothly. Intrafaciality *between* files, software packages and operating systems can be more problematic. Several of our interviewees attempted to open CGI files on their office desktop during the interview; if they could find the right file (not always easy, given the numbers of image files generated in the course of this project), it could take minutes to open; often it would hang or freeze the whole machine. The Downtown Doha project had another layer of complexity, however, because all the different CGIs files created by different architects and visualisers had to be compatible with each other. This was because the CAD models and associated visualisations of individual buildings made in each DA's office had to be integrated into a single file in order to create the 'views' specified by the ALA.

Early on, then, the EC produced a pdf of guidelines that all the 3DS Max models created as part of the design process were obliged to follow. Its aim was "to deliver consistent electronic deliverables". The document ordered visualisers to use the co-ordinate template provided by the EC; specified acceptable file formats; described the required conventions for naming each file, each material, and each layer within the 3DS Max model; noted the geometry to be used (for example, "all objects will have welded vertices", "no double geometry is allowed"); and insisted on the inclusion of "all native package files" in the deliverable. These guidelines were a crucial member of the 'swarm of entities' that held the CGIs together as objects. Without these guidelines, the CGI views – which were built from multiple distinct, CAD models – would not have been possible. Here, then, we can see that the work that creates a CGI is not only the work that is done on the CGI file itself, but

also the work that is done to ensure that it can move through its network and be acted on elsewhere.

3.2 anthological

The previous sub-section noted that one interfacial zone where work had to be done to minimise potential difficulties in bringing different things together was the intraface between different CGI files. That work involved specifying the technical parameters to which each CGI file had to conform. This sub-section looks at another aspect of these CGIs' intrafaciality – the importing of other sorts of image files into the CGI as it is being worked on in Photoshop – which generated both a different kind of incompatibility and a less reliable means of managing it.

Photoshop is an image editing software which, like 3DS Max, structures images in layers. Each component of a Photoshop image resides in its own layer, which makes individual components of an image easy to change; elements can be inserted, removed or changed simply by editing their layer. In the CGI production process, Photoshop is used to add subtlety to the image generated by 3DS Max, particularly the quality of its light. However, its equally important use is to insert visually complex elements, such as people, or trees, into a CGI, by inserting a new layer that carries a *photograph* of such an element (Houdart, 2008). Very often, these photographs are sourced from online image banks that offer a wide range of such elements, either for free or to subscribers: people, vegetation, street furniture. Some architecture offices have also created their own banks of suitable images to use in their visualisations.

Several commentators have suggested that the process of cutting-and-pasting – or mashup or mixup (Deuze, 2006; Jenkins, 2008; Kress, 2010) – is a key

characteristic of contemporary digital practice in many fields. Digital forms of text, audio and image can very often easily be copied from one place – a digital camera, say – and inserted into another – a blog post, for example – and many forms of digital media are premised precisely on this process: Facebook pages carry cameraphone albums, tweets are retweeted into multiple Twitter feeds. Doueih (2011) has named this widespread practice of cutting and pasting *anthological*. "Why an anthological practice? Simply because it would seem that the fragment, the basic element of an anthology, is the most appropriate form and format of the digital age. An anthology is constituted by assembling various pieces of material under a unifying cover, and for the use of an individual or a group brought together by common interest" (Doueih, 2011, page x). And indeed, these CGIs are anthological all the way down: based on imported CAD models, full of photos and digitally-manipulated versions of photos, and worked on by a group. The intrafaciality of this is fairly unproblematic, since 3DS Max and Photoshop are designed to work together (though it can and does result in very large files which can produce other difficulties, as the previous sub-section noted).

However, the anthological is not only technical, it is also, as Doueih (2011) insists, a form of *reading*: that is, in our case, the notion of the anthological directs attention to human interaction with the image. And in the case of the Downtown Doha CGIs, different actors evaluated the results of their visual anthologicality differently. This was particularly evident in relation to the photographs of people that were cut-and-pasted by visualisers into the CGI views. One aspect of the client's expectations was that the whole project should convey a distinctively Qatari

identity.⁴ Unfortunately, however, online image banks do not contain large numbers of Qatari figures, and an early animation created for Msheireb Properties "took a hammering" (MDC manager) from the client because it did not look sufficiently Qatari.

Once it became clear that the client had specific expectations about wanting Qatari-looking people in the CGIs, visualisers were forced to look beyond their usual image banks to find properly Qatari figures to insert into the Downtown Doha CGIs. One tactic was to search the online photo-sharing website Flickr for holiday snaps taken in Qatar that they could cannibalise. Another was to create their own. Thus one of us found ourselves in a warehouse in London on a cold November morning in 2012, in a huge room with white walls and floor, at a photoshoot organised by the studio who had been tasked to rework some of the forty-two CGIs to bring them up to date. Three photographers were taking shots of individuals who had been recruited through a film extras agency in London: with printouts of the CGIs at hand, a visualiser was there too, asking the extras to act as if they were strolling and chatting in the public spaces the CGIs were picturing. These photographs of people were then masked and pasted into the revised forty-two CGIs. The extras were costumed in what the visualisers thought were Qatari-looking clothes (actually bought from Asian stores in Southall, a London suburb). But the visualiser was having problems reading the 'Qatariness' of the photos being produced, and ended up asking one of us if *we* thought the clothes looked sufficiently Qatari. Unlike the potential frictions at intrafacial interface, this anthological interface was problematic because the visualiser in London was not able to *read* the photographs

⁴ This is a very significant aspect of the Downtown Doha project, but one which cannot be addressed adequately in this paper.

to assess whether they looked sufficiently 'Qatari'. As the following two sub-sections will show, the anthologicality of these CGIs created a number of other frictions at interfaces between the visualisations these files generated and the viewing practices brought to bear on them, frictions which also needed managing.

3.3 designed

To describe these CGIs as 'anthological' emphasises that, as well as digital files, they are also something that is seen by people. In fact, the need for CGIs to be appropriate for *specific* viewers was a recurring theme as we discussed CGIs with architects, visualisers and various employees at Msheireb Properties. It became very clear that they were all aware that CGIs could – and indeed should – be put to work in very different ways at different points in their circulation and modification. As a visualiser commented, "you can change [digital] content a lot more easily than you can change a physical thing, and you can tell multiple different stories with different options depending on who you are talking to". This acute awareness of the 'audience' has been identified by Kress (2010) as a distinctive aspect of digital communication. As puts it, in a world:

"marked by instability and provisionality, every event of communication is in principle unpredictable in its form, structure and in its 'unfolding'. The absence of secure frames requires of each participant in an interaction that they assess, on each occasion, the social environment, the social relations which obtain within it and the resources available for shaping the communicational encounter." (page 26)

He describes that process of assessment as *design*, and suggests that it is core to the "new principles of text-making composition" (page 20) driving all forms of digital communication.

As the paper has already noted, it was the master planners – Allies and Morrison and AECOM – who initiated the process of creating CGIs for Downtown Doha very early on in the project, when they were 'pitching' to Msheireb Properties to take the project on. CGIs were understood as a crucial means for describing to the client what sort of place the proposed plans would create: "you need the image. It's a sales pitch in a funny way" (MDC manager). There was also widespread agreement among the visualisers and architects we interviewed that leading the pitch for Downtown Doha with photo-realistic CGIs was especially important for a project in the Middle East, because clients there were often not experienced in interpreting the plans, sections and elevations with which architects would usually explicate their designs. In that context, you "almost have to make CGIs before you have a scheme" (AECOM manager).⁵ After an initial presentation which included a separate presentation from each of four architects was rejected by the client because of its incoherence, the sorts of images designed for the client focussed much more on the overall 'look' of the project, and showed "all the buildings, all the environment built, cars, people, bicycles, you know" (visualiser). Once the client agreed to invest in the project, this sort of image was then used to present portions of the development to the most senior figures at Msheireb Properties at Design Review and Special Design Review meetings.

⁵ It should be noted, though, that the architects also agreed that actually very few clients anywhere had such expertise.

While, as has been noted, a set of forty-two CGIs are being used to publicise the development, in spring 2013 a completely new set of CGIs was commissioned specifically to market the development to investors. The Development Manager at Msheireb Properties was clear that, to lease office space, for example, different sorts of visualisations were required:

"the leasing team are very particular on what they want. So you'll see of all these office buildings, there's really four shots that they're interested in seeing and that is a shot of the main entrance. A shot of within the lobby. A shot internally on one of the standard floors looking out if there's a feature like the Baraha they're going to show that. And they also want a hero shot of the building possibly showing, you know, two facades or two sides of the building that they can put on the cover of the brochure. And then obviously within the brochure there'll be some other images of sitewide attractions and different facilities that they believe will help market the building or the project."

Even among CGIs used for 'marketing', then, different visualisations are used for different sorts of selling.

However, as the opening section of this paper noted, marketing these "promissory spaces" (Jackson and della Dora, 2011b, 100) – whether to Msheireb Properties or to potential leasers of office space – is only one of the uses to which CGIs were put as part of the Downtown Doha project by architects, visualisers, the MDC and the client.

The client was sent less polished CGIs by architects to demonstrate that a certain design task had been finished and to request payment, for example. And the architects themselves worked with digital visualisations as part of their design

process. Many CGIs were created by the architects and master planners themselves as a means of developing designs for buildings, streets and squares. Relatively basic, pre-Photoshop CGIs can be quickly changed, which also allows architects to experiment with different volumes and materials. As one DA said, CGIs (made in Sketchup in this case) are a "quicker means of showing the massing, changing massing. We used to have a top floor overhang; when we removed it, what did it look like?" Sometimes these basic CGIs were also shown to the client to see if a new idea was worth pursuing. Different kinds of CGIs were also used by the EC to coordinate the various contributions from different architects into integrated streets and squares. Using 3DS Max models from each DA, the EC produced around 300 basic CGIs "to describe every corner of the project"; these 'massing studies' showed buildings as simplified white blocks because their purpose was to ensure that all the different volumes and shapes cohered to produce a good urban design.

The Downtown Doha CGIs, then, exemplify Kress's (2010) argument that digital forms of communication are very often tailored to the specific context of their use. Their interface is designed to engage with specific actors, in particular circumstances. A consequence of this *designed* interface, however, travelling through a network of diverse actors, is that different allies of the CGIs disagreed over specific CGIs. Throughout the Downtown Doha project, there were tensions between architects, master planners, ALA, client and visualisers, who all wanted different kinds of images which would do different things by looking different. The previous section noted the client's rejection of CGIs that didn't look adequately Qatari, and this was just one example of how the different actors in the CGIs' network had different views on the images. Neither the DAs nor the ALA liked the marketing 'hero shot'; the architects tended to be much more fascinated by what

one called "the backstreet world". Both the DAs and the master planners were also uncomfortable with the sorts of CGIs made for the client, both as part of the pitch and as part of the design process. They are "one sided," according to an AECOM interviewee: good at "engaging people" but not so useful for design work because they often show "things that lead to inappropriate discussions". Another architect explained, "people tend not to look at the architecture but at the image and make decisions based on liking or not liking the image." And a visualiser pointed to another tension, between his desire to produce a beautiful, well-composed image and the architects' desire to show the details of their buildings, which led to his views on how the image should look being "slightly hijacked".

This sub-section has suggested, then, that it is not only the anthologicality of these CGIs that creates frictional interfaces as the digital files circulate through, and are read by, their network of different actors. So too does the fact that DAs, EAs, master planners, visualisers, the client, and the ALA are considerably more complex than "a group brought together by common interest" (Doueihi, 2011, page x). Indeed, a lot of the disagreement about the CGIs was between groups with *different* interests, which were expressed through distinct forms of visual imagery: the architects wanted CGIs that showed their buildings in the best light, for example, while the visualisers preferred striking images of the development's public spaces that would demonstrate their creative expertise. Once again, however, action occurred that minimised these frictions between the (different) CGIs' (different) allies. In particular, a clear decision-making hierarchy emerged as the project developed, supported by an infrastructure for sharing commentary on, and decisions about, specific images. This is detailed in the next sub-section.

3.4 embodied

Sub-section 3.1 discussed the importance of 'consistent electronic deliverables' to the CGIs in terms of their technical specifications. The CGIs were also all contributing, as the paper has already noted, to creating a sense of 'how that place will look and feel'; they thus all also had to be "of similar style and similar quality" (MDC manager). Sub-section 3.2 suggested, however, that not all of the CGIs' allies agreed on their 'quality' (recall that some 'took a hammering'), while sub-section 3.3 noted that their 'style' was also contentious. This section emphasises the specific ways in which these different opinions about the CGIs were articulated in a form that could travel through their network, to distribute action on the CGIs elsewhere.

As the previous sub-sections noted, CGIs undergo a near-constant process of drafting and redrafting. Architects want their buildings to look right; visualisers want the CGI views to look striking; the ALA wants them to have "magic moments"; the client wants them to look distinctively Qatari. These various allies of the CGIs all look at versions of the CGIs at various points in their production, as printouts, as projections and on computer screens. As part of that looking, they also make comments about how the CGIs need to be modified. Comments are made verbally, in architect's and visualiser's offices, at Design Review meetings, in other face-to-face meetings and over the phone. There is also lots of discussion in front of screens by both visualisers and architects (see figure 3). Many of these comments are about the accuracy of the CGI in relation to agreed design, but others are much more subjective, remarking on the aesthetic feel, or quality, of the image. One architect suggested these conversations around a screen were the most effective form of communication between architects and visualisers, a claim which favours working

with local collaborators (see also Sunley et al., 2011). And this points towards a particular problem faced by the Downtown Doha project: many of the comments about CGIs could not be made between people having a conversation in front of a screen, because the person to whom the comments were directed was located in a different place in the network. Hence, comments on a CGI had to travel with the CGI, from location to location, from DA to visualiser, or from ALA to MDC, or from client to DA.

This paper approaches the way that comments made about a CGI in one place to travelled to another by considering the embodied interface between design professionals and the CGI view. Much scholarship concerned with the interfaces of digital technology depends on the work of Suchman (2007), among others, to argue that digital technologies are always collaborating with human bodies. This was the situation in our case study. Whether we witnessed a flamboyant performance of aesthetic judgement by the ALA in Msheireb Properties' Doha office, or the silent rows of visualisers staring intently at their screens, only their hands moving, as they worked on detail after detail of a CGI in a Liverpool studio, the CGIs interface with human actors through specific and embodied "skilled visions" (Grasseni, 2011).

However, that embodied interaction between image and human viewer had to be converted into something that could travel with the CGI, to communicate the work that had to be done on it to others. Various devices were employed to achieve this transfer. Word documents and spreadsheets were created, listing the actions required or completed on specific files; pdf files of the images were annotated on screens and then saved as new files to be sent on; while the ALA preferred to print out copies of the pdf files, scribble his comments on them, and then scan the printouts for onward circulation (for an example, see figure 4). (The ALA also wrote

a document entitled "Ten Golden Rules for CGIs" and sent it to all the visualisers working on the project in an attempt to cohere the CGIs' style.) These various textual devices acted as inscriptions of the embodied viewings of the CGIs by various actors in the network, carrying their reactions to, and instructions about, the CGIs to other actors elsewhere, initiating more actions.

This was how the 'hammering' that the animation took from the client in Doha, mentioned in sub-section 3.2, travelled back to the visualisers; and it was also how a lot of the friction described in section 3.3 was articulated, as instructions from the ALA conflicted with what visualisers thought was best, or as visualisers' comments trumped those of the DA. Another difficulty was how to circulate large numbers of both images and comments among so many people efficiently. It was difficult to know if a DA or visualiser had the latest version of a CGI when they were being circulated and downloaded in lots of different places.

Once again, work was done to lubricate these frictions. The project's EC set up a cloud storage facility to ensure that everyone had access to the latest versions of files. More importantly, a clear hierarchy was established which reflected, and enacted, whose comments mattered most; and it was this, in the end, was what cohered the anthologicality of these images, if not into a 'common interest', at least into a common understanding. As one DA explained, "there was a hierarchy to the comments... [the client's] were the most important... [the MDC manager's] were kind of the second most important. And, you know, [laughing] then there was sort of [the ALA] was somewhere way up there. And, you know, my comments were sort of, you know, scraping the ground somewhere." Indeed, the DAs particularly resented their views being ignored, and so the EA eventually began to respond to the architects' frustration by acknowledging their comments even when they were

"subjective" (EA) and had been overridden by the EA's overview of the project. However, the EA also ensured that the client/MDC/ALA decisions were implemented by sending "the master comments" direct to DAs, who could not then ignore them.

However, these efforts to co-ordinate and prioritise the actions required on the CGIs were not entirely adequate, and this was because of the translation required from a *visual* encounter with a CGI to a *written* description of that encounter. There was something about the embodied interface between certain actors and the CGIs that did not in fact travel very well. In particular, the ALA's suggestions for ways to create more "poetic" images – his requests, visible in figure 4, for "atmosphere", "more magic" and "MM"s (magic moments) – proved difficult for visualisers and architects to understand. One DA told us, " [the in-house visualiser] just kept looking at me going, 'I don't understand. What does he mean 'more magic'? He wants like a man flipping cards? I don't know!'"

This visualiser's puzzlement exemplifies the value of the concept of the 'interface' for understanding what sort of things these CGIs are, as they travel between Europe, the USA and the Gulf. As a 3DS Max or Photoshop file is run in specific offices – whether the office of an architect or a visualiser, or the client – it visualises a specific view of the unbuilt Downtown Doha project. It does so by integrating a number of different software elements; by gathering together a range of different images; by having specific anticipated viewers shape its content; and by encountering particular embodied viewers. At all of those various interfaces, work is done *both* to create the image but *also* to smooth its further circulation through the frictions inherent in its network of allies, accomplices and helpers.

4 conclusion

In their book *Code/Space*, Kitchin and Dodge (2011) call for more specific studies of software in action (see also Kinsley 2013). This paper has responded to that call by exploring the creation of computer-generated images of an urban redevelopment project. Our focus has been on the work of visualising future urban places: a visualisation which is more and more often achieved using software such as 3DS Max and Photoshop.

It was evident at an early stage in our study of the CGIs associated with the Downtown Doha project that such CGIs are highly mobile. This suggested that they should be conceptualised as circulating through a *network* of relations, and this paper has sketched that network, which is enacted as digital files circulate between architects, visualisers, Executive Consultants, Master Development Consultants, the Architectural Language Advisor and the client Msheireb Properties. The geometry that the paper has used to map that network is that of the *interface*: that is, the network has been understood as a series of encounters between human and non-human actors – "allies, accomplices and helpers", to quote Latour again – where work is done both to create the CGI and to smooth the friction inherent in all interfaces. The paper has identified four of these interfaces as particularly important in understanding what sort of objects these CGIs are, as they circulate among diverse and dispersed allies. It has emphasised the *intraface*, where for example separate 3DS Max files (standardised by the EC's guidelines) are integrated, thus allowing the EC to modify individual designs in relation to one another. It has explored the *anthological* interface, where different images are brought together. It has stressed the multiple ways in which CGIs are used by different 'allies', and the way those allies *design* specific uses into how the CGIs look. And it has examined the

necessity for traces of *embodied* interactions with CGIs to travel through the network. At all of these interfaces, work is done. Work is done to create a digital visualisation of a view of Downtown Doha; and work is also done to make that work possible by managing the frictions created by the interfaces between software, hardware and various humans.

This paper has emphasised in particular those frictions in the circulation of CGIs. The circulation of CGIs *designed* in one context may 'take a hammering' in another; the immense size of the *intrafacial* CGI files can cause computer systems to crash as they move from a large server or hard drive to a smaller one; traces of *embodied* encounters with CGIs do not always travel effectively; *anthological* imagery can be a solution for some CGI allies but a problem for others. These CGIs must therefore be conceptualised as being as complex and crafted as the frictional, interfacial relations between the various entities in their network. Hence our claim that they are better understood as *interfaces* rather than *images*.

As Galloway (2012) points out, it is very difficult to see friction at interfaces. Interfaces are designed to be invisible and unremarkable. The best touch screens, for example, are so responsive to fingers that they are no longer noticed when they are used; which means that, as Galloway (2012) notes, if the work done at an interface to make it work is effective, then, paradoxically, it appears as if no work is taking place. As a consequence, interfaces cast what he calls "the glow of unwork" (Galloway, 2012, page 25). The beautiful surfaces of the CGIs that appear in urban spaces, selling new urban developments, are thus created not only by efforts to visualise seductive places, but also by that 'glow of unwork'. As this paper's introduction noted, other scholars have already criticised the seductive allure of CGIs as *images*. Here, this paper takes a different critical tack, and attempts to resist

the 'glow of unwork' precisely by reconceptualising the smooth surface of surface of CGIs as a *site of net-work* (see also Graham et al., 2013). Rather than take these CGIs at, literally, their face value – that is, rather than focus on their materialisations as images – this paper advocates approaching them as digital files created by, and therefore materialising, a *net-work* of interfaces. This paper proposes to critical urban scholarship that that network – and specifically its frictional interfaces – should be what is seen when these CGIs are examined. The glow of unwork should not dazzle us; instead it should alert us to the work done to create it.

The sort of CGIs with which this paper has been concerned are part of a much wider turn within contemporary visual culture, however. Digital visualisations are now commonplace in many medias and genres: in movies, in still and moving advertisements, in much art practice, in data visualisations, in computer games. Their scintillating on-screen glow is a constant companion in many forms of everyday life. Looking at what those screens show less as images and more as interfaces in a complex, extensive and frictional network of different kinds of actions, allows us to see that glow as an achievement, something assembled and crafted and created.

Understanding images as interfacial, then, means seeing them as articulations of what particular networks bring together. It also means acknowledging their mobility, multiplicity and mutability. As they move through a network, digital visualisations change and shift, they are modified and decay, they leave trails of earlier versions as they go. Many scholars of digital media are exploring the implications of these characteristics of digital images and digital communication more generally. This paper has already drawn on Kress's account of the "new principles of text-making composition" that are enacted in digital networks in its

account of the CGIs as designed, for example, with its emphasis on the "provisionality and instability" of such communication (Kress, 2010, pages 20 and 6). Joselit (2012) has recently explored the networked dispersion and provisionality of digital visual interfaces in relation to artworks. He suggests that much art practice now must be understood, not as the creation of individual auratic objects, but as "the emergence of form from populations of images" (page 43) (which rather nicely also describes the emergence into visibility of the forty-two CGIs from the great crowd of digital files held on various servers and computers in this paper's case study). And Hartley (2012, page 57), too, in a recent bracing polemic on *Digital Futures for Cultural and Media Studies*, suggests that looking at individual images to interpret their 'essence' is less and less relevant in the digital context of the huge, mutating image populations that constitute popular visual culture. All emphasise the changes wrought to meaning-making by the emergence of digital networks through which data is constantly mobile, shifting and proliferating, moving between different actors and media, ported and patched, altered and designed, collaged and commented on, such that digital visualisations now should be considered as networked "configurations" rather than as "discrete objects" (Joselit, 2012, page 43).

Joselit (2012, page 43) expands on the methodological implications of this shift:

"The shift... from an object-based aesthetics in both architecture and art to a network aesthetics premised on the emergence of form from populations of images, calls for a corresponding revision of critical methodology. Objects characterized by discernible limits and relative stability lend themselves to singular meanings – almost as though well-

defined forms are destined to *contain* a significance like vessels. Emergence, however, unfolds in time: it must be narrated."

The claim that the emergence of specific images into heightened visibility from a much wider networked population of images requires *narrating* is a claim repeated in other discussions of aspects of the digital network. Douehi's (2011, page 79) account of anthological practice also claims that "multiple and deliberative authorship calls for an equivalent form of reading [...] a reading anew each time, but with a particular attention to the archive or to the changes introduced into each text." This paper reflects these arguments; it has narrated the changes in a population of images. However, it has also paid careful attention, not only to the *temporality* that inheres in understanding visualisations as networked interfaces, but also to the *spatiality*. It has argued the need to pay attention, not only to visualisations *of* space, but to visualisations *as* a particular spatial geometry (cf. Ash and Gallacher, 2011). A digital visualisation is a provisional and sometimes precarious coming-together of a series of frictional interfaces. This is their distinctiveness, and it demands a new methodology attentive to the work done as they circulate through software-supported spatialities.

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