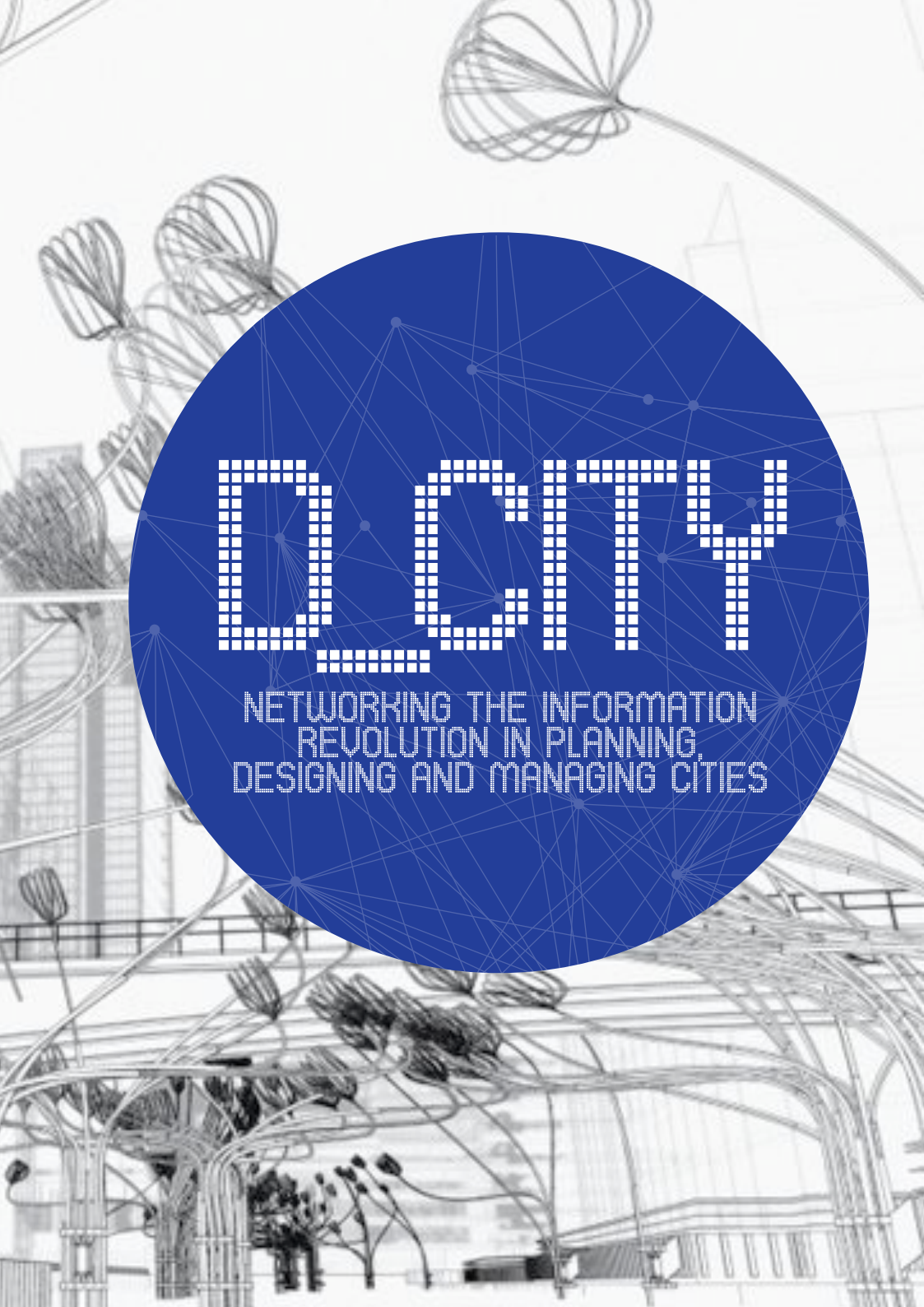
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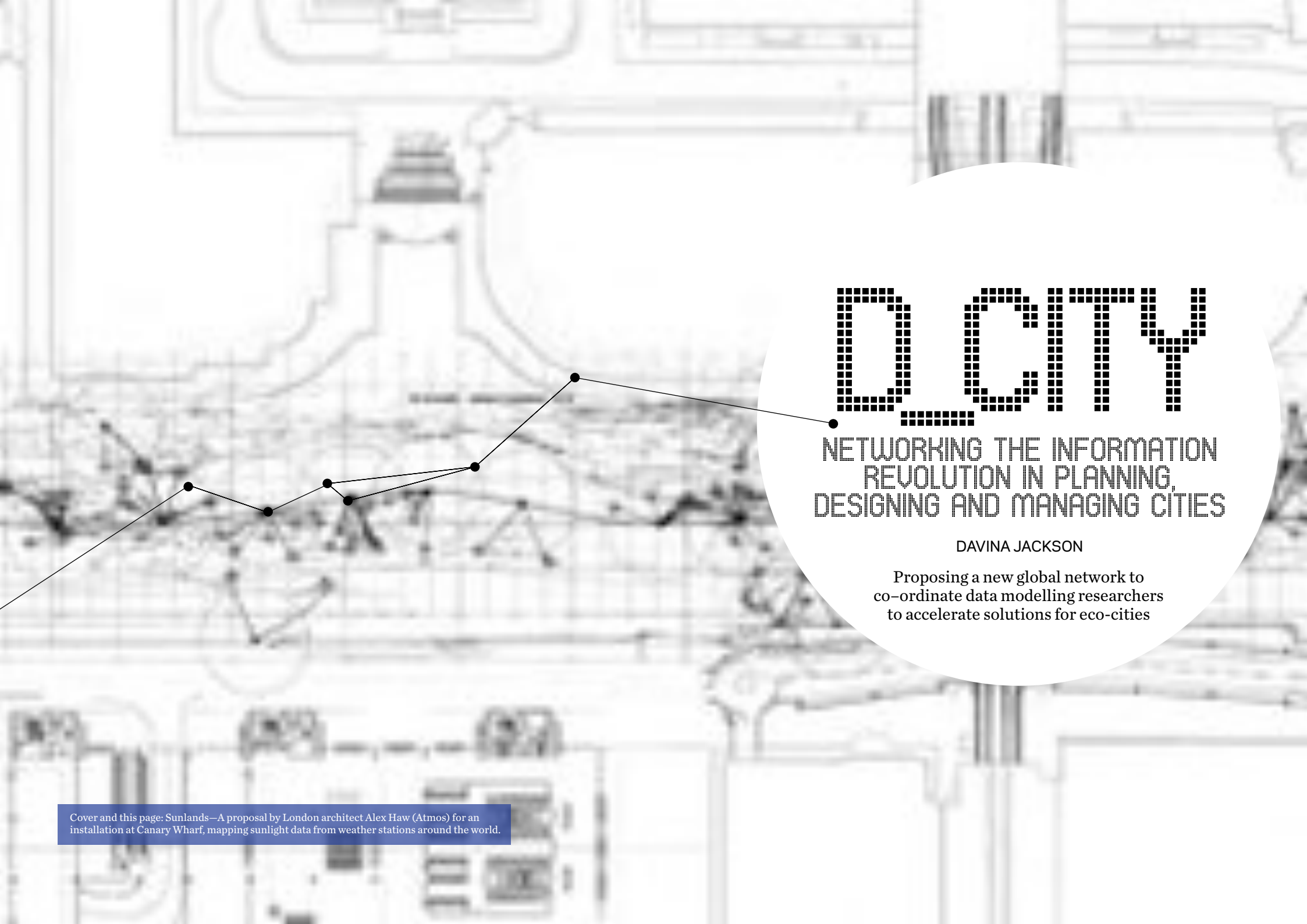


D_CITY

NETWORKING THE INFORMATION REVOLUTION IN PLANNING, DESIGNING AND MANAGING CITIES

DAVINA JACKSON

Proposing a new global network to co–ordinate data modelling researchers to accelerate solutions for eco-cities

Cover and this page: Sunlands—A proposal by London architect Alex Haw (Atmos) for an installation at Canary Wharf, mapping sunlight data from weather stations around the world.

Debate about climate change often has focused on potential sacrifices which could be made by individuals, households and neighbourhoods. Now there is a growing emphasis by governments (for example via the Clinton Foundation's c40 climate cities program, and the Metropolis network of city governments) on improvements at urban scales.

One way to accelerate viable solutions to global environmental problems is to exploit the massive calculation powers of computers—fed with reliable data. With recent advances in sensor and satellite positioning technologies, the planning, property and construction sectors are beginning to recognise how past inefficiencies gradually might be resolved by collaborating with the digital technologies sector to process these new streams of evidence about dynamic behaviours in cities.

Precursors to this ambitious vision have cropped up regularly since the early 19th and 20th centuries. The first significant steps towards computing were taken with philosopher Charles Babbage's 1820 proposal for a 'Difference Engine' to calculate and print astronomical and nautical data. A later theory from physics was James Clerk Maxwell's 1873 proposition that the void between atoms was filled with an electromagnetic field through which energy moved at the speed of light.

Both of those concepts (among others) have been progressively developed by scientists towards the 'global information space' or World Wide Web, that was initially presented to the cern European particle physics laboratory by Tim Berners–Lee in 1989. Only now, however, are digital technologies becoming computationally powerful, instantaneous and ubiquitous enough to enable 'scale–free networks' to operate dynamically around the planet.

According to New York architect Winka Dubbeldam, scale–free networks need a combination of random growth and preferential attachments to thrive. This combination—of fresh energies and outputs supported by established chains of wisdom—is now proposed for the D_City global online research network.

D_City aims to co–ordinate global research (mainly academic) to gradually support developers and governments of eco–intelligent cities.

ONE WAY TO ACCELERATE VIABLE SOLUTIONS TO GLOBAL ENVIRONMENTAL PROBLEMS IS TO EXPLOIT THE MASSIVE CALCULATION POWERS OF COMPUTERS—FED WITH RELIABLE DATA

DATA MODELLING TO INFORM BETTER DECISIONS ABOUT CITIES

Use of 'data simulation' and 'virtual prototyping' technologies is increasing in the advanced building sectors of Japan, Korea and Scandinavia—inspired by similar technologies in the aerospace and manufacturing sectors, where it long has been understood that human brainpower alone cannot deliver the precision required to drive complex machines in 'mission critical' (no room for error) conditions.

The most advanced systems of information modelling allow—indeed require—teams of diverse specialists to collaborate online to optimise accurate designs for ecologically intelligent new buildings and cities. One term used for this team approach is 'integrated practice'—and it implies simultaneous rather than sequential processes of planning and designing major urban projects.

Information modelling offers not only ecological efficiencies, but also economic efficiencies (cost and time reductions, minimisation of investment risks)—so financiers of major building projects are becoming enthusiastic to implement these systems. Some governments (led by New York's Police Department under the leadership of Rudolph Giuliani, and by cities which host Olympic Games) also see potential for more efficient monitoring and managing the needs and activities of their citizens (often generating debate about individual rights to privacy).

The major source of resistance to information modelling has come from the architecture and engineering professions, where many small to medium enterprises do not want to update their processes or cannot invest in the necessary retraining and equipment to the levels becoming expected of them.

FROM CAD TO CAM

In the West, the well-known cad (computer-aided design) phase that followed the arrival of personal computers in 1980, has largely (but not entirely) converted the aec (architecture, engineering and construction) sector from its 20th century reliance on layers of drawings on large rolls of paper, to two-dimensional drawings on screens (which can be transmitted as files over the Internet).

Now it's becoming recognised that drawings (whether by hand or in the computer) are not enough: what's needed now are computable virtual models—capable of adding and crunching more and more levels of data—and increasingly dynamic data gathered via satellites, mobile phones, gps devices, etc.

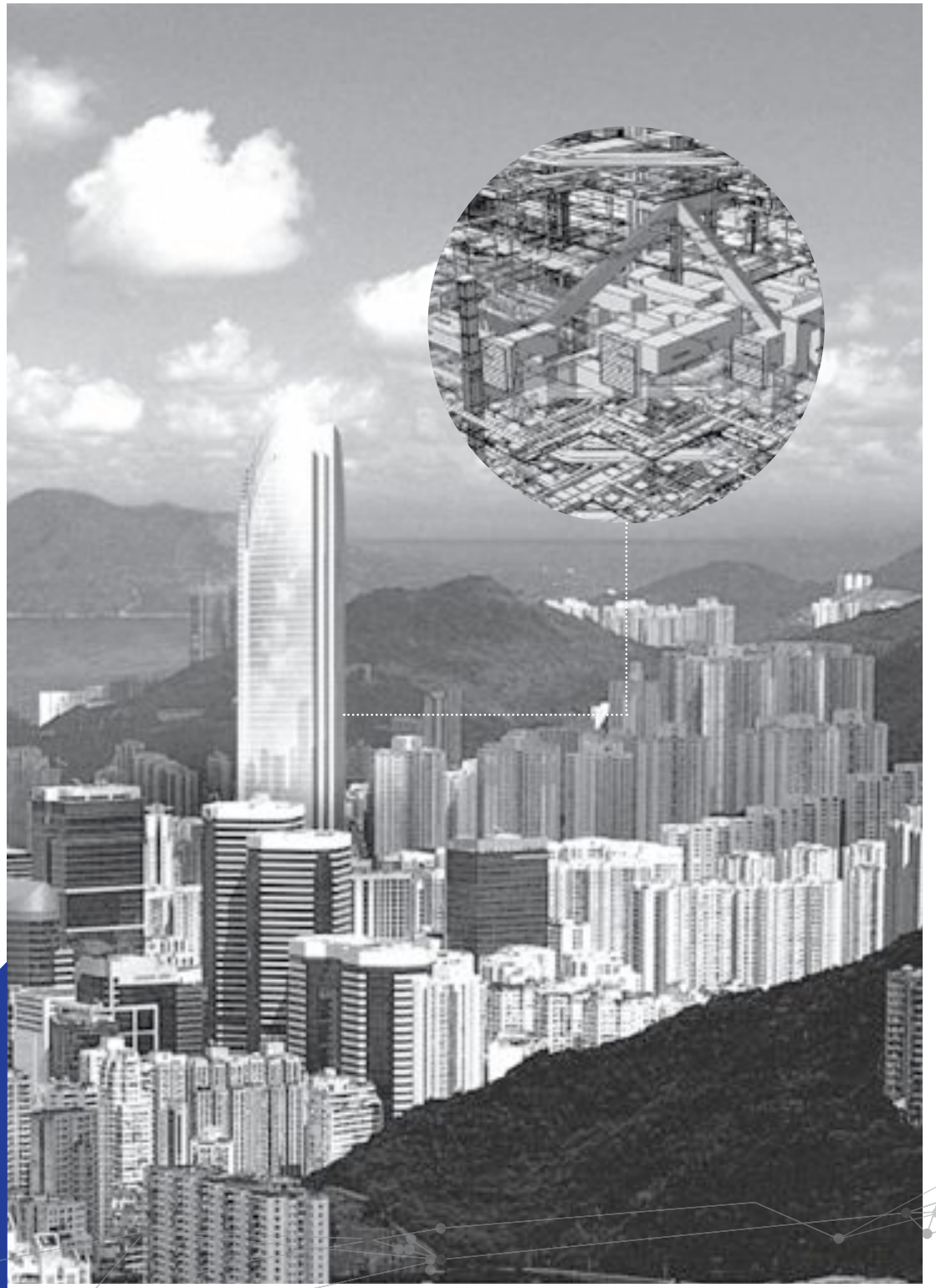
The combination of cad and the Internet significantly reduced time frames in designing for the built environment. But major technology revolutions always take much longer to bed down in government planning and mainstream architecture and construction than in other sectors because of the high capital costs, uniqueness of each project and one-off project development teams.

In most Western countries, there is a current transition from cad and manual construction of buildings to building information modelling (bim) as the primary information source which can drive computerised manufacturing of structural components (computer-aided manufacturing: cam).

BUILDING INFORMATION MODELLING

Los Angeles architect Frank Gehry is credited for heading the first architectural practice to shift from cad to bim technologies. After making models of radically sinuous buildings with flexible manila cardboard and tape, he won a commission in the early 1990s to build a Guggenheim Museum in Bilbao on the north coast of Spain. To deliver his extremely complex waves of roof-walls in titanium metal, Gehry turned to the leading supplier of aeronautical software, Dassault Systemes of France. Since then his spin-off company, Gehry Technologies (cto Dennis Shelden), has been adapting Dassault's catia virtual modelling software into a sophisticated system for modelling buildings and cities, called Digital Project.

Recently, the world's first complete Digital Project virtual model delivered major savings of construction time, cost, materials wastage



and risk management for financiers of a 70–storey office tower in Hong Kong named One Island East (UK developer Swire Properties).

Most leading suppliers of CAD softwares—the best–known being Autodesk and Bentley—are upgrading their programs to incorporate information modelling and database manipulation features. These firms offer a variety of software products to cater for the specialist needs of different consultants in the design of built environments—and the products are becoming increasingly integrated or interoperable.

Stanford University's Centre for Integrated Facilities Engineering (CIFE) recently researched the benefits of BIM across 32 major construction projects in the United States. Its report claims that the advantages include:

40%
FEWER UNBUDGETED CHANGES (4-8% OF PROJECT COST)

±3%
ACCURATE COST ESTIMATES TO ±3%

<1%
LESS THAN 1% COST GROWTH

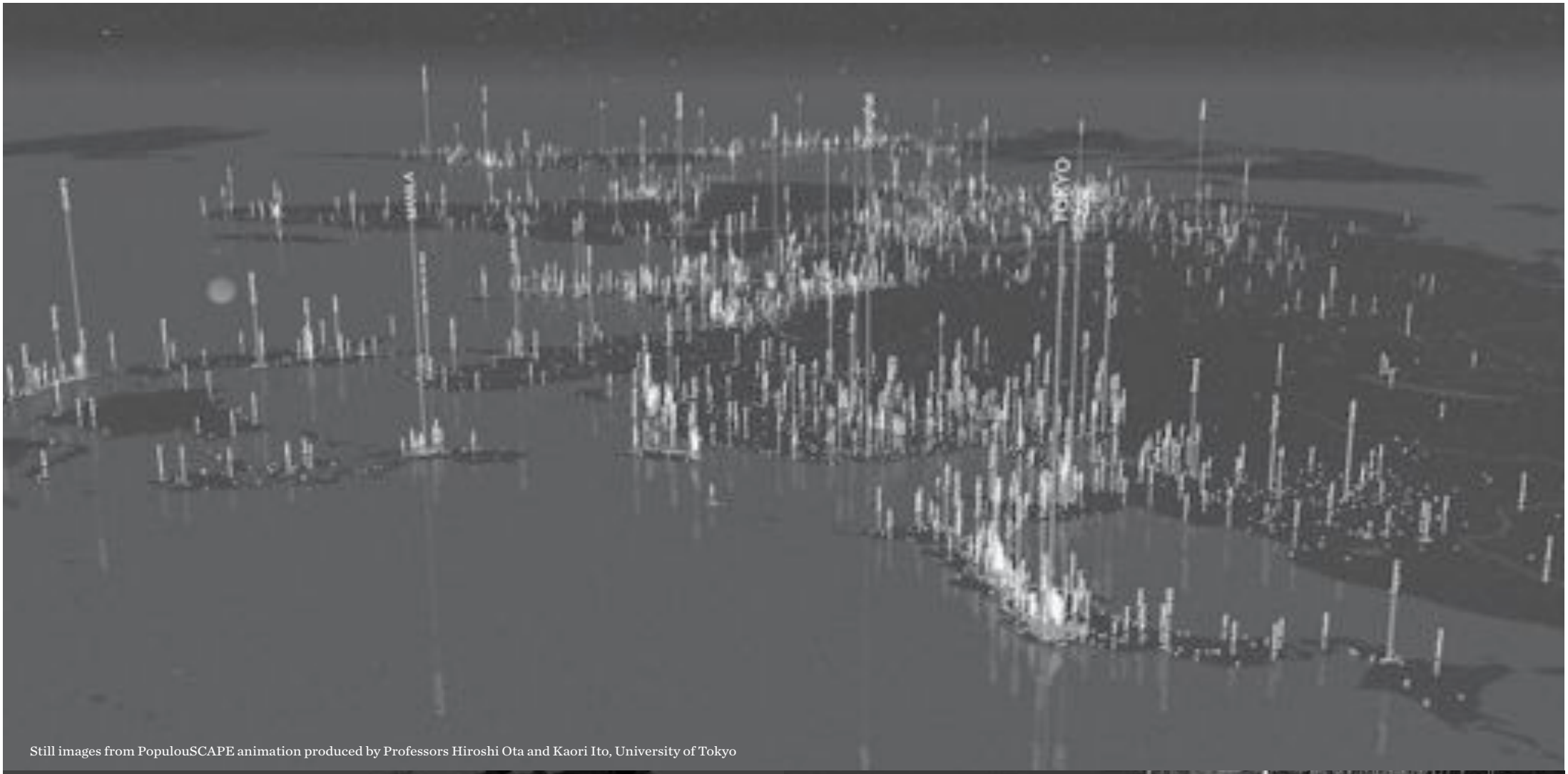
±2.5%
BIDS WITHIN PLUS OR MINUS 2.5%

80%
REDUCTION IN COST ESTIMATING TIME

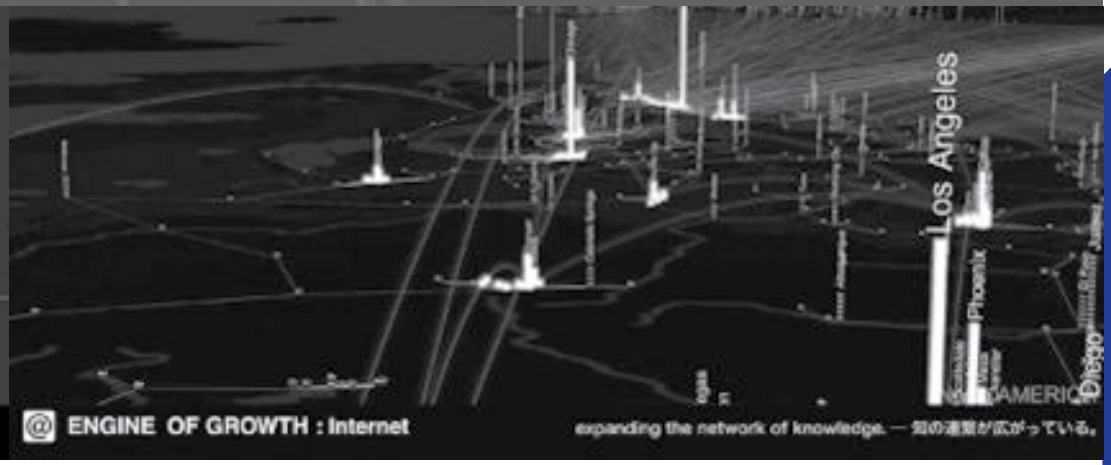
5-10x
RETURN OF INVESTMENT OF THE VIRTUAL MODEL

10%
SAVING THROUGH DETECTING & RESOLVING STRUCTURAL CLASHES
(BASED ON A 2D VERSUS 3D PROJECT)

Left: Thousands of clashes of structure and airconditioning ducts were detected and resolved in the Gehry Technologies Digital Project virtual model for One Island East, an office tower nearing completion in Hong Kong. Developer: Swire Properties.



Still images from PopulouSCAPE animation produced by Professors Hiroshi Ota and Kaori Ito, University of Tokyo



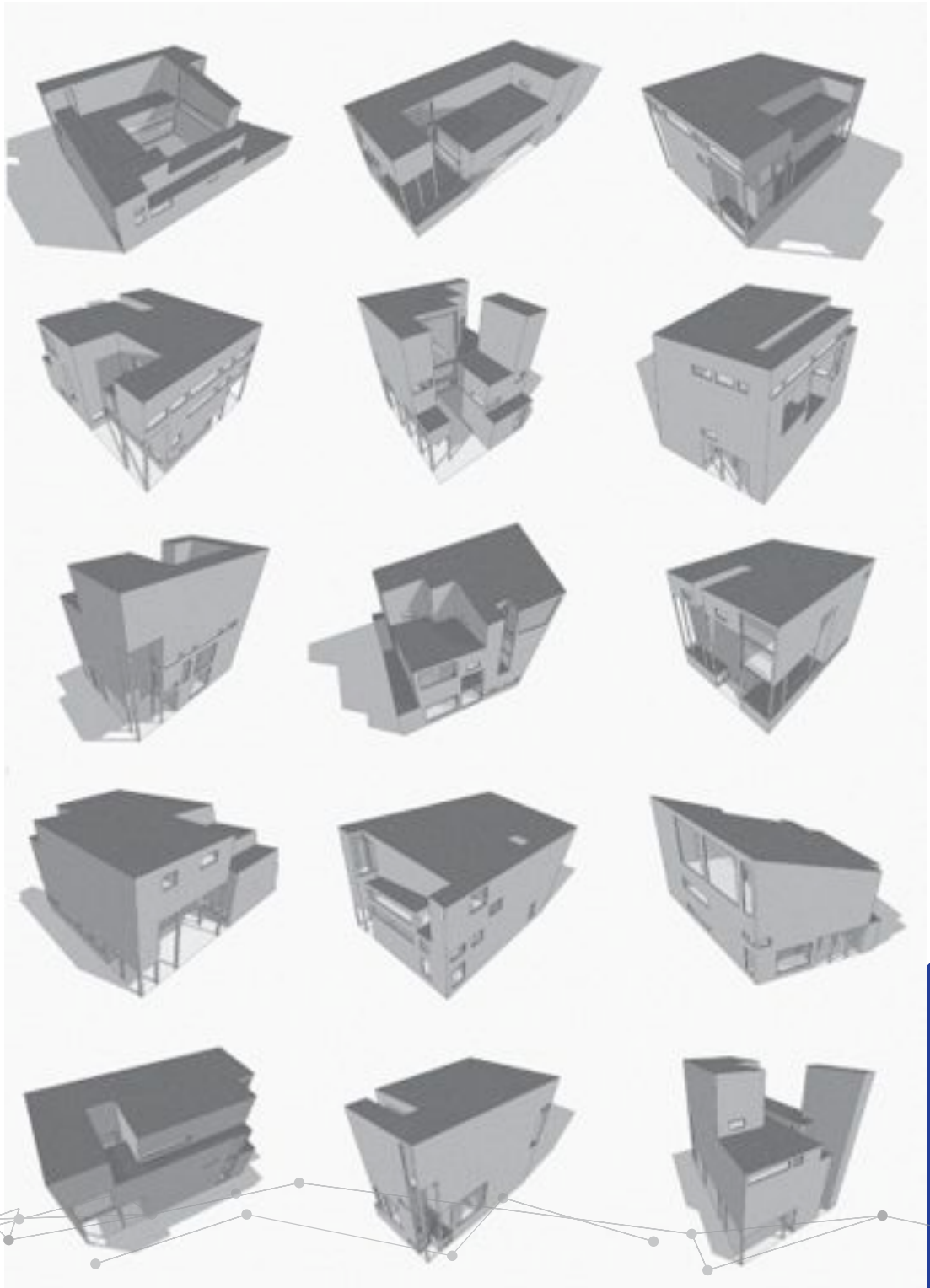
BEYOND BIM TOWARDS DATA CITIES

BIM IS ONLY PART OF THE CURRENT REVOLUTION IN MODELLING SYSTEMS destined to reform the planning, design and management of future cities. One key to this phenomenon is today's global mobility of information, communications, capital, goods and services—forecasted at the dawn of the commercial internet in the mid 1990s by academic writers including Nicholas Negroponte and William J. Mitchell, Saskia Sassen and Manuel Castells.

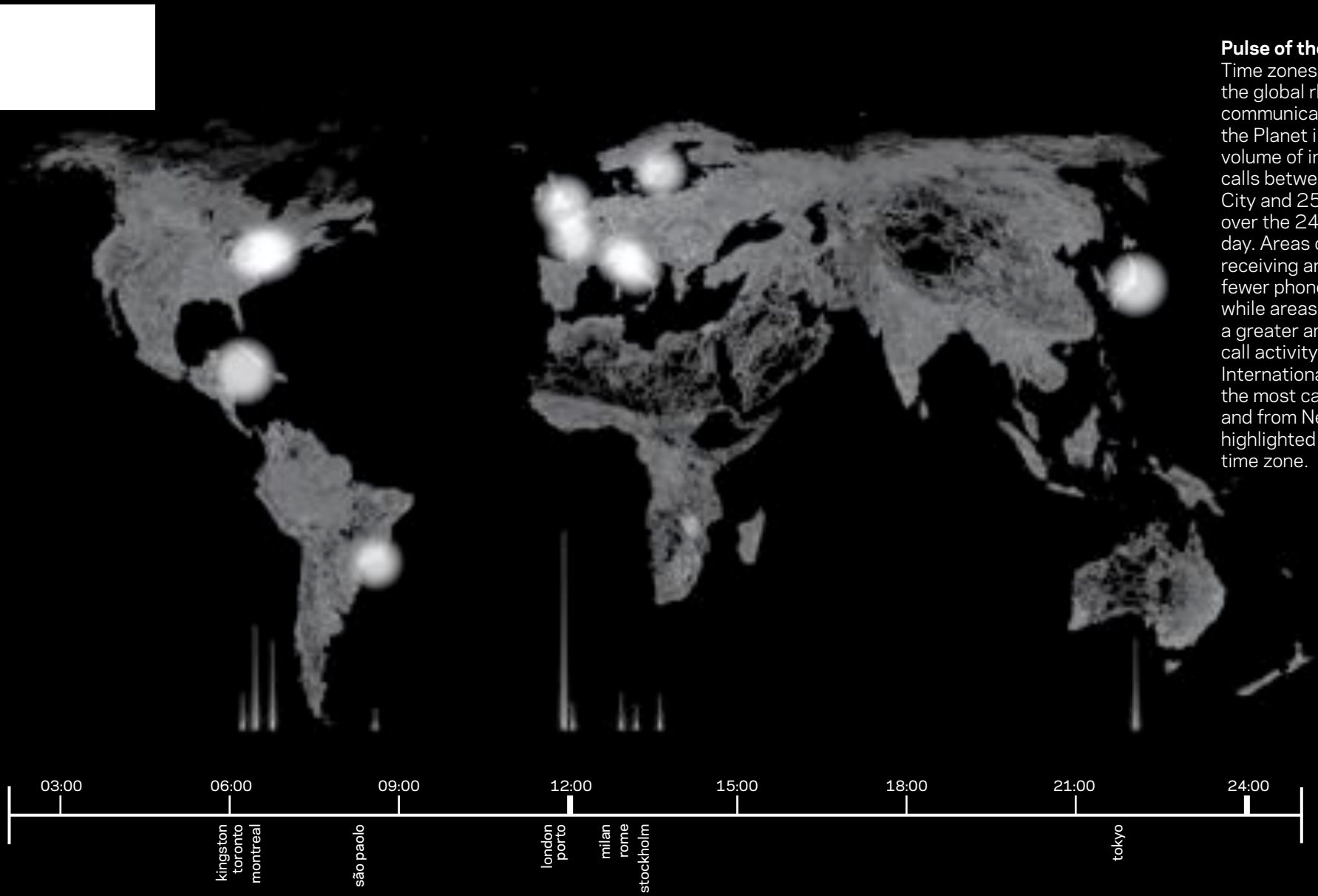
Around the same time, architectural scientists John and Julia Frazer highlighted a sequence of experiments towards 'an evolutionary architecture'—using electrical engineering, algorithmic and artificial intelligence principles to automatically generate and modify designs for buildings. Earlier John von Neuman, Stanislaus Ulam and John Conway initiated experiments with cellular automata: one of the systems now in common use for modelling urban dynamics. Mark Burry, Hugh Whitehead, Robert Aish and other digital architects began experimenting with 'parametric modelling'—using code–scripted rules to generate virtual prototypes for irregular forms and building components. And in the early 1980s, Professor Bill Hiller, of London's Bartlett School, developed the Space Syntax system for predicting and analysing people and traffic movements in city streets and spaces.

Experiments and discoveries by these and other leaders of the cybernetics movement, combined with common access to wireless and web technologies, now are forcing a conceptual reversal from understanding cities as static buildings and streets (the traditional architecture mindset), to a perspective (derived more from physics, electrical engineering and biology) of them being dynamic and constantly interacting flows of evolutionary behaviours (weather patterns, people and vehicle movements, soils and vegetation, water, electricity use, etc).

Certainly digital technologies are fast dissolving centuries of ideology about architecture symbolising static permanence, monumentality and hierarchical power structures. Today's socio–economic foci include information accessibility and transparency, and there is a growing emphasis in many nations on how to repair Mother Earth.



Right: Concepts for buildings can now be algorithmically generated to evolve automatically on screen—a technology which is radically changing architectural practice. Example by Patrick Janssen.



Pulse of the Planet
Time zones influence the global rhythm of communications. Pulse of the Planet illustrates the volume of international calls between New York City and 255 countries over the 24 hours in a day. Areas of the world receiving and making fewer phone calls shrink while areas experiencing a greater amount of voice call activity expand. International cities with the most call activity to and from New York are highlighted according to time zone.

From the New York Talk Exchange exhibition by MIT's SENSEable City Lab, led by Carlo Ratti with advice from Professors Saskia Sassen and William J. Mitchell, at the New York Museum of Modern Art, 2008.
http://senseable.mit.edu

COORDINATING RESEARCH TOWARDS MAXIMUM EFFECTS

Developing new data sets and software tools for planning, designing and managing cities needs a coordinated international approach to research and development across many specialist disciplines and industry sectors. This long–term and highly complex ambition is being pursued by an emerging international online research network called D_City. Founded by six internationally noted digital architecture research leaders in Australian universities, it is rapidly gathering diverse supporters concerned with new systems of modelling natural, built and virtual environments.

D_City's Founders in Australia are Professor John Frazer (founding Chair) and Professor Robin Drogemuller of the Queensland University of Technology, Professor Mark Burry of RMIT University, Professors Tom Kvan and Bharat Dave of the University of Melbourne and Davina Jackson (Catalyst), with National ICT Australia.

If D_City's participants can be coordinated to collaborate and communicate using new social e–research and networking systems ranging from websites to surface computing to various new forms of video conferencing, they could do much to accelerate information modelling technologies towards the ultimate goal of creating a multi–dimensional information model of the planet.

The D_City project still is gathering major financial partners but its researchers already are working on key advances via existing alliances developed around the international academic conference circuits. Northern hemisphere universities with research leaders who are supporting this project before its formal launch include MIT, UCLA, USC, Columbia, the University of Manitoba, Tongji University, Tokyo University and the Tokyo University of Science, University College London, the London School of Economics, the Architectural Association, Imperial College, Loughborough University and the University of Westminster.

Also supporting the D_City concept is a venerable British Enlightenment institution, the Royal Society of Arts (Manufactures and Commerce). Founded in 1754 as a 'force for social progress', the RSA now has 27,000 influential Fellows around the world, united behind a tradition of 'enlightened inquiry and positive social action'. D_City shares with the RSA an approach that is 'multi–disciplinary, politically independent and combines cutting edge research and policy development with practical action.'

NATURAL SYSTEMS MODELLING
Gathering and incorporating terrestrial, meteorological, oceanographic and other environmental data and modelling systems (already strongly advanced) into the first strategic planning processes of designing large urban developments. In principle, this should automatically lead to more eco–sensitive master plans.

BUILDING INFORMATION MODELLING
Improving products and systems for 'virtually prototyping' and optimising proposals for complex buildings, structures and environments.

CITY INFORMATION MODELLING
Creating virtual models of cities and improving digital systems of predicting and monitoring movements of people, traffic, water and other dynamic flows within urban environments.

CITY INFORMATION NETWORKING
Exchanging increasingly sophisticated data between cities to track and compare their performances on different criteria.

PLANETARY SYSTEMS MODELLING
Gradually developing a dynamic, multi–dimensional, data–based, integrated real–time virtual model recording and predicting evolutionary behaviours around planet Earth.

D_CITY RESEARCH THEMES

This project is too ambitious and amorphous to be easilygrasped by today's decision–makers in terms of practical outcomes. So it is being divided into five new streams for research, development and impacts for governments and the property development sector.

Each theme roughly corresponds to natural clusters of contemporary professional disciplines—which allows these groups to adapt gradually to the significant changes ahead.

All of these research themes currently are being explored by digitally advanced environmental scientists and engineers, surveyors, architects, artists, film makers and other designers of built and virtual environments. But much more R&D—and effective commercialisation—is needed to accelerate convergences of all the technologies and principles into flexible and easily used systems.

MONITORING BEHAVIOUR PATTERNS

The fastest information modelling advances currently seem to be coming from the aerospace and geospace fields, exploiting real–time satellite positioning and locational systems, and airborne (LIDAR: Light Detection and Ranging) scanners of large tracts of landscape, as well as new land–based scanners of buildings and vehicle–based scanners of streets and precincts.

Also relevant are digital photography and video to record built environment behaviours. For example, photogrammetric cameras are able to show in dazzling colours exactly how energy is being lost from inefficient buildings—this technology alone will transform monitoring of construction quality in the mass–housing industry.

Crucial to the future of built environments are the designers of virtual environments: the animators (many of them dropouts from analog–age architecture programs over the past decade) who now toil in special effects agencies like Peter Jackson's Weka in New Zealand, Animal Logic in Sydney (regularly used by Happy Feet director George Miller) or Star Wars creator George Lucas' consortium in California.

VIRTUAL WORLDS

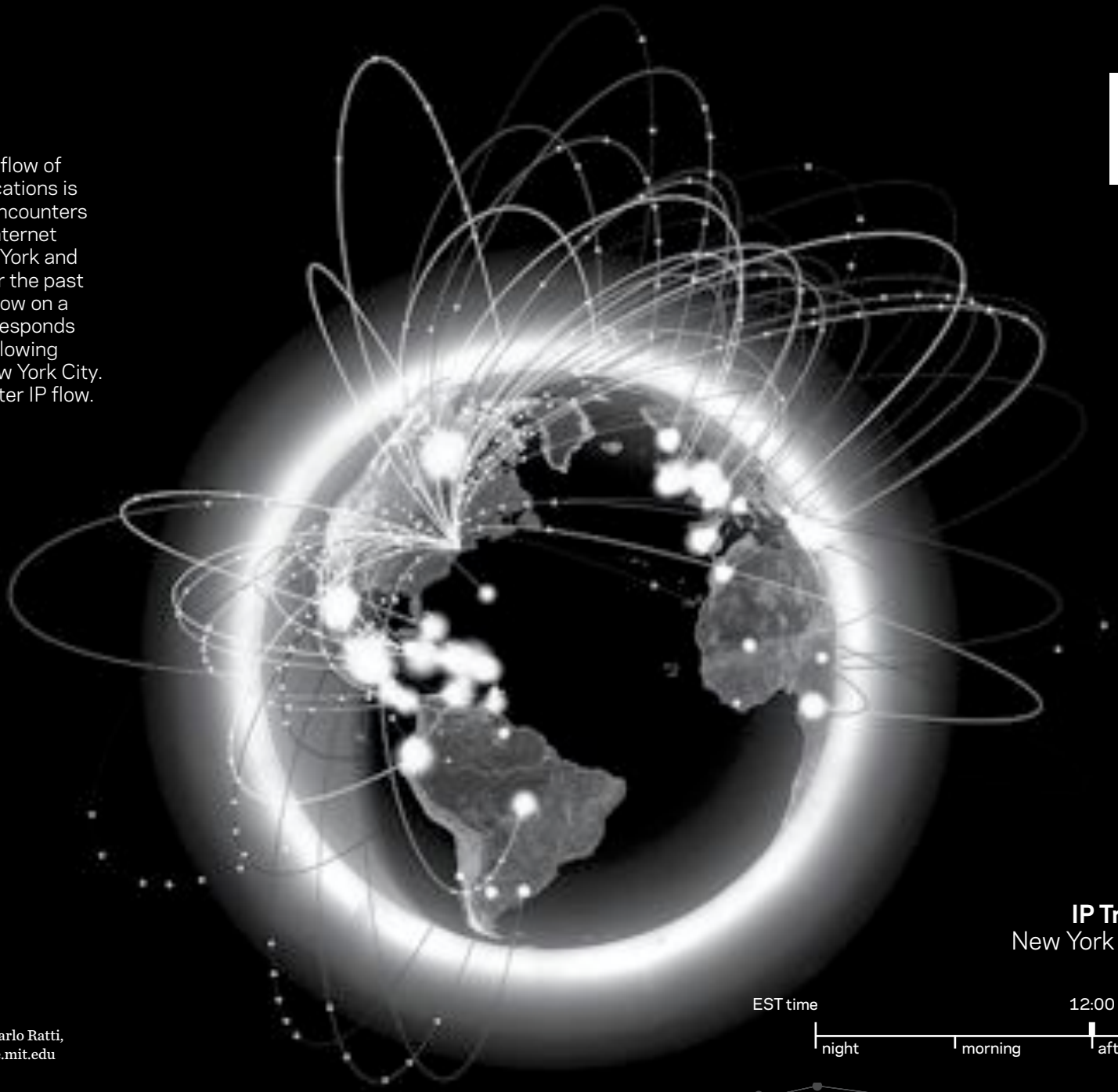
Evolving rapidly too are ways to create imaginary urban environments and represent existing urban situations in online domains like Second Life, where players can use their virtual selves—avatars—to live dreams that are impossible within the practical restrictions of conventional human relationships.

Major corporations and governments have been buying plots of virtual land in Second Life, and are developing extensions of their advertising and promotional campaigns to attract young generations of online gamers. Real money is involved: Linden dollars in Second Life can be exchanged for some national currencies. Naturally, competitors are rapidly moving into this internet gaming business based on author Neal Stephenson's concept of 'metaverses'.

Right: Potentials for avatars to aerially navigate cities in Second Life.
From Dr Andrew Hudson–Smith 'Digital Geography', UCL CASA.

Globe Encounters

In the Information Age, the flow of Internet traffic between locations is nearly ubiquitious. Globe Encounters visualises the volumes of Internet data flowing between New York and cities around the world over the past 24 hours. The size of the glow on a particular city location corresponds to the amount of IP traffic flowing between that place and New York City. A larger glow inplies a greater IP flow.



IP Traffic Total | Real Time
New York to the rest of the world

MIT SENSEable City Lab, Director Carlo Ratti,
image Aaron Kaplin, http://senseable.mit.edu

NEXT OPPORTUNITIES FOR GOVERNMENTS

How can government decision-makers best exploit these teeming streams of data—now requiring not just terabytes but pedabytes of storage capacity for many large enterprises—and still exponentially escalating?

Several next steps seem logical for governments. First, survey today's state of play. Clarify what data-based digital systems already are being used to understand behaviour patterns in cities by national and international defence, police, geoscience research and insurance organisations (which traditionally employ the most advanced technologies and data-gathering systems). Also by the most advanced engineering consultancies.

Then consult with the environmental science and engineering research leaders at major universities to compare the strengths, weaknesses and opportunities for applying meteorological, oceanographic and geographic data in the early strategic planning phases of large urban developments. Encourage and continually monitor further research of world's best practices and research and development to fill necessary vacuums towards improving inefficient aspects of environmental design.

Compare those with current activities and performance criteria within different arms of government—which departments are effective in gathering and monitoring metrics, which need improvement.

D_CITY AIMS TO WORK WITH METROPOLIS TO DEVELOP A SOUND RESEARCH SYSTEM TO DELIVER IMPORTANT IMPROVEMENTS IN PLANNING AND MANAGING CITIES

CONNECTING CITIES

One of the most exciting potentials for D_City and Metropolis is for the researchers to work with city governments to progressively develop an idea first demonstrated in Groningen, the Netherlands, in 1995.

At an international urban design studio led by D_City's founding chair, Professor John Frazer, one of his students, Cristiano Ceccato, suggested creating a global network of computer models of cities. Different models could learn from each other, producing a wealth of experience in different situations.

This idea was prototyped by networking a series of computers each representing a different city at different latitudes and with different economies. This made it possible to demonstrate dramatic differences in the solar envelope at different latitudes and the effect of different economies on growth patterns.

Today, with vastly more powerful computational tools, it is even more exciting to imagine a global network of cities co-operating with each other in their evolution.

d_city

info@dcityresearch.net

FOUNDING RESEARCH PARTNER:

NICTA