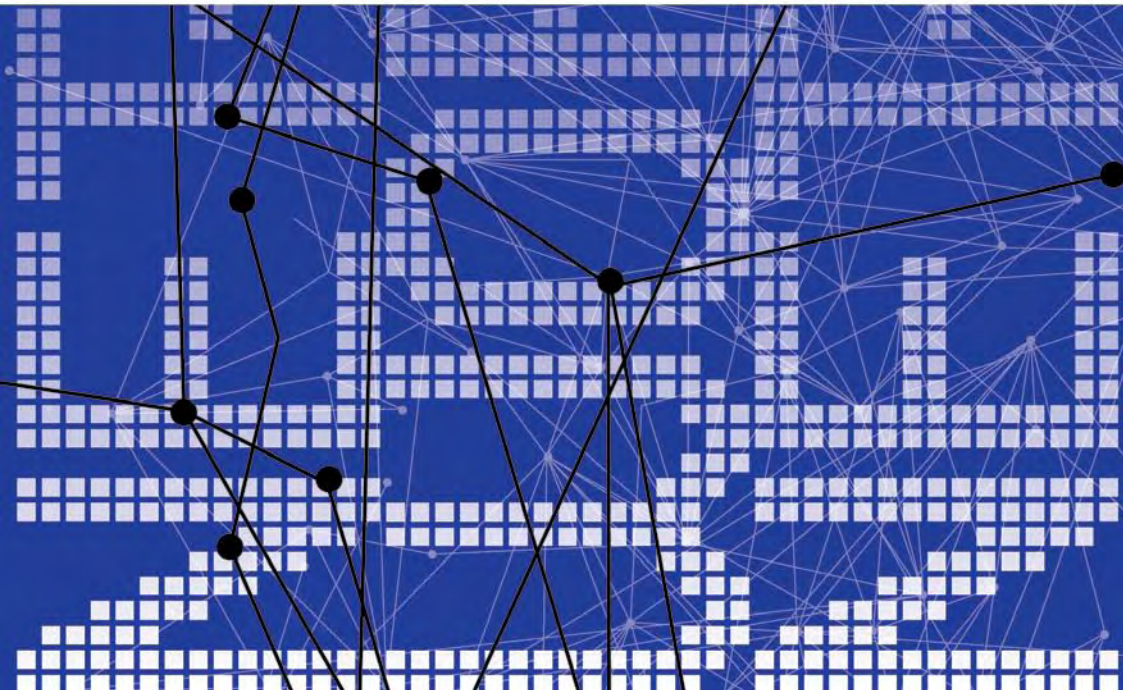
CONNECTING CITIES : NETWORKS

A Research Publication for Metropolis Congress



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A research Publication for the
9th World Congress Of Metropolis

Essays by
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FOREWORD

The 9th World Congress of Metropolis, to be held in Sydney in October 2008, is a great opportunity to generate research into the future direction of cities. With this in mind, the organisers of the congress have developed a number of research publications that explore new concepts related to cities as well as the emerging cities of India and China.

In organising the Congress, we found that there was a network of researchers and commentators about cities across the globe who had very interesting issues to raise. While many of these will be presenting papers at the Congress, we also thought it would be useful to develop a series of publications that raise these issues in a provocative manner. The first of these books will be about networks—the concept of cities interacting across the globe. The second examines the spreading urban regions around many cities followed by publications that look in detail at the cities of China and India.

Contemporary world urbanisation, particularly the rise of Chinese and Indian cities, means both opportunities and challenges for Australian cities. These publications put Sydney and other Australian cities in scenarios with global counterpart cities to benchmark their urban performance. The provocative topics are aimed to trigger fruitful debate in government, private sector and the general public regarding how to create better strategies for the future of Australian cities.

We would like to thank all contributors, sponsors and research coordinators. Without their work, these publications could not have been possible. The influence of their contributions will be far reaching.

Chris Johnson
Director, Metropolis Congress 2008

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Saskia Sassen is the Lynd Professor of Sociology and serves on the Committee on Global Thought at Columbia University. Her recent books are *Territory, Authority, Rights: From Medieval to Global Assemblages* (2006), and *A Sociology of Globalisation* (2007).

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Davina Jackson is an international writer and promoter of progressive Australian architecture and design. She is the Catalyst of the D_City project, Strategy Director for the forthcoming Smart Light Sydney festivals, and author of *Next Wave: Emerging Talents in Australian Architecture* and *Australian Architecture Now.*

WHERE IS SYDNEY?

Until recently cities were seen as places. Think of New York skyscrapers, the streets of Paris, the canals of Venice or Sydney Harbour.

Over the last 20 years or so a new reading of cities has emerged and that is their role as connectors of global capital or as satellites for global networks of advanced service providers. The new reading of the relevance of individual cities is based on how global they are as opposed to how local they are. This reading comes partly from the writings of Manuel Castells on the *City of Flows* and the pioneering research of Saskia Sassen on *Global Cities* (she framed the concept). But the role of cities as being networks of economic activity also comes from the rise of service providers in the areas of law, accounting, insurance, management, finance and design that are located everywhere. Well—perhaps not everywhere—but certainly where they see individual cities as being globally significant.

So a city like Sydney can rank well down the list of cities defined by size, yet can be the 5th most connected city in the area of advertising services and 13th most connected city in the world. Sydney also rates highly in terms of its branding, its image to the world, where the city is number one according to the Anholt City Brands Index. Clearly Sydney rates well as a place and as a networked city to the rest of the world.

CITY BRANDS INDEX

WWW.CITYBRANDSINDEX.COM

1 SYDNEY
2 LONDON
3 PARIS
5 NEW YORK
8 MELBOURNE
22 TOKYO
35 SINGAPORE
37 HONG KONG
47 SHANGHAI
57 MUMBAI

LARGEST CITIES

WWW.CITYMAYORS.COM

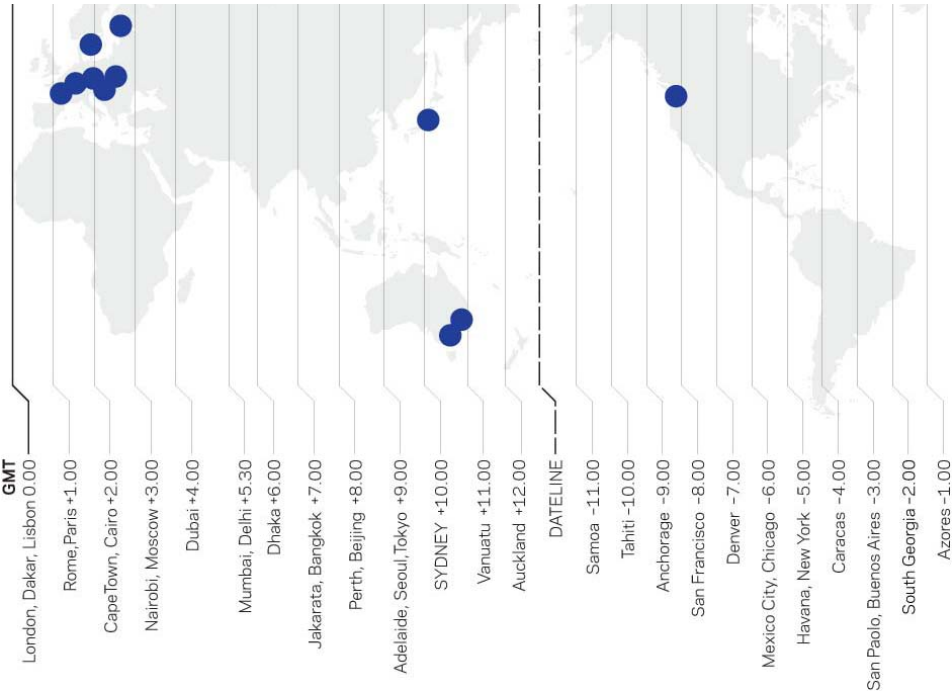
This book explores this new dimension of global networks, of connected cities, of the role of the internet in linking businesses across the globe, or the rise of aircraft connectivity to world cities. To set the scene Saskia Sassen, the originator of the very concept through her 1991 book *The Global City* writes about the evolution of the city as part of a network of cities. Her book focused on New York, London and Tokyo as the most global cities at the time of writing. Since that time Tokyo has dropped down the list to leave NYLON (New York and London) as the name that represents the zenith of global cities.

Much of the content of the book comes from the Globalisation and World Cities (GaWC) research unit at Loughborough University in the UK. Under the leadership of Professor Peter Taylor, GaWC has become the acknowledged leader in the concept and the ranking of world cities. Peter writes about his research into the connectivity factor of cities under a number of service providers and then ranks cities. Other members of GaWC also contribute chapters to the book covering the role of air traffic and the connectivity the internet provides.

QUALITY OF LIFE

WWW.MONOCLE.COM

1 COPENHAGEN
2 MUNICH
3 TOKYO
4 ZURICH
5 HELSINKI
6 VIENNA
7 STOCKHOLM
8 VANCOUVER
9 MELBOURNE
10 PARIS
11 SYDNEY



WORLD CITY CONNECTIVITY

WWW.LBORO.AC.UK/GAWC/

1 LONDON
2 NEW YORK
3 HONG KONG
4 PARIS
5 TOKYO
6 SINGAPORE
13 SYDNEY
21 MUMBAI
24 MELBOURNE
31 SHANGHAI

The issue of global connectivity is the underlying theme of the Metropolis Congress being held in Sydney in October 2008. Indeed the conference is called CONNECTING CITIES and this refers to the global city network as well as the growing connectivity of Sydney to the emerging cities of China and India. Or the congress title could refer to the network of regional cities most metropolitan regions contain. In Sydney this could be Parramatta, Penrith, Liverpool, Wollongong, Gosford and Newcastle, all connected to Sydney's historic centre and also all connected to each other.

Global networks is also a very appropriate descriptor of many of Australia's, and particularly Sydney's, companies who have taken on the world. Companies like Lend Lease, Macquarie Bank, Westfield, Leighton (all partners of the Metropolis Congress) have hubbed their businesses out of Sydney to the rest of the world. Often driven by entrepreneurial immigrants like Dick Dusseldorf or Frank Lowy, these companies replicated the travelling gene that remote Aussies developed to become world travellers. The Lonely Planet guides are another manifestation of the global network drive of Australians. Based in Melbourne, Tony and Maureen Wheeler now produce travel guides for backpackers to most countries in the world.

CENTRES OF COMMERCE

WWW.MASTERCARDWORLDWIDE.COM

1 LONDON
2 NEW YORK
3 TOKYO
4 SINGAPORE
6 HONG KONG
7 PARIS
12 SYDNEY
24 SHANGHAI
41 MELBOURNE
48 MUMBAI

This book challenges the comfort level of many cities.

It is not sufficient to be a nice place, it is not even sufficient to have good local employment from local industries. The cities that are going to lead the world need to be connected to flows of capital, they need to be visited by tourists, they need to have satellite offices of the world's biggest firms.

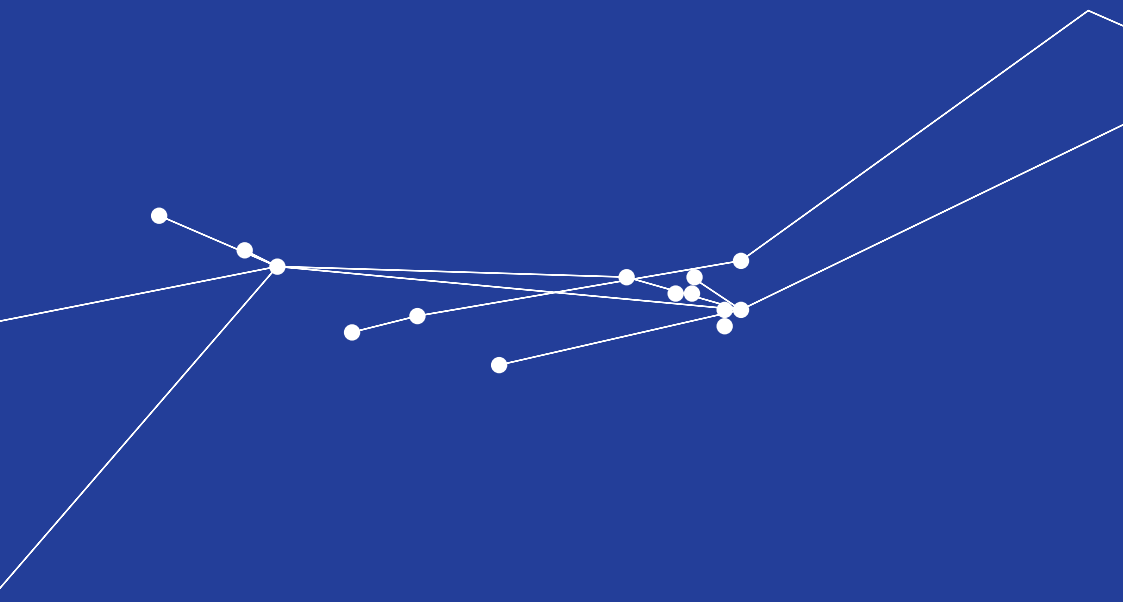
Technology is one of the drivers of connectivity. The internet and the build up of data and its use to test city models will cross city boundaries. The chapter on D_City by Davina Jackson visualises a virtual simulation of cities as a network sharing comparative data to drive environmental, social and economic outcomes. Through technology people connections can occur in a virtual, fuel saving world that transfers knowledge instantly.

Connectivity through air travels is outlined by Ben Derudder and Frank Witlox with some amazing statistics about the most important intercity connections: The Hong Kong–Taipei route tops the list followed by New York–Los Angeles and New York–London. But sitting fourth in the inter–city connectivity index is the Sydney–Melbourne route, demonstrating the importance of the relationship between these two relatively small cities by world standards.

Jonathan Rutherford examines the virtual connections between cities and the instant access to information. In the area of education the global trends continue. Michael Hoyler and Heike Jöns measure which countries have the most international students and Australia at 17.3% comes out top of the list with the USA down at 3.4%.

As we extrapolate the city of flows into local manifestations we are likely to see quite different cities emerge. Will the local be subsumed be global quarters as Shanghai developed in the 1920s with French, American and English quarters sitting with the traditional Chinese city? Will global networks lead to Hong Kong like cities filled with expatriates from other places? Sydney's multicultural mix of restaurants represents a global city. Maybe future measures of the degree of connectivity will use restaurant diversity as a measure, or the number of international finance firms, or the number of buildings designed by international architects like Norman Foster or Renzo Piano.

Global networks of cities inevitably lead to the establishment of a hierarchy of nodes. It is not surprising therefore to find that with the rise of the concept of city networks has come a series of measures of where your particular city may sit. Is your city the biggest? (TOKYO), or the most globally connected? (LONDON) or the best 'city brand'? (SYDNEY)



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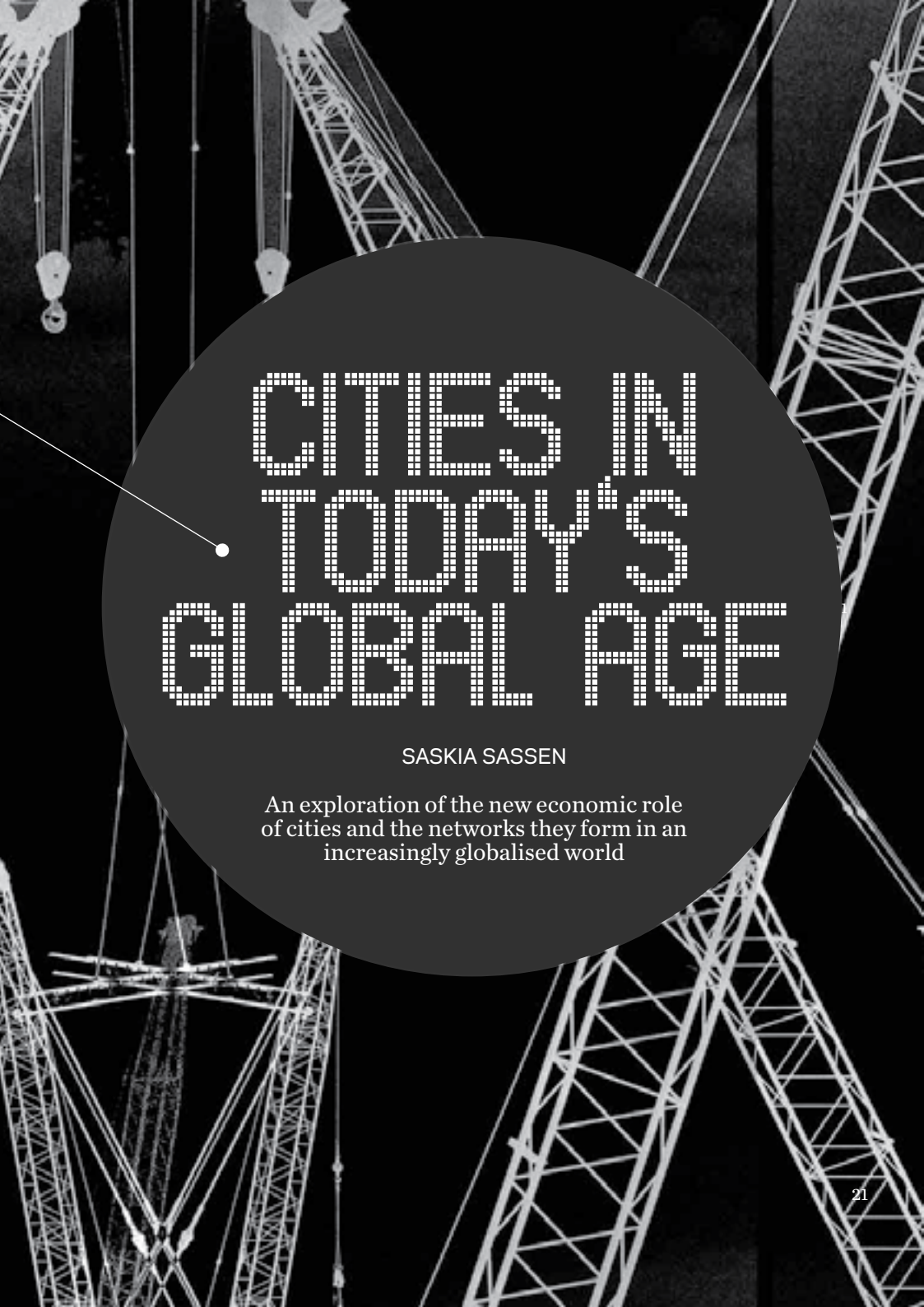


CITIES IN TODAY'S GLOBAL AGE

SASKIA SASSEN

An exploration of the new economic role of cities and the networks they form in an increasingly globalised world

SINCE THE EARLY 1980S THERE HAVE BEEN DRAMATIC CHANGES IN THE STRUCTURE OF THE BUSINESS AND FINANCIAL SECTORS, AND A SHARP ASCENDANCE OF A CULTURAL SECTOR

As recently as the 1970s, many of our great cities were in physical decay and losing people, firms, key roles in the national economy, and their share of national wealth. As we move into the 21st century, a rapidly growing number of cities have re–emerged as strategic places for a wide range of activities and dynamics. Even though major cities worldwide have long been centres for business and banking, since the early 1980s there have been dramatic changes in the structure of the business and financial sectors, and a sharp ascendance of a cultural sector. Further, the number of global cities has grown sharply as globalisation expanded. Critical, and partly underlying all the other dimensions, is the new economic role of cities in an increasingly globalised world, and the associated architectural and technical revolutions.

The network of about 50 global cities in the world today provides the organisational format for cross–border flows. A key feature of this format is that it contains both the capabilities for organising enormous geographic dispersal of firms and jobs on the one hand, and the capabilities for maintaining centralised control over that dispersal. The management and servicing of much of the global economic system takes place in this growing network of global cities and regions. This role involves only certain components of urban economies, but it has contributed to a repositioning of cities both nationally and globally. The implantation of global processes and markets has had massive consequences for the restructuring of large stretches of urban space.

While this mix of activities is part of a new urban economy that is most pronounced in global cities, it is also emerging in smaller and less globalised cities. This new urban

services–centred core has mostly replaced the older, typically more manufacturing oriented core of service and production activities. Some of these cities serve regional or subnational markets. Regionally and nationally oriented firms need not negotiate the complexities of international borders and the regulations of different countries, but they are still faced with a regionally dispersed network of operations that requires centralised control and servicing, and the full range of corporate business services—insurance, legal, accounting, advertising and other such services. Thus these cities have also seen an increase in high–income professional jobs and thereby growth in sectors linked to quality of life, including the cultural sector. And, like global cities, they have also seen a growth in economic and spatial inequalities. Thus, the specific difference that globalisation makes to the growing service–intensity in the organisation of the economy is to raise the scale and the complexity of transactions and the orders of magnitude of profits and incomes.

Although many of these changes are by now familiar, it is far less clear why cities should matter more today in a globalised world than they did in the Keynesian world of the mid–1900s. In contrast, much is known about the wealth and power of today's global firms and global financial exchanges. Their ascendance in a globalising world is not surprising. And the new information and communication technologies are typically seen as the handmaiden of these firms and exchanges—both tool and infrastructure.

What then are the origins and the explanation of this urban transformation?

1. For data and additional sources on the empirical trends referred to in this article please see the following texts by the author. *Territory, Authority, Rights: From Medieval to Global Assemblages* (Princeton University Press 2008), especially chapters 5 and 7; the 3rd. fully updated edition of *Cities in a World Economy* (Sage 2006); *The Global City* (2nd. Ed. Princeton University Press 2001).

WHAT HAS MADE CITIES STRATEGIC IS THE NEW CHALLENGE OF COORDINATING, MANAGING, AND SERVICING THE INCREASINGLY COMPLEX, SPECIALISED AND VAST ECONOMIC ACTIVITIES OF MORE AND MORE GLOBAL FIRMS AND MARKETS

FROM THE KEYNESIAN CITY TO THE GLOBAL CITY

In that earlier period, cities were above all centres for corporate administration, small–scale manufacturing, and commerce. Cities were mostly the space for rather routinised endeavours. The strategic spaces where the major innovations were happening were the government (the making of social contracts, such as the welfare state) and mass–manufacturing, including mass–construction of suburbs.

The most common and straight forward answers as to why cities have become strategic in a global corporate economy are the ongoing need for face–to–face communications and the need for creative classes and inputs. Both are part of the answer. But in my reading, they are surface conditions—the consequences of a deeper structural transformation. It is the latter that contains the answer.

What has made cities strategic is the new challenge of coordinating, managing, and servicing the increasingly complex, specialised and vast economic activities of more and more global firms and markets. It is perhaps one of the great ironies of our global digital age that it has produced not only massive dispersal but also extreme concentrations of top level resources in a limited number of places. Indeed, the organisational side of today's global economy is located, and continuously reinvented, in what has become a network of about 50 major and not so major global cities. These global cities need to be distinguished from the hundreds of cities which are located on often just a few global circuits; while the latter kind of city is articulated with the global economy, it lacks the mix of resources to manage and service the global operations of firms and markets.

The more globalised a firm's operations and the more digitised its product, the more complex its central headquarter functions become and hence the more their execution benefits from dense, resource–rich urban environments. In global cities, then, the interaction of centrality and density takes on a whole new strategic meaning: physical density is the urban form housing an increasingly complex set of activities for the management, servicing, designing, implementing and coordinating of the global operations of firms and markets.

Further, the outcomes of this structural transformation get wired into urban space. In this process, urban space itself is one of the actors producing the outcome. This link partly explains why architecture, urban design and urban planning have each played such critical roles with the onset of economic globalisation. Architecture and civil engineering have been central to the building of the new expanded urban settings for the organisational side of the global economy. But it also explains the emergence of a kind of spatial politics with struggles against gentrification the emblematic case. Beginning in the 1980s, we see the partial rebuilding of cities as platforms for a rapidly growing range of globalised activities and flows, from economic to cultural and political.

When I first developed the global city model in the 1980s, my starting points were the global networks of affiliates of firms, global financial exchanges, global trade routes, and global commodity chains. The emergent scholarship on globalisation examining these global operations emphasised geographic dispersal, decentralization, deterritorialisation. This was indeed all happening. But I was interested in the *territorial moment* of all these increasingly globally dispersed operations. At that time my idea was to focus on New York and Los Angeles. They seemed to be major territorial moments. But sticking to my own methodology—starting with global operations and tracking the sites where they hit the ground—forced me to recognise that it was, at that time, New York, London and Tokyo that stood out, with Los Angeles way down on the list.

Applying this methodology today leads one to a vastly expanded global geography of sites. There is more of everything—export processing zones, off–shore banking centres, massive warehouses that are one stop on global trade routes, and many more global cities. It is clear that as globalisation has expanded since the 1980s it has multiplied the sheer number of its territorial moments. The massive move of more and more economic activities to electronic spaces could not override the need for a growing number of territorial spaces all over the world. The most highly developed is the network of global

cities, some major and some minor. This network is a platform for the global operations of firms and markets and increasingly also for civil society organisations and cultural activities.

In my research, I use a series of analytic steps to capture this *territorial moment of the global economy*. This allows the researcher to capture in great detail how a particular city is articulated with the global economy.

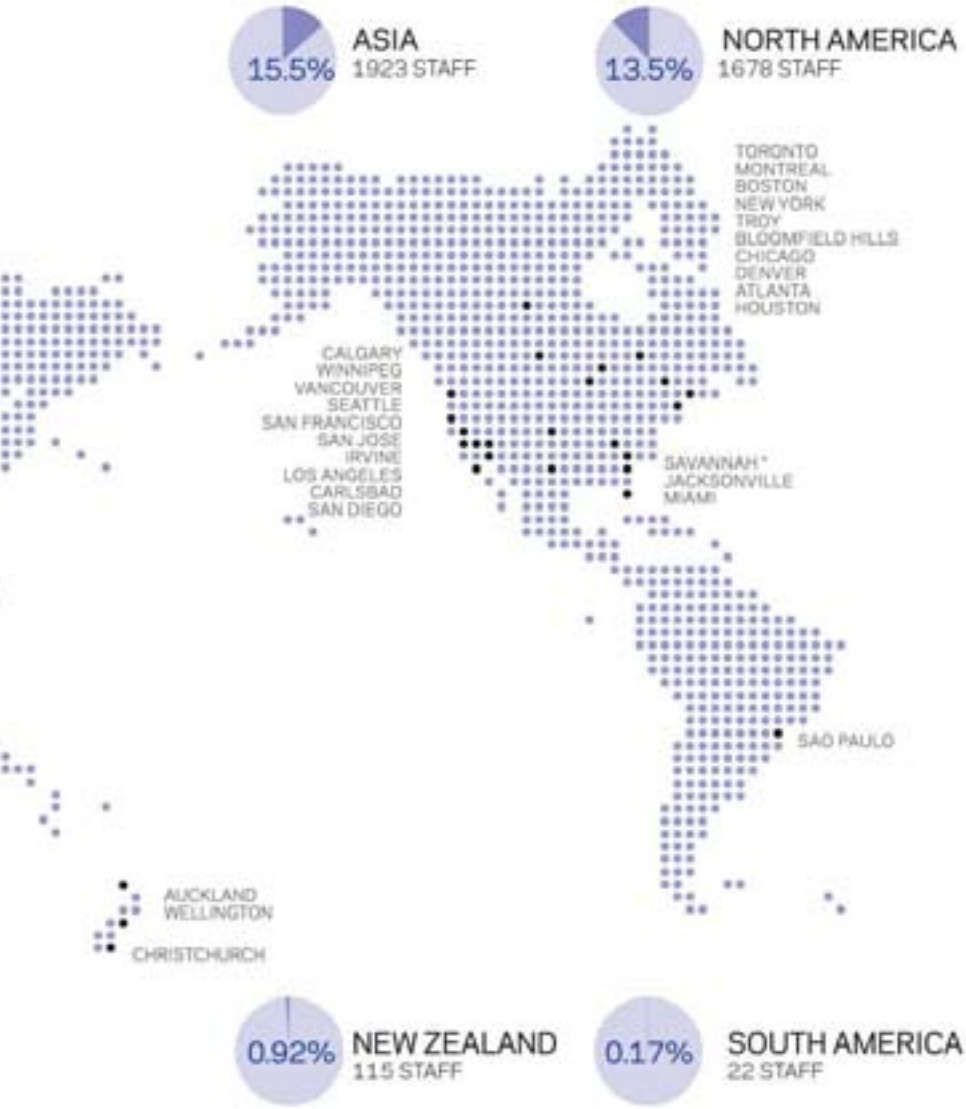
These analytic steps also carry the researcher deep inside the city. They do so not through some general descriptive approach, but in very specific and partial ways. Figuratively speaking, the researcher rides the variety of global circuits as they hit the ground in a city and get wired into urban space.

Today, there is a new type of informal economy that is part of advanced capitalism but is usually overlooked in standard analyses of global cities that just count headquarters

Riding these circuits allows the researcher to arrive at parts of the city that look like they have nothing to do with the global economy. In the case of New York and most other major global north cities, this includes a new type of informal economy that brings flexibility, customisation, and speed to tasks that are usually part of routinised and slow sectors. No one can imagine that Manhattan's Wall Street and corporate mid–town centre, or the world–class Broadway theatre district and Metropolitan Opera are actually articulated with local informal economies. They are. If I were doing research on Sydney, I would want to see where all I would arrive riding those global circuits.

Today, there is a new type of informal economy that is part of advanced capitalism but is usually overlooked in standard analyses of global cities that just count headquarters. Being part of advanced capitalism also explains the particularly strong growth and dynamism of informal economies in global cities. The growth of this new informal economy is also happening in cities of the global south, but there it is often submerged under the older informal economy. And it contributes to explain the proliferation of an informal economy of creative professional work in these cities—artists, architects, designers, software developers. The new types of informalisation of work are the low cost equivalent of formal deregulation in finance, telecommunications and most other economic sectors in the name of flexibility and innovation. The difference is that while formal deregulation was costly, and tax revenue as well as private capital went into paying for it, informalisation is low–cost and largely on the backs of the workers and their households.

CITIES ARE CONNECTED BY ADVANCED SERVICE PROVIDERS WITH THEIR PRESENCE OF BRANCH OFFICES AND STAFF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1678 STAFF
TORONTO
MONTREAL
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CALGARY
WINNIPEG
VANCOUVER
SEATTLE
SAN FRANCISCO
SAN JOSE
IRVINE
LOS ANGELES
CARLSBAD
SAN DIEGO
SAVANNAH *
JACKSONVILLE
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SAO PAULO
AUCKLAND
WELLINGTON
CHRISTCHURCH
0.92%
NEW ZEALAND
115 STAFF
0.17%
SOUTH AMERICA
22 STAFF


ONE WAY
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WALL ST
STOP

THE MULTIPLE CIRCUITS OF THE GLOBAL ECONOMY: BEYOND COMPETITION

There is no such entity as 'the' global economy. Rather, there is a vast multiplication of global circuits that criss–cross the world, some specialised and some not. While many of these global circuits have long existed, what began to change in the 1980s are their proliferation and their increasingly complex organisational and financial framings.

Different circuits contain different groups of countries and cities. The task then becomes to establish on what global/regional circuits a city is located and what other cities are parts of each of these circuits. This makes the global economy concrete and enables us to do more detailed research on global cities than the usual counting of headquarters.

If I were to track the global circuits of gold as a financial instrument, it is London, New York, Chicago, and Zurich that dominate. But if I track the direct trading in the metal, Johannesburg, Mumbai, Dubai, and Sydney all appear on the map. Coffee is mostly produced in Brazil, Kenya, Indonesia, but the main trading place for futures on coffee is Wall Street, even though New York does not grow a single bean. The specialised circuits in gold, coffee, oil, and other commodities, each involves particular places, which will vary depending on whether it is a production circuit, a trading circuit, or a financial circuit. And then there are the types of circuits a firm such as Walmart needs to outsource the production of vast amounts of products, including manufacturing, trading, and financial/insurance servicing circuits.

There is no such entity as 'the' global economy, rather, there is a vast multiplication of global circuits that criss–cross the world, some specialised and some not

This proliferation of specialised circuits, each containing particular groups of cities, also brings out the important fact that it is not just a question of competition among cities, but in good part a division of specialised functions with global scope. New York and London are the biggest financial centres in the world. But they do not dominate all markets. Thus Chicago is the leading financial centre for the trading of futures, and Frankfurt is the leading trader for, of all things, British treasuries. These cities are all financial leaders in the global economy, but they lead in different sectors and they are different types of financial centres. Each of these financial centres is particularly specialised and strong in specific segments of global finance, even as they also engage in routinised types of transactions

which need to be executed by all financial centres. Increasingly these urban economies are part of a networked global platform.

The critical nodes in these intercity geographies are not simply the cities, but more specifically, the particular, often highly specialised capabilities of each city. Yes, there is competition among cities, but there is less of it than is usually assumed because it is precisely this specialised difference that is critical for a city as it gives it a particular advantage in the global economy. This also points to the possibility of an urban global politics among cities on similar circuits which confront similar corporate giants.

Not only global economic forces feed this proliferation of circuits. Global migration, cultural work, civil society struggles around global issues (human rights, the environment, social justice); these and others also feed the formation and development of global circuits. Thus NGOs fighting for the protection of the rainforest function in circuits that include Brazil and Indonesia, the main global media centres (New York, London), and the places where the major forestry companies and the main buyers of wood are headquartered (including cities as diverse as Oslo, London, and Tokyo). Detailed research from the perspective of a given city makes legible the diversity and specificity of each city's location on some or many of these circuits, and makes legible what other cities are on each specific circuit.

These emergent inter–city geographies begin to function as an infrastructure for multiple forms of globalisation. The other side of these trends is an increasing urbanising of global networks.

URBAN/REGIONAL SPECIFICITY FEEDS THE KNOWLEDGE ECONOMY

There is an interesting discovery that comes out of recognising the value of the specialised differences of cities in today's global economy. It is that the deep economic history of a place matters for the type of knowledge economy a city or a city–region winds up developing. This goes against the common view that globalisation homogenises economies. How much this deep economic history matters varies, partly depending on the particulars of a city's or a region's economy. But it matters more than is commonly assumed, and it matters in ways that are not generally recognised. Globalisation homogenises standards and management models. But it needs diverse specialised economic capabilities.

Establishing how a city–region becomes a knowledge economy requires highly detailed research. I will use a case I researched, Chicago, to illustrate some of the issues.

Chicago is usually seen as a latecomer to the knowledge economy—almost fifteen years later than New York and London. Typically the answer is that Chicago had to overcome its heavy agro–industrial past: its economic history is usually seen as a disadvantage compared to old trading and financial centres such as New York and London. But I found that its past has not been a disadvantage. It is one key source of its competitive advantage in the global knowledge economy. This is most visible in the fact of its preeminence as a futures market built on pork bellies. The complexity, scale and international character of Chicago's historical agro–industrial economy required highly specialised financial, accounting, legal expertise. But these were/are quite different from the expertise required to handle the sectors New York specialised in—service exports, finance, and trade.

It was Chicago's past as a massive agro–industrial complex that gave it some of its core and distinctive knowledge economy components and has made it the leading global futures financial centre and global provider of specialised services (accounting, legal, insurance, etc) for handling heavy industry, heavy transport, and agribusiness. Chicago, São Paulo, Shanghai, Tokyo, and Seoul are among the leading producers of these types of specialised corporate services, not in spite of their economic past as major heavy industry centres, but because of it.

THE ONGOING WEIGHT OF CENTRALITY AND DENSITY: THE OTHER SIDE OF GLOBAL DISPERSAL

Cities have historically provided national economies, polities and societies with something we can think of as centrality. The usual urban form for centrality has been density, specifically the dense downtown. The economic functions delivered through urban density in cities have varied across time. But it is always a variety of agglomeration economies, no matter how much their content might vary depending on the sector involved. While the financial sector is quite different from the cultural sector, both benefit from agglomeration; however, the content of these benefits can vary sharply. One of the advantages of central urban density is that it has historically helped solve the risk of insufficient variety. It brings with it diverse labour markets, diverse networks of firms and colleagues, massive concentrations of diverse types of information on the latest developments, diverse marketplaces.

The new information and communication technologies (ICTs) were expected to neutralise the advantages of centrality and density. No matter where a firm or professional is, there should be access to many of the needed resources. But the new ICTs have not quite eliminated centrality and density, and hence the role of cities as economic and physical entities. Even as economic activity has dispersed, the centres of a growing number of cities have expanded physically, at times simply spreading and at times in a multi–nodal fashion. The outcome is a new type of space of centrality in these cities: it has physically expanded over the last two decades, a fact we can actually measure, and it can assume more varied formats including physical and electronic formats. The geographic terrain for these new centralities is not always simply that of the downtown; it can be metropolitan and regional. In this process, the geographic space in a city or metro area that becomes centralised often grows denser than it was in the 1960s and 1970s. This holds for cities as different as Zurich and Sydney, São Paulo and London, Shanghai and Buenos Aires.

The global trend of expanded newly built and rebuilt centralised space suggests an ironic turn of events for the impact of ITCs on urban centrality. Clearly, the spatial dispersal of economic activities and workers at the metropolitan, national and global level that began to accelerate in the 1980s actually represents only half of what is happening. New forms of territorial centralisation of top–level management and

control operations have appeared alongside these well–documented spatial dispersals. National and global markets as well as globally integrated operations require central places where the work of globalisation gets done, as shown by the case of financial centres.

Centrality remains a key feature of today's global economy. But today there is no longer a simple straightforward relationship between centrality and such geographic entities as the downtown, or the central business district (CBD). Until quite recently, the centre was synonymous with the downtown or the CBD. Today, partly as a result of the new ICTs, the spatial correlate of the centre can assume several geographic forms, ranging from the CBD to the new global grid comprising the fifty plus global cities discussed earlier.

There are several logics that explain why cities matter to the most globalised and digitised sectors in a way they did not as recently as the 1970s. Here I briefly focus on three of these logics.

The first concerns technology and its many misunderstandings. When the new ICTs began to be widely used in the 1980s, many experts forecast the end of cities as strategic spaces for firms in advanced sectors. But it was the routinised sectors that left cities while advanced sectors kept expanding their operations in more and more cities. Today's multinationals have over one million affiliates worldwide. But they also have expanded their central headquarter functions and fed the growth of a separate specialised services sector from which they are increasingly buying what they once produced in–house. Why were those experts so wrong? They overlooked a key factor: when firms and markets use these new technologies they do so with financial or economic objectives in mind, not the objectives of the engineer who designed the technology. The logics of users may well thwart or reduce the full technical capacities of the technology. When firms and markets globalise their operations thanks to the new technologies, the intention is not to relinquish control over the worldwide operation or appropriation of the benefits of that dispersal. Insofar as central control is part of the globalising of activities, their central operations expand as they expand their operations globally. The more powerful these new technologies are in allowing centralised control over globally dispersed operations, the more these central operations expand. The result has been expanded office operations in major cities. Thus the more these technologies enable global geographic dispersal of corporate activities, the more they produce density and centrality at the other end—the cities where their headquarter functions get done.

A second logic explaining the ongoing advantages of spatial

agglomeration has to do with the complexity and specialisation level of central functions. These rise with globalisation and with the added speed that the new ICTs allow. As a result global firms and global markets increasingly need to buy the most specialised legal, accounting, consulting and other such services. These service firms get to do some of the most difficult and speculative work. To do this work they benefit from being in complex environments that function as knowledge centres because they contain multiple other specialised firms and high level professionals with worldwide experience. Cities are such environments—with the network of global cities the most significant of these environments, but a growing number of other cities developing one or another element of such environments. A third logic concerns the meaning of information in an information economy. There are two types of information. One is the datum, which may be complex yet is standard knowledge: the level at which a stock market closes, a privatisation of a public utility, the bankruptcy of a bank. But there is a far more difficult type of 'information,' akin to an interpretation/evaluation/judgment. It entails negotiating a series of data and a series of interpretations of a mix of data in the hope of producing a higher order datum. Access to the first kind of information is now global and immediate from just about any place in the highly developed world and increasingly in the rest of the world thanks to the digital revolution. But it is the second type of information that requires a complicated mixture of elements—something we might think of as—the social infrastructure for global connectivity. It is this which gives major financial and/or business centres a leading edge. When the more complex forms of information needed to execute major international deals cannot be gotten from existing data bases, no matter what one can pay, then one needs the social information loop and the associated de facto interpretations and inferences that come with bouncing off information among talented, informed people. It is the importance of this input that has given a whole new importance to credit rating agencies, for instance. Part of the rating has to do with interpreting and inferring. When this interpreting becomes 'authoritative' it becomes 'information' available to all. The process of making inferences/interpretations into 'information' takes quite a mix of talents and resources.

In brief, the density of central places provides the social connectivity which allows a firm or market to maximise the benefits of its technological connectivity. Cities can generate kinds of 'knowledge,' both formal and informal, that go beyond the sum of recognised knowledge actors (e.g. professionals and professional firms in the case of the economy). This is a type of immaterial capital I call 'urban knowledge capital.'

SYSTEMIC DEMAND FOR GLOBAL CITIES

A country's global city (or cities) contains the needed resources and talents (often foreign firms and foreign professionals) to bridge between global actors and national specifics. The results of a recent large–scale study of 75 major and minor global economic centres, the MasterCard Worldwide Centres of Commerce (2008), makes it clear that as globalisation has expanded, the number of these centres has grown. We used 100 data points organised into sub–indicators, which eventually were aggregated into seven overall indicators (Legal and Political Framework, Economic Stability, Ease of Doing Business, Financial Flow, Business Centre, Knowledge Creation and Information Flow, Liveability). This allows to identification of cities that function as global centres. We then compared how cities perform critical functions that connect markets and commerce globally. The Index was developed by a panel of eight experts from different parts of the world (including Peter Taylor and myself) under the direction of Dr. Yuwa Hedrick–Wong from MasterCard Worldwide.

The tables presented here only cover the overall WCOC (Worldwide Centres of Commerce) Index and aggregate seven indicators, focusing particularly on Sydney and what are considered its main rivals: Melbourne, Singapore, Hong Kong, Kuala Lumpur, and Shanghai. We have included the top ten cities and a variable number of cities in each table, so as to include those cities ranked closely to each of these six cities. There is a ranking that emerges from the aggregate data of all the indicators and subindicators with some expected outcomes—London and New York at the top. But once we enter other variables, the results are far more distributed. This should suffice to illustrate a few key issues. One issue is the variability of rankings for each city across diverse criteria. It is also evident with the top–ranked cities (London and New York) in the overall study: neither is in the top ten for all the sub–indicators considered in the larger study. Such a ranking system is one way of beginning to understand the fact that we are dealing with a networked platform for globalisation and this networked platform is more important than having a single 'perfect' global city, or a very small number of them.

As globalisation expanded in the 1990s, it actually created a systemic demand for a growing number of global cities—their number grew and came to include more and more regions of the world. This demand for global cities continues to grow even if many of these cities are found wanting on critical issues.

WORLDWIDE CENTRES OF COMMERCE INDEX

INDICATOR 1
Political and Legal Frameworks

		WORLDWIDE CENTRES OF COMMERCE INDEX		INDICATOR 1 Political and Legal Frameworks	
TOP 3	1	London	79.17	Stockholm	90.82
	2	New York	72.77	Singapore ◄	90.82
	3	Tokyo	66.60	Copenhagen	89.53
TOP 10	4	Singapore ◄	66.16	New York	88.28
	5	Chicago	65.24	Chicago	88.28
	6	Hong Kong ◄	63.94	Philadelphia	88.28
	7	Paris	63.87	Los Angeles	88.28
	8	Frankfurt	62.34	Boston	88.28
	9	Seoul	61.83	Atlanta	88.28
	10	Amsterdam	60.06	Miami	88.28
	11	Madrid	58.34		
	12	Sydney	58.33		
	13	Toronto	58.16		
	23	Berlin	53.22		
	24	Shanghai ◄	52.89		
	25	Atlanta	52.86		
	40	Geneva	50.13		
	41	Melbourne ◄	49.93		
	42	Bangkok	48.23		
	49	Prague	45.50		
	50	Kuala Lumpur ◄	45.28		
	51	Moscow	44.99		
	30			Osaka	83.60
	31			Sydney	82.90
	32			Melbourne ◄	82.90
	33			Hong Kong ◄	82.16
	34			Madrid	81.86
	49			Bangkok	71.29
	50			Shanghai ◄	71.09
	51			Beijing	71.09
	52			Shenzhen	71.09
	53			Chengdu	71.09
	54			Chongqing	71.09
	55			Mexico City	69.30
	56			Kuala Lumpur ◄	69.26
	57			Warsaw	67.37

◄ SYDNEY'S MAIN COMPETITORS

INDICATOR 2
Economic Stability

1	**Vienna**	*92.42*
2	**Madrid**	*92.07*
3	**Barcelona**	*92.07*
4	Lisbon	*91.67*
5	Brussels	*91.65*
6	Paris	*91.58*
7	Milan	*91.20*
8	Rome	*91.20*
9	Copenhagen	*90.72*
10	Zurich	*90.47*
18	Dusseldorf	*89.88*
19	Singapore ◄	*89.74*
20	London	*89.66*
40	Vancouver	*85.74*
41	Sydney	*84.97*
42	Melbourne ◄	*84.97*
43	Seoul	*84.63*
44	Bangkok	*82.78*
45	Dublin	*82.54*
46	Tel Aviv	*81.88*
47	Hong Kong	*81.85*
48	Beirut	*79.60*
49	Budapest	*79.32*
50	Kuala Lumpur ◄	*78.90*
51	Santiago	*78.36*
52	Mumbai ◄	*77.66*
53	New Delhi	*77.66*
54	Bangalore	*77.66*
55	Mexico City	*77.05*
56	Manila	*76.99*
57	Shanghai ◄	*76.40*
58	Beijing	*76.40*

INDICATOR 3
Ease of Doing Business

1	**Singapore ◄**	*82.82*
2	**Hong Kong ◄**	*80.37*
3	**London**	*79.42*
4	Toronto	*76.24*
5	New York	*75.91*
6	Dublin	*75.71*
7	Edinburgh	*75.29*
8	Vancouver	*74.89*
9	Montreal	*74.60*
10	Chicago	*73.81*
11	San Francisco	*73.68*
12	Sydney	*72.39*
13	Los Angeles	*72.34*
14	Boston	*71.89*
15	Washington	*71.78*
16	Copenhagen	*71.72*
17	Atlanta	*71.69*
18	Miami	*71.51*
19	Melbourne ◄	*71.34*
20	Dallas	*71.32*
32	Paris	*66.17*
33	Kuala Lumpur ◄	*65.95*
34	Dusseldorf	*64.70*
52	Mexico City	*57.76*
53	Shanghai ◄	*57.16*
54	São Paulo	*56.89*

Source: MasterCard Worldwide Centres of Commerce Index 2008

INDICATOR 4
Financial Flow

1	**London**	*84.70*
2	**New York**	*67.85*
3	**Frankfurt**	*52.88*
4	Seoul	*52.76*
5	Chicago	*52.51*
6	Tokyo	*48.95*
7	Mumbai	*47.32*
8	Moscow	*47.27*
9	Shanghai ◄	*46.54*
10	Madrid	*44.60*
11	Singapore ◄	*42.15*
12	Paris	*41.85*
13	Hong Kong ◄	*39.61*
14	Sydney	*39.47*
15	Milan	*38.45*
27	Dubai	*24.74*
28	Kuala Lumpur ◄	*24.54*
29	Mexico City	*24.18*
65	Manila	*7.76*
66	Melbourne ◄	*7.70*
67	Miami	*7.54*

INDICATOR 5
Business Centre

1	**Hong Kong**	*72.25*
2	**London**	*67.44*
3	**Singapore ◄**	*62.58*
4	Shanghai	*60.30*
5	Dubai	*59.34*
6	Tokyo	*58.15*
7	Paris	*57.73*
8	New York	*54.60*
9	Amsterdam	*48.00*
10	Seoul	*47.33*
23	Dallas	*30.82*
24	Sydney	*30.55*
25	Shenzen	*29.55*
32	Brussels	*25.69*
33	Kuala Lumpur ◄	*25.66*
34	Philadelphia	*25.60*
44	Copenhagen	*22.59*
45	Melbourne ◄	*22.35*
46	Hamburg	*22.34*

Source: MasterCard Worldwide Centres of Commerce Index 2008

INDICATOR 6
Knowledge Creation & Information Flows

1	**London**	*71.89*
2	**New York**	*71.75*
3	**Tokyo**	*66.16*
4	Paris	*51.65*
5	Seoul	*51.31*
6	Zurich	*47.84*
7	Chicago	*46.31*
8	Geneva	*45.28*
9	Stockholm	*44.15*
10	Los Angeles	*43.08*
11	Osaka	*40.87*
12	Boston	*40.58*
13	Copenhagen	*39.57*
14	Singapore ◄	*39.45*
15	Berlin	*39.41*
16	Amsterdam	*39.11*
17	Atlanta	*38.21*
18	Philadelphia	*37.80*
19	Washington D.C.	*37.46*
20	Taipei	*37.00*
21	Hong Kong ◄	*36.62*
22	Toronto	*36.56*
28	Madrid	*34.10*
29	Sydney	*34.10*
30	Dallas	*33.70*
31	Melbourne ◄	*33.35*
32	Tel Aviv	*33.30*
52	New Delhi	*17.99*
53	Shanghai ◄	*17.55*
54	Bogota	*17.22*
66	Chongqing	*9.62*
67	Kuala Lumpur ◄	*8.61*
68	Beirut	*8.27*

INDICATOR 7
Liveability

1	**Vancouver**	*94.38*
2	**Dusseldorf**	*93.88*
3	**San Francisco**	*93.44*
4	Frankfurt	*93.38*
5	Vienna	*93.38*
6	Munich	*93.13*
7	Zurich	*92.81*
8	Tokyo	*92.69*
9	Paris	*92.63*
10	Copenhagen	*92.63*
11	Sydney	*92.56*
12	Berlin	*92.56*
13	Toronto	*92.38*
14	Boston	*92.19*
15	Geneva	*92.06*
16	Stockholm	*92.00*
17	Los Angeles	*92.00*
18	Amsterdam	*91.63*
19	Montreal	*91.63*
20	Melbourne ◄	*91.63*
39	Lisbon	*86.06*
40	Singapore ◄	*84.94*
41	Hong Kong ◄	*82.25*
42	Prague	*82.25*
51	Santiago	*75.19*
52	Kuala Lumpur ◄	*74.19*
53	Dubai	*71.75*
59	Bangkok	*67.75*
60	Shanghai ◄	*64.31*
61	Cairo	*63.31*

CONCLUSION:

EVEN FACTORIES AND MINES FEED THE DEMAND FOR MORE GLOBAL CITIES

At the heart of this expanding network of (imperfect) global cities lie two major structural trends.

One of these is that even the most material economic sectors (mines, factories, transport systems, hospitals) today are buying more insurance, accounting, legal, financial, consulting, software programming, and other such services for firms. And these so–called intermediate services tend to be produced in cities, no matter the non–urban location of the mine or the steel plant that is being serviced. Thus even an economy centred in manufacturing or mining will feed the urban corporate services economy. Firms operating in more routinised and sub–national markets increasingly buy these service inputs from more local cities, which explains why we see the growth of a professional class and the associated built environments also in cities that are not global. The difference for global cities is that they are able to handle the more complex needs of firms and exchanges operating globally.

A second critical trend is that, ultimately, being a global firm or market means entering the specificities and particularities of *national* economies. This explains why such global actors need more and more global cities as they expand their operations across the world. Handling these national specificities and particularities is a far more complex process than simply imposing global standards.

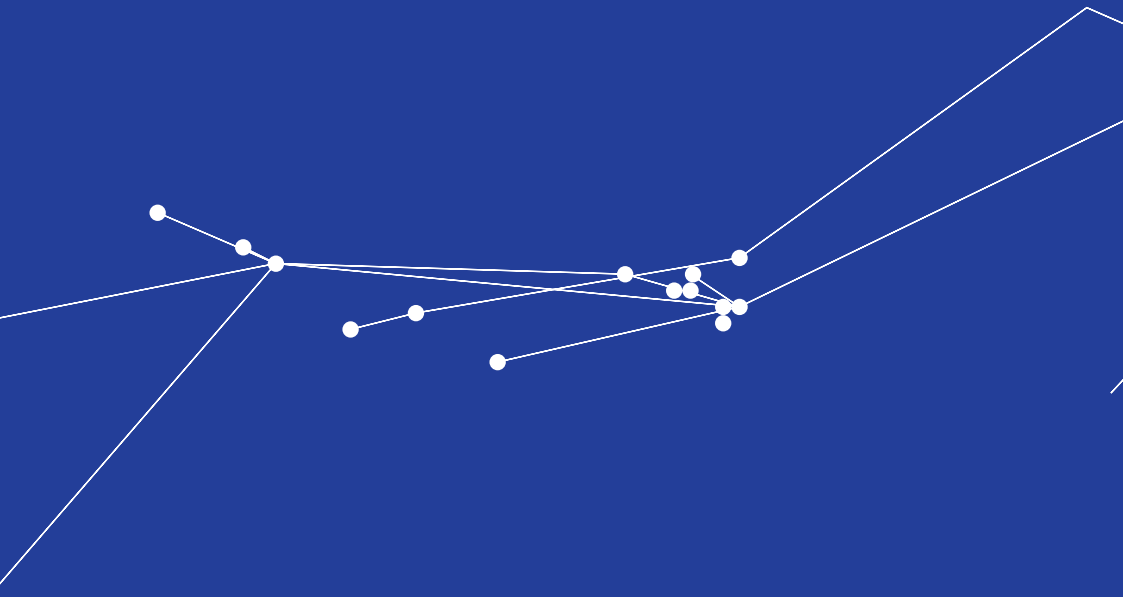
This process is easier to understand if we consider consumer sectors rather than the organisational/managerial ones addressed in this piece. Thus even such a routinised operation as McDonald's adjusts its products to the national cultures in which it operates, whether that is France, Japan or South Africa. When it comes to the managerial and organisational

THE NETWORK OF GLOBAL CITIES HAS EXPANDED AS MORE AND MORE FIRMS GO GLOBAL AND ENTER A GROWING RANGE OF FOREIGN NATIONAL ECONOMIES

aspects, matters become complicated. The global city contains the needed resources and talents to bridge between global actors and national specifics. Even a highly imperfect global city is better for a global firm or exchange than no such city. And this then explains why the many and very diverse global cities around the world do not just compete with each other but also collectively form a globally networked platform for the operations of firms and markets.

The network of global cities has expanded as more and more firms go global and enter a growing range of foreign national economies. The management and servicing of much of the global economic system takes place in this growing network of global cities and city–regions. And while this role involves only certain components of urban economies, it has contributed to a repositioning of cities both nationally and globally.

The rebuilding of central areas that we see in all of these cities, whether downtown and/or at the edges, is part of this new economic role. It amounts to rebuilding key parts of these cities as platforms for a rapidly growing range of globalised activities and flows, from economic to cultural and political. This also explains why architecture, urban design and urban planning have all become more important and visible in the last two decades. It explains the emergence of strong competition for space and the development of a new type of politics: the right to the city.



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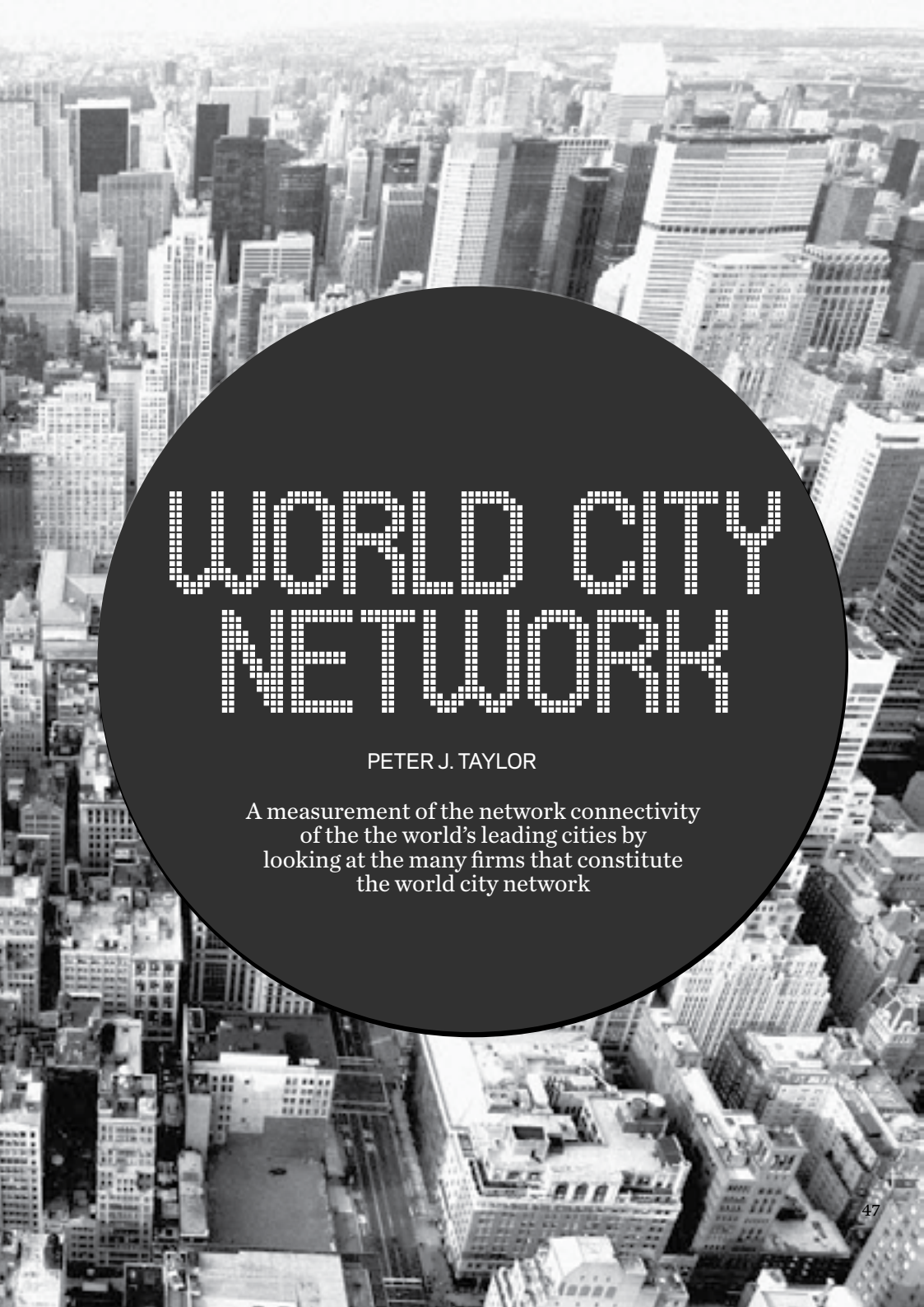


WORLD CITY NETWORK

PETER J. TAYLOR

A measurement of the network connectivity of the the world's leading cities by looking at the many firms that constitute the world city network

IT IS THIS CONCENTRATION OF MANAGEMENT ALONGSIDE FINANCIAL, PROFESSIONAL AND CREATIVE SERVICES THAT DEFINE WORLD CITIES TODAY

Traditionally, the importance of cities has been judged in terms of their population sizes. However, this is no longer the case in the twenty first century. Today, the most important cities are not necessarily the largest cities. Thus, it is vital not to confuse *world city* with *mega–city*. In the second half of the twentieth century the historical link between a city's economic development and its population size was broken through the demographic explosion of 'third world' cities. The result has been many poor cities with very large populations that are called mega–cities. These are defined simply by population size: the current UN threshold is 8 million. Relatively few major cities in the richer part of the world reach this threshold but, under conditions of contemporary globalisation, it is these cities that have prospered economically. They have come to be called global or world cities and are defined by their economic vibrancy. This separation of the demographic from the economic indicates two quite different urban processes; in this chapter *the focus is solely on world cities*. These are defined by their economic functions.

There is a specific technological development that made the rise of world cities possible. In the 1970s two separate industries, computers and communications, merged their technologies to enable work to be coordinated worldwide based upon simultaneous connections. This had

two economic geography effects: first, a dispersal of production to cheaper labour locales, and second, a contrary trend towards concentration of management and business service industries. The latter were required to organise the new worldwide production and were concentrated in cities. It is this concentration of management alongside financial, professional and creative services that define world cities today. Of course, service firms have always clustered in cities to provide such services to their clients but under conditions of *contemporary globalisation* those specialised services became worldwide with fundamental implications for work practices.

The new practice was service *network formation*. As their clients went 'global', the service firms had to follow them or lose them. Thus from the 1980s onwards there has been a strong movement towards multi–locational service provision. That is to say, service firms set up new offices where their clients did business. This proved to be just a transitional stage; soon the service firms widened their practices to become trans–national corporations in their own right. Now they competed for new clients by offering a seamless global service through networks of offices in major cities across the world. Their new work facilitated global commodity production through easing the difficulties of operating across myriad national boundaries. For instance, new 'global law practices' emerged to provide inter–jurisdictional legal services: thus, an Australian firm going into partnership with a Brazilian firm funded through a German bank will need contractual work incorporating Australian, Brazilian and German law brought together in a single legal framework. That framework will be either English common law if the contract work is led by the law firm's London office, or New York State law if the New York City office leads but in both cases legal inputs will be needed from offices in Sydney, Sao Paulo and Frankfurt. Similar practices obtain for other services including advertising, accountancy, various financial services including insurance, and a multitude of management consultancy services. Multiple offices are required in all cases to provide the seamless service and to protect global brand integrity by keeping all work in–house.

This is how it came to be that by the turn of the new century there were hundreds of large service firms with trans–national office networks, many of them global in scope. Each firm had its own locational strategy—which cities to have offices in, what size and functions those offices will be, and how the offices will be organised (e.g. regional offices such as using Miami as the 'economic capital' of Latin America). Since these are independent firms with different origins and histories every location strategy is distinctive. But the result is anything but random: there is a basic common pattern to the office networks that is the *world city network*. In this chapter the office networks of numerous business service firms are analysed to reveal this world city network.

AN INTERLOCKING NETWORK

Networks are relatively easy to understand. They usually consist of two layers, the net level and the node level. For instance, in a social network analysis of a gang, members are nodes, the gang is the net level and relations between the nodes (members) define the nature of the network. Formal city associations work in this way with the cities (members) as nodes, the city association represents the net level, and the formal relations between members within the association define the network. Such networks can be an important component of global governance but this is not how cities operate as key components of the global economy. As we have argued above, it is the service firms that are the network makers; they create the world city network through their every day practices linking offices across the world. This defines a different type of network, an *interlocking network*.

An interlocking network is unusual in having three layers. In the case of the world city network there is the net level of the global economy, the node level of cities, and an additional *sub–nodal level* of service firms. The latter are not just an additional level, they define the critical level: this is where the agents of network formation are found. In the global economy, it is firms who are the network makers not the cities themselves. Thus for studying the world city network it is service firms that are investigated in order to understand the city network as the outcome. In other words, it is through studying the locational strategies of firms that it is possible to describe and analyse the world city network: firms are the object of the research, cities are the subject of the research.

IN THE GLOBAL ECONOMY, IT IS FIRMS WHO ARE THE NETWORK MAKERS NOT THE CITIES

Think visually. What is the basic image of a world city? It is the clusters of high–rise office blocks and towers that come to mind immediately. And it is here, not in the various 'city halls', that the central economic powerhouse of world cities is to be found. It is the work done in these offices that 'interlock' various cities in projects that require multiple office inputs. Thus the inter–city relations that define the network are numerous electronic communications—information, instruction, advice, planning, interpretation, strategy, knowledge, etc., some tele–conferencing as required, and probably travel for face–to–face meetings at a minimum for the beginning and end of a given project. These are the *working flows* that combined across numerous projects in many firms constitute the world city network.

So we have to study firms to describe and analyse the world city network. Unfortunately, there is no feasible way that data could be collected from firms on these working flows. As well as the obvious confidentiality issues with competing private firms, there is also a feasibility issue: the degree of cooperation that would be needed from a large number of firms makes such a data collection exercise beyond reasonable social science research logistics. However, this is not a particularly rare situation in measurement practices: where direct measures cannot be obtained, there is the fall back position of carrying out *indirect measurement*. This requires access to more easily available data plus credible assumptions about how the firms operate.

As mentioned previously, service firms offer a seamless service across their office networks. This means that the geographical distribution of their offices, and their scope and range, are important selling points in attracting new clients. Hence such information is commonly available on *service firms' web sites*. This has been the main source of data for measuring the world city network: for each firm, offices are assessed individually by asking what is the importance of this office in this city within the firm's overall office network? Answers to this question are coded and become the quantitative input into the study. (The coding was from 0 (a firm having no office in a city) to 5 (a city housing the headquarters of a firm; standard or typical offices of a firm score 2, minor and major offices 1 and 3, respectively leaving 4 for scoring cities housing exceptionally important offices such as regional headquarters.) The credible assumption that is made is that the more important an office the more working flows it will generate. Therefore two important offices will generate a much higher level of flow between their respective cities than two minor offices between their respective cities. These data and this assumption are

combined to generate estimates of inter–office working flow levels between cities for each firm; they are not actual working flows, but *potential working flows*, indirect measures derived from the data and the model assumptions. By aggregating all potential working flows for all firms located in a city this generates its working flow relations with other cities; when this is done for all cities it constitutes the world city network. This exercise was carried out in 2000 utilising 100 office networks of *global service firms* in accountancy, advertising, banking/finance, insurance, law, and management consultancy. The 'global' focus was ensured by every firm having offices in 15 different cities or more including at least one office in each of the three main globalisation arenas—northern America (USA plus Canada), western Europe, and Asia Pacific. Offices were traced across 315 cities worldwide. This exercise was repeated in 2004. Firms showing exceptionally important offices in Sydney are shown in FIGURE 1. Because of corporate reorganisations, direct comparisons could only be made with 80 of the original firms but this was sufficient to monitor changes from 2000 to 2004. All the results reported below are from these data.

Geographical distribution of their offices, and their scope and range, are important selling points in attracting new clients

FIGURE 1
FIRMS IN THE CONNECTIVITY ANALYSES THAT HAVE VERY IMPORTANT OFFICES IN SYDNEY

These are firms whose Sydney office scored 4 on a scale from 0 (no office) to 5 (headquarters) indicating that the city is very important in their worldwide office network

BUSINESS SERVICE SECTOR	BUSINESS SERVICE FIRM	2000	2004
ADVERTISING	TMP	●	●
	J Walter Thompson	●	–
	Ogilvy & Mather Worldwide Inc.	–	●
BANKING/ FINANCE	Westdeutsche Landesbank Gironentrale	●	●
	Chase Hambrecht & Quist (ceased trading)	●	–
	ING	●	●
LAW	Baker and McKenzie	●	●
	Coudert Brothers (ceased trading)	●	●

NEW YORK/LONDON: NYLON

...there is a large gap between *London and New York* and the rest indicating the critical importance of these two cities in the world city network...

NETWORK CONNECTIVITY

The basic measurement on cities from an interlocking network analysis is network connectivity. This is simply the sum of all a city's links with other cities across all 100 firms in 2000 and 80 firms in 2004. Thus because London and New York have many important offices (e.g. headquarters, main global office, regional office, etc.) their potential working flows are nearly always very large and therefore their aggregated inter–city links are large: *ipso facto* they both will have very high network connectivity scores. The initial interpretation of such measures is that they show the *degree of integration* of a city into the world city network.

FIGURE 2
NETWORK CONNECTIVITIES
Top 20 cities in 2000

Connectivities are derived from aggregating the office networks of 100 global service firms and presented as percentages of the highest scoring city (London)

As can be seen above in FIGURE 2, London and New York are indeed easily the two most integrated cities; network scores are given as percentages of the highest city network connectivity score (London's) to facilitate easy comparison. The figure shows the top 20 cities (out of 315) in terms of network connectivity. A fairly straightforward triple pattern emerges: (i) there is a large gap between *London and New York* and the rest indicating the critical importance of these two cities in the world city network (together they are commonly referred to as 'NYLON'); (ii) there are four other cities that stand out as very important (Hong Kong, Paris, Tokyo and Singapore); (iii) the remaining cities are a mixture of leading cities in important national economies plus three other leading US cities. The surprising features in these original results are that Tokyo is not closer to London and New York (these three are usually identified as the three 'global cities'), that Hong Kong is ranked third (showing the importance of being the service gateway to the fastest growing national economy), and the paucity of US cities.

In FIGURE 3, the 2000 network connectivities are broken down into the six service sectors. London and New York are ranked one and two for all services but notice that New York overtakes London in the

two archetypal US business services: advertising and management consultancy. Also note that when just banking/finance firms are studied, Tokyo does rise to obtain the highest non–NYLON score and therefore does appear as one of the 'big three' as a global financial centre. Elsewhere, London and New York's highest level of dominance is in law, and London's individual highest dominance is in insurance. Beyond NYLON, it is noteworthy that Asia Pacific cities feature particularly prominently in the banking/finance rankings, and the high positions of Brussels and Washington (law making centres) in legal networks are expected. All these highlighted results fit into what we know about the individual service markets and therefore provide credibility to the method and findings. Thus the results not expected can be taken seriously as new findings such as Paris third in accountancy, Sydney fifth in advertising, Frankfurt seventh in banking/finance, Zurich eighth in insurance, Moscow tenth in law, and Madrid fourth in management consultancy.

FIGURE 3 TOP 10 CITIES FOR NETWORK CONNECTIVITIES IN DIFFERENT SERVICES, 2000

These connectivities are produced by disaggregating the results from FIGURE 2 *into the six studied. As in* FIGURE 2, *the connectivities are presented as percentages of the highest scoring city in each sector (London four times and New York twice).*

Accountancy

1	London	100.0
2	New York	88.6
3	Paris	68.0
4	Los Angeles	65.7
5	Toronto	65.1
6	Amsterdam	64.5
7	Chicago	63.8
8	Tokyo	62.4
9	Copenhagen	58.6
10	Hong Kong	58.1

Advertising

1	New York	100.0
2	London	78.6
3	Hong Kong	59.8
4	Toronto	57.6
5	Sydney	57.4
6	Amsterdam	56.4
7	Miami	54.5
8	Singapore	53.1
9	Milan	52.8
10	Madrid	52.1

Banking & Finance

1	London	100.0
2	New York	88.6
3	Tokyo	68.0
4	Hong Kong	65.7
5	Singapore	65.1
6	Paris	64.5
7	Frankfurt	63.8
8	Madrid	62.4
9	Jakarta	58.6
10	Chicago	58.1

NEW YORK OVERTAKES LONDON IN THE TWO ARCHETYPAL US BUSINESS SERVICES: ADVERTISING AND MANAGEMENT CONSULTANCY

Insurance

1	London	100.0
2	New York	73.8
3	Hong Kong	71.3
4	Singapore	61.2
5	Los Angeles	60.1
6	Paris	59.3
7	Chicago	57.1
8	Zurich	56.7
9	Milan	55.8
10	Boston	54.8

Law

1	London	100.0
2	New York	88.6
3	Paris	68.1
4	Los Angeles	67.3
5	Toronto	66.1
6	Amsterdam	61.9
7	Chicago	55.3
8	Tokyo	52.9
9	Copenhagen	48.6
10	Hong Kong	42.4

Management Consultancy

1	New York	100.0
2	London	87.5
3	Paris	75.8
4	Madrid	72.6
5	Stockholm	71.7
6	Toronto	68.9
7	Milan	68.3
8	Singapore	67.7
9	Chicago	65.2
10	Washington	64.4

FIGURE 4
CHANGE IN RANKS, 2000–2004

STABLE TOP 6: LONDON, NEW YORK, HONG KONG, PARIS, TOKYO, SINGAPORE

UP: TORONTO, BRUSSELS, SAO PAULO, KUALA LUMPUR, BEUNOS AIRES

DOWN: CHICAGO, MILAN, SYDNEY, SAN FRANCISCO, LOS ANGELES, TAIPEI

BIG DECLINES: USA, SUB-SAHARAN AFRICA

DROP OUT: SAN FRANCISCO, TAIPEI

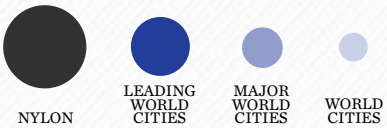
FIGURE 4 shows changes in connectivity rankings between 2000 and 2004 for the top twenty ranked cities in terms of network connectivity. The most noteworthy feature is the stability: all six top cities remain in the same order and although there is movement elsewhere, only two cities drop out of the top 20. However there is one interesting feature of the shuffling below Singapore and that is the decline of the three leading US cities after New York. In further analysis of all 315 cities, it turns out that there are just two regions with systematic change in their cities' connectivities between 2000 and 2004: both USA and Sub–Saharan Africa record significant declines. Obviously these are two very different regions with contrary reasons for relative decline. In the case of the African region this is further evidence of the continent's economic woes, with leading cities like Nairobi and Lagos not living up to the potential they appeared to have in 2000. The case of US cities is very different and relates to firm's strategies in relation to what is by far the largest domestic service sector market. Quite simply the size of their domestic market means that US service firms have less incentive to 'go global'. Further, non–US firms find it hard to penetrate such an established large market and often just have the one US office in New York. Both of these processes mean that US cities tend to be less well integrated into the world city network than we might expect and this feature is increasing as cities in other regions (outside Africa) are becoming more integrated as economic globalisation proceeds.

The latest results on network connectivity for 2004 are shown in the cartogram in FIGURE 5. This features 38 cities whose network connectivity is at least 40% of London's. The cities are divided into three categories below 'NYLON', the four other 'leading world cities' identified in FIGURE 2 and FIGURE 4, 'major world cities' with at least 50% of London's connectivity, leaving the remainder as simply 'world cities'. The geography is fairly simple given the lack of African, Middle Eastern or central Asian cities: all designated cities fall into three regions—Americas, western Pacific, and Europe. The latter is distinctive for its number of cities included (15), western Pacific for having three leading world cities, and the Americas for exhibiting a gulf between New York and all other cities. Remember that this diagram does not represent the whole world city network: there are 315 cities in the data including Johannesburg in Africa ranked 42, Dubai in the Middle East ranked 51, and Alma–Ata in central Asia ranked 135. What FIGURE 5 does show is where the network is most dense; clearly the world city network is very uneven in its global coverage.


MELBOURNE
SYDNEY
SANTIAGO
BEUNOS AIRES
SAO PAOLO
JAKARTA
SINGA PORE
KUALA LUMPAR
MUMBAI
BANGKOK
MEXICO CITY
HONG KONG
MIAMI
LOS ANGELES
TAIPEI
SAN FRANCISCO
SHANGHAI
BEIJING
CHICAGO
SEOUL
NEW YORK
TOKYO
TORONTO

TOP 38 CITIES WITH NETWORK CONNECTIVITY OF AT LEAST 40% OF LONDON

FIGURE 5
NETWORK CONNECTIVITY, 2004



CITY HINTERWORLDS

IT IS COMMONPLACE TO STUDY A CITY IN RELATION TO ITS HINTERLAND, the local area dependent on it, but in world city network analysis it is relations beyond the local that are measured. Using the data behind the connectivity measures, the specific relations of a given city with every other city in the network can be measured. For any pair of cities their inter–city relations are the sum of potential working flows between the cities of the firms located in both cities. The term *hinterworld* has been coined to describe a city's pattern of relations across the world city network.

Hinter worlds are most usefully measured as follows:

1. using a regional framework; this means aggregating a city's connections with all cities in a given region;
2. using relative measures; this means showing where a city is 'over–connected' and 'under–connected' relative to the overall pattern of world city network connections.

From such analyses the *hinterland orientations* of a city can be easily illustrated. This is shown in FIGURE 6 in which orientations towards USA, European Union, and Asia Pacific cities are shown for six selected cities in 2000. The selected cities are pairs from each of the regions featuring the most connected city in a region paired with one much more weakly connected city from the region. The idea is

FIGURE 6
SELECTED HINTERWORLD ORIENTATIONS, 2000

These selected results show the relative importance of world regions to a city's overall connectivity. A positive value indicates that, relative to other cities in the network, the given city has more connections (office links) than expected. A negative value indicates that, relative to other cities in the network, the given city has less connections (office links) than expected. Generally, the more important city, the more over–connected it is to the critical globalising regions.

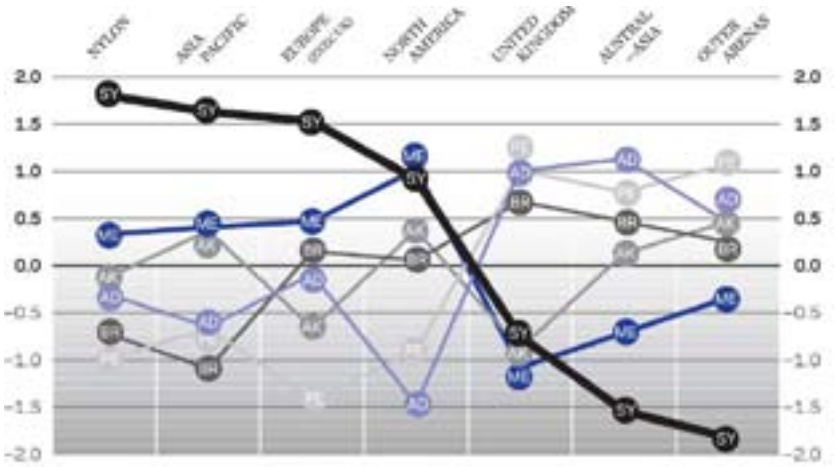
	ORIENTATION		
CITY	USA	EU	ASIA PACIFIC
NEW YORK	+0.3	–0.2	+0.2
PITTSBURGH	+2.3	–0.5	–0.4
LONDON	+ 0.3	–0.1	+0.2
COLOGNE	–0.3	+1.5	–0.4
HONG KONG	+0.1	–0.0	+0.3
GUANGZHOU	–1.3	–0.5	+1.1

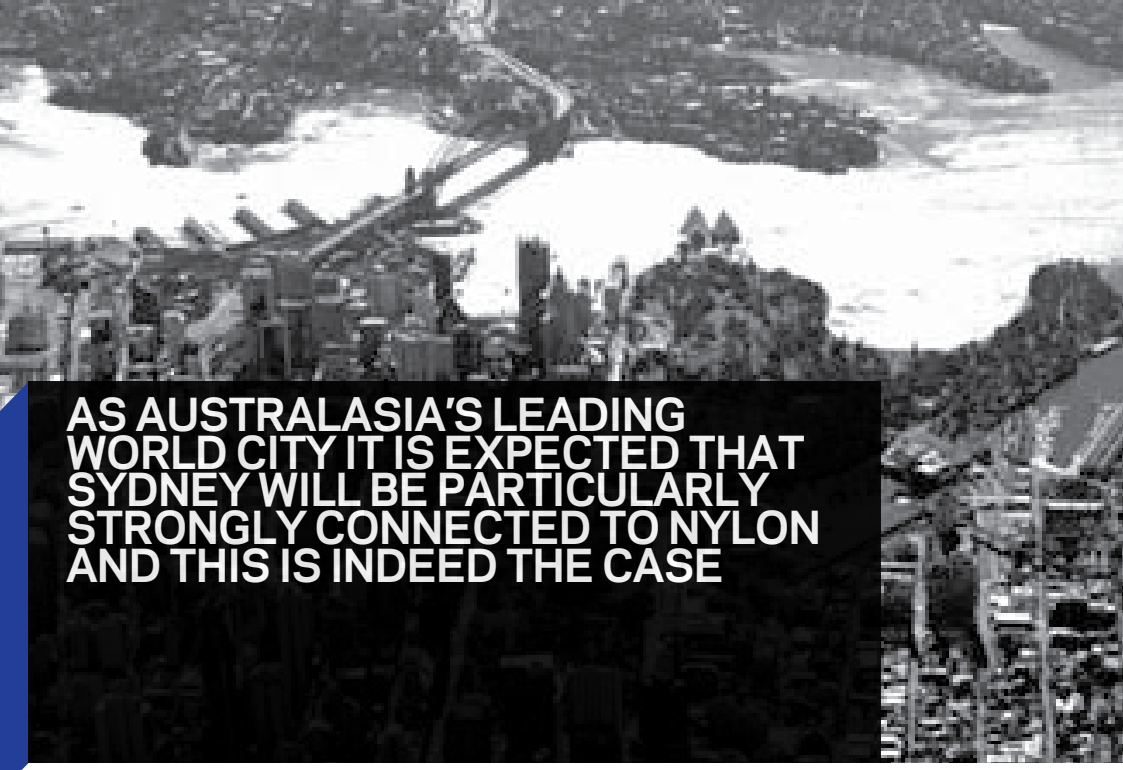
to produce contrasting hinterworlds and such a result is most clearly indicated in the three highest positive scores in the table. These are Pittsburgh's score of +2.3 for its USA orientation, Cologne's score of +1.5 for its EU orientation, and Guangzhou's score of +1.1 for its Asia Pacific orientation. This shows that these less important cities are strongly linked within their own world regions at the expense of wider connections: the scores for these three cities on regions outside their own are all negative indicating relative under–connections. In complete contrast the most connected cities are much less orientated to their home regions and are relatively well–connected to the other regions, especially New York and London to Asia Pacific.

The hinterworld orientations of the leading six Australasian cities in the world city network in 2004 are shown in FIGURE 7. For this case, orientations are shown for seven categories: (i) Australasian cities; (ii) the special city dyad of London and New York to indicate over—or under—connection to the two cities that dominate the world city network; (iii) UK cities as a special case for historical reasons; (iv) cities in the three main globalisation arenas—northern America (USA and Canada), Europe (excluding the UK), and Asia Pacific; and (iv)

FIGURE 7
HINTERWORLDS OF AUSTRALASIAN CITIES 2004
SY: Sydney, ME: Melbourne, AK: Auckland, AD: Adelaide, BR: Brisbane, PE: Perth

See FIGURE 2 *for interpreting these results. The basic finding for Sydney is that, relative to other Australasian cities, it is over–connected to the important parts of the world economy and has less well connected tradition links to the UK, and is less well connected to other cities in its own regions, and to cities in less important parts of the world.*





AS AUSTRALASIA'S LEADING WORLD CITY IT IS EXPECTED THAT SYDNEY WILL BE PARTICULARLY STRONGLY CONNECTED TO NYLON AND THIS IS INDEED THE CASE

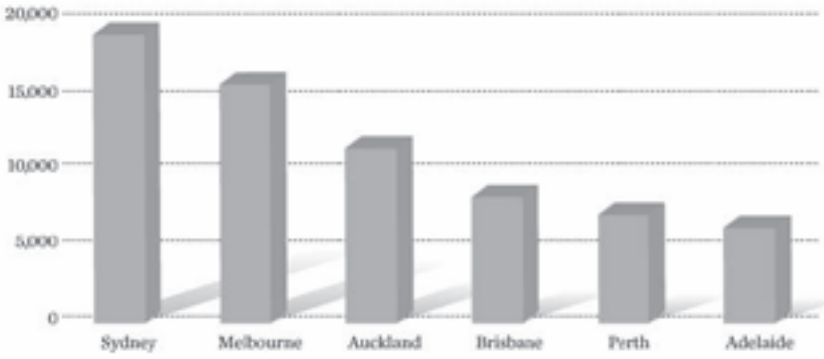


FIGURE 8
TOTAL CONNECTIVITY

cities in the rest of the world—the 'outer arenas': Latin America, South Asia, Middle East, Africa and Central Asia but not including Australasia. Australasian cities in FIGURE 7 are listed by the network connectivity ranking (FIGURE 8); orientation categories are ordered in terms of Sydney's degree of over–connection. As Australasia's leading world city it is expected that Sydney will be particularly strongly connected to NYLON and this is indeed the case. It is then most over–connected to the three globalisation arenas. Sydney is under–connected to UK cities, other Australasian cities and particularly to cities in the outer arenas. This shows similarities to interpretation of the three leading cities in FIGURE 6. Melbourne has exactly the same breakdown of positive and negative scores as Sydney but its over–connections with the key categories of cities are much weaker.

For interpreting the remaining cities in relation to Sydney and Melbourne, the orientations in FIGURE 7 are converted into hexagonal figures (each city represented by a point). In each diagram there are two hexagons: the regular hexagon (in purple) represents all cities scoring zero, that is to say being neither over or under connected; the irregular white hexagon shows the actual orientations (from FIGURE 7) with relative under–connection falling inside the purple hexagon and relative over–connection outside. In this visual presentation, it is the different shapes of the white hexagon that are of interest. Starting with NYLON connections (FIGURE 9), the strength of Sydney's over–connection is very clear, with a much lesser over–connection for Melbourne and the other four cities relatively under–connected. FIGURE 10 shows Asia Pacific orientations and is very similar to FIGURE 9 except that Auckland is now showing over–connection. FIGURE 11 for the EU follows a similar pattern but in this case it is Brisbane as the third city showing over–connection. However, with FIGURE 12 there is a change because in terms of northern American orientation, Melbourne is slightly more over–connected than Sydney, and both Auckland and Brisbane now show slight over–connection. The reason for this changing

FIGURE 9: NYLON

FIGURE 10: ASIA PACIFIC

FIGURE 11: EUROPEAN UNION

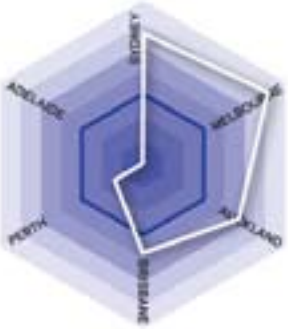


FIGURE 12: NORTH AMERICA

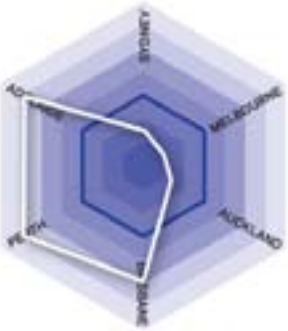


FIGURE 13: UK

FIGURE 14: AUSTRALASIA

position of Melbourne in relation to Sydney may be a result of earlier globalisation by US service firms when Melbourne was more of a world city rival to Sydney. But overall the NYLON orientation and the globalisation arenas' orientations show Sydney's hinterworld to be particularly orientation to main centres of economic globalisation. This is what is expected of Australasia's leading world city.

FIGURES 13, 14 and 15 show a very different pattern of orientations. The relations with UK cities are very stark (FIGURE 13), with Sydney, Melbourne and Auckland all relatively under–connected and Brisbane, Perth and Adelaide strongly over–connected. This may relate to UK insurance and accountancy firms that expanded into white–settler colonies in the first half of the twentieth century and have subsequently been enveloped by globalisation. These offices remain relatively important in Brisbane, Perth and Adelaide but have been rather swamped by more recent service globalisations in Sydney, Melbourne and Auckland. FIGURE 14 shows a similar pattern for regional city connections within Australasia; in this case Adelaide clearly appears as the city with relatively most over–connections to its neighbours. Finally, FIGURE 15 emphasises Sydney's high degree of relative under–connection to outer arenas; in this case it is Perth that has the most over–connection. This may be related to servicing Perth's energy market through which the city is sharing firms with outer cities in resource–rich regions. More generally the over–connections in FIGURE 15 will

ECONOMICALLY, LEADING WORLD CITIES ARE FEEDING OFF EACH OTHER WITHIN THE WORLD CITY NETWORK AND SYDNEY IS PART OF THIS

be largely derived from accountancy firms; these firms have more offices than in any sector and their resulting ubiquitous nature means that they dominate the connectivity patterns of the less connected cities in Australasia and all outer arenas.

Hinterland orientation of cities within the world city network indicates where a city's business links are distributed across the world. As such it has potential as an indicative policy guide towards what a city government should be promoting in terms of external business connections. It appears that the leading world cities are economically feeding off each other within the world city network and Sydney is clearly part of this; Melbourne, on the other hand, is more on the edge of this mutuality.

FIGURE 15: OUTER ARENAS

THUS LONDON AND NEW YORK ARE THE MOST IMPORTANT ECONOMIC LOCALES AND THEIR CITY DYAD, NYLON, IS 'MAIN STREET, GLOBAL ECONOMY'

CONCLUSION:

THE MEANINGS OF CONNECTIVITY

HAVING PRESENTED A SERIES OF FINDINGS on cities in contemporary globalisation it is important that the implications of this work are carefully spelt out. The discussion can start with the ranking of cities that has dominated much of the discussion, tables and figures. The first key point to make is that ranking of any sort in and of itself does NOT indicate a hierarchy although urban researchers are prone to make this conjecture. Hierarchy implies power relations—those above impinging on those below—whereas ranking is merely an ordered list on a given variable. The model being calibrated here is a network structure and these operate through mutuality, all cities contribute to the inter-city relations. In this situation the decline of a city lessens the vitality of the whole network affecting all other cities. In a hierarchical structure, of course, the decline of a city is an opportunity for other cities: hierarchies are there to climb and the model assumes competitive cities, eschewing mutuality. Thus whether cities are modelled as a hierarchy or network is much more than simply a matter of semantics; it specifies the very nature of inter-city relations.

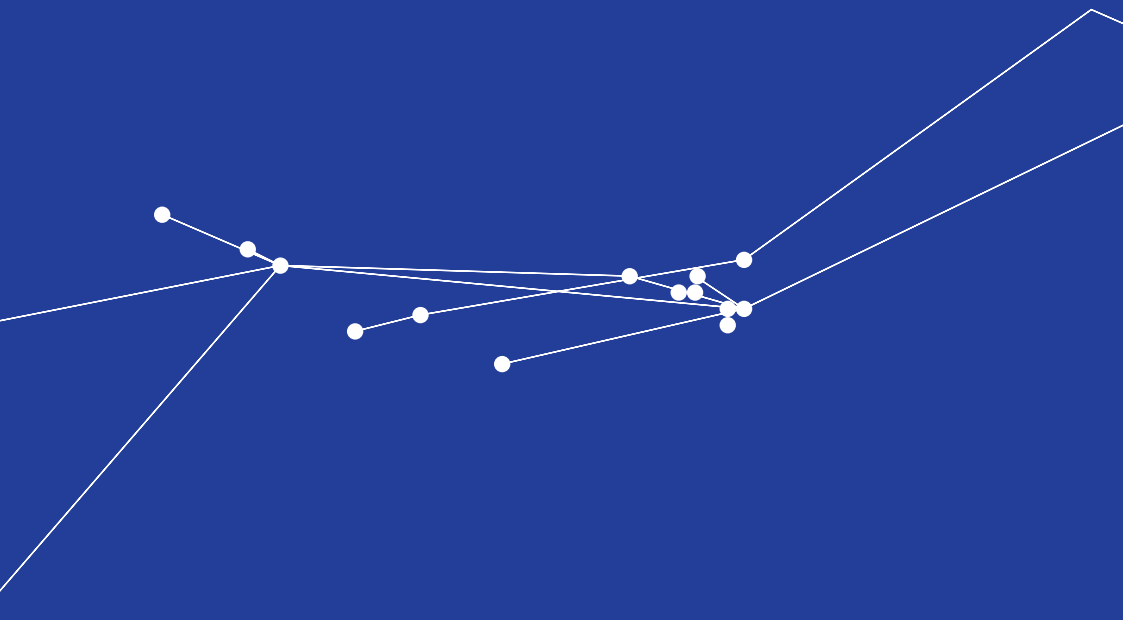
In the recent past urban researchers studying at the national scale assumed 'national hierarchies' and therefore postulated competitive cities. With world city research, especially that using the interlocking network model, the presence of hierarchy becomes an empirical question, one that cannot be answered by simple rankings. The essence of the network model assumes cities need each other; mutuality is the fundamental network property. Connectivity is

an expression of that mutuality and therefore ranking by this variable, as done above, it particularly unsuited for making city hierarchical presumptions.

Therefore ranking is used in this chapter not to imply hierarchy but to show the patterning of uneven network density. Ranking is an ideal pedagogic tool to help in understanding network density and, therefore, the manner in which the world city network provides an organisational framework for economic globalisation. In this model there are hierarchical relations but these are within firms (headquarters, regional headquarters, etc.), not directly between cities. Although consistently ranked higher in tables and figures above, there is no meaningful sense in which London as a city has power over Paris, but London law firms will have power over what goes on in their Paris offices. But this is not a simple one–way flow of power; French banks headquartered in Paris will have power over their London branches. Thus there is no simple city hierarchy; rather there is a complex of interweaving power relations through myriad firms. Certainly there is more power wielded through some cities than others—London does have more global service firm headquarters than Paris, for instance—but there is no simple 'world city hierarchy' as commonly asserted.

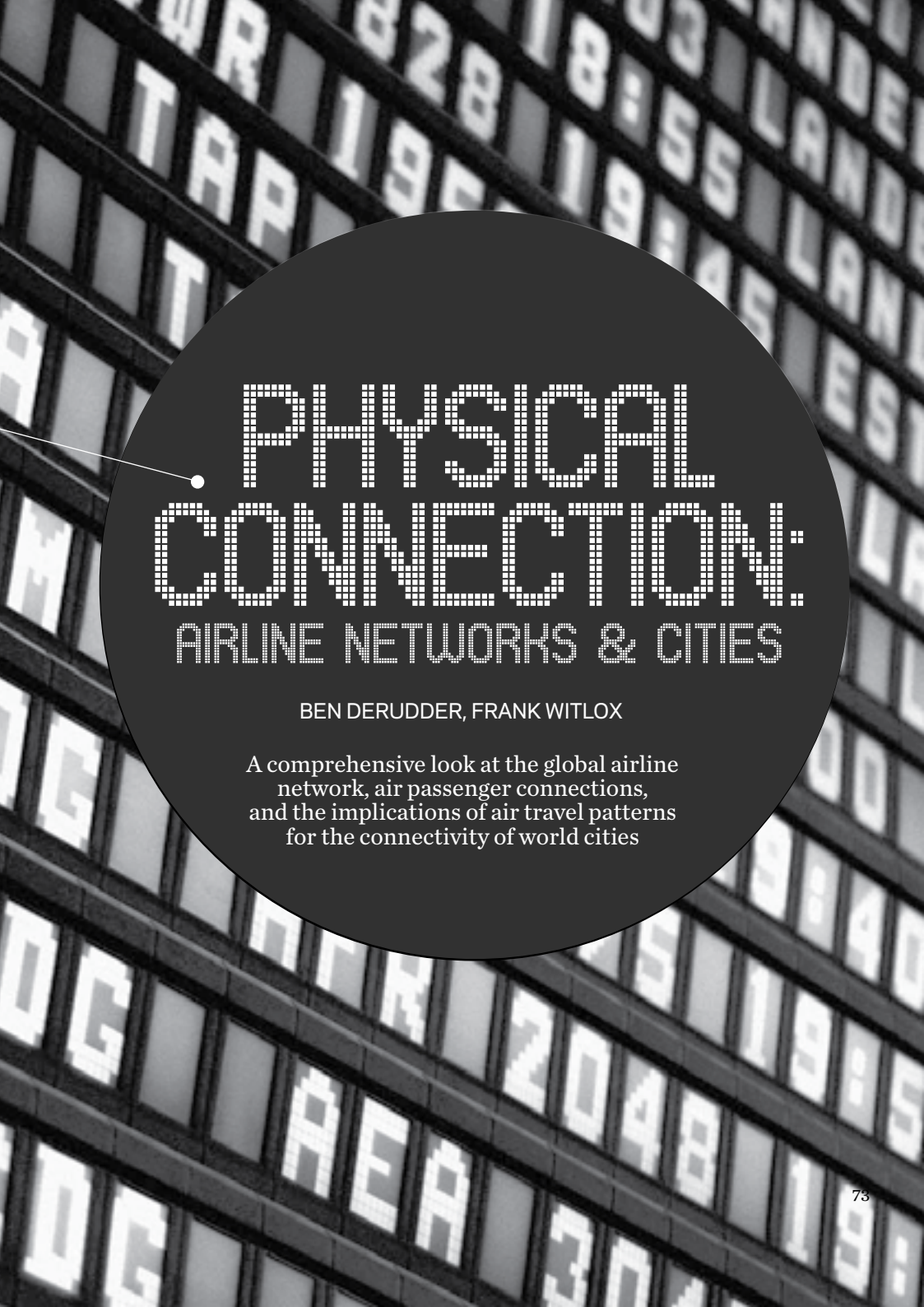
If the method used here is not predicated on simple inter–city power relations, how is it best to interpret the findings on connectivities and associated hinterworlds? This question can be answered at two levels. First, network connectivity is based upon the locational decisions of service firms and therefore rests upon their investment decisions. They are choosing to locate offices where there is an adequate market for their services, and where it complements their existing provision of services. For instance, if a firm has an office in Prague, it might make sense to extend their office network to other eastern Europe cities such as Warsaw, Budapest and Moscow so as to enhance their market prospects in the region. This is, therefore, a simple market argument: cities are chosen for office location as a strategy for future profit growth. The result is an uneven world geography of offices and therefore of office connections (network connectivities).

Second, the network connectivities can be interpreted in city terms as an indicator of economic vibrancy. The services studied are sometimes called 'advanced producer services' and they are at the cutting edge of the global economy because they enable all large corporations to operate globally. Hence even though these global service firms are not themselves the largest firms in the global economy (aside from financial service corporations, service firms hardly feature in lists like the Fortune 500), they are key indicator firms. They are located where city economies are vibrant because their market is economic globalisation. Thus, to say that a city is highly connected in the world city network is an indication that it is a global economic 'hotspot' that includes not just the service firms but their myriad global corporate clients. Thus London and New York are the most important economic locales and their city dyad, NYLON, is 'Main Street, Global Economy.'



3


AMSTERDA
PARIS/C
PARIS/C
PARIS/C



PHYSICAL CONNECTION:
AIRLINE NETWORKS & CITIES

BEN DERUDDER, FRANK WITLOX

A comprehensive look at the global airline network, air passenger connections, and the implications of air travel patterns for the connectivity of world cities

THE GLOBAL AIRLINE NETWORK IS A PRINCIPAL CHANNEL FOR THE FLOWS THAT DEFINE THE ARCHITECTURE OF URBAN CONNECTIONS

A COMPREHENSIVE ANALYSIS OF the connectivity of the world's major cities would not be complete without a chapter examining the worldwide urban geography of air transportation. There are a number of important reasons to include such an analysis. First, information on a city's connectivity in airline networks is comparatively easy to interpret in comparison with other forms of urban connectivity. Second, airline links and their associated infrastructures are at the same time an important component and the most visible manifestation of a city's aspiration to world city status. And third, air transport is the preferred mode of inter–city movement for the transnational business class, migrants, tourists, and high–value goods that together underpin contemporary globalisation. Taken together, then, connectivity in airline networks can clearly be thought of as a significant determinant of the 'network potential' of urban agglomerations, and this chapter therefore presents an assessment of global urban connectivity under the form of a large–scale analysis of the geography of airline networks.

The global airline network is thus a principal channel for the flows that define the architecture of urban connections, and by discussing the spatial organisation of the global airline network in more detail, this chapter attempts to contribute to a better understanding of the connectivity of key cities. To this end, this chapter consists of two main sections. First, we briefly discuss general trends and patterns in worldwide air transportation. This overview of the industry's major characteristics is then further elaborated in the second section, in which we present an analysis of urban connectivity in worldwide air transport networks.

MAJOR TRENDS IN GLOBAL AIR TRANSPORT

Origins and Aggregate Trends

ALTHOUGH THE WORLD'S AIR TRANSPORT NETWORKS WERE LARGELY pioneered before the Second World War, the origins of mass air travel date back to no earlier than around 1960. Aggregate growth rates since then have been quite dramatic, although there seems to be an ever–present sense of volatility in the industry. The long–term aggregate growth in demand for air transport has largely been driven by growing gross domestic product (GDP) per capita and disposable incomes. This growing demand for air transport has, however, been further fuelled by radical changes in the geopolitics of air transport, as government regulation and control have increasingly been replaced by an ethos of deregulation, liberalisation, privatisation and increased competition. Cumulatively, the result has been a steep change in the supply and pricing of air transport. Both the rising demand and supply of air transport have led to ever–increasing urban connectivity at a variety of scales.

5.1%

FORECAST ANNUAL GROWTH AI R PASSENGER 2007–2011

In spite of some intermittent falls in this aggregate growth pattern (such as the industry's slump after '9/11' and the SARS outbreak in Asia) and structural constraints on the development towards evermore connectivity (such as rising fuel costs, negative environmental impacts and congestion around key metropolises), the aviation industry remains confident about long–term growth. The International Air Transport Association (IATA), for instance, has recently stated that—in spite of seemingly ever–worsening predictions about global economic conditions—growth in air transport will remain strong, albeit that international passenger volume growth has passed its peak level for the current growth cycle. Indeed, IATA expects that international air passenger numbers will continue to grow at an average annual growth rate (AAGR) of 5.1% between 2007 and 2011, which is only slightly lower than the average rate of 7.4% seen between 2002 and 2006. These predictions are based

FIGURE 1
ANNUAL GROWTH RATE AVERAGE PER REGION
For the period 2007 to 2011 Source: IATA 2007

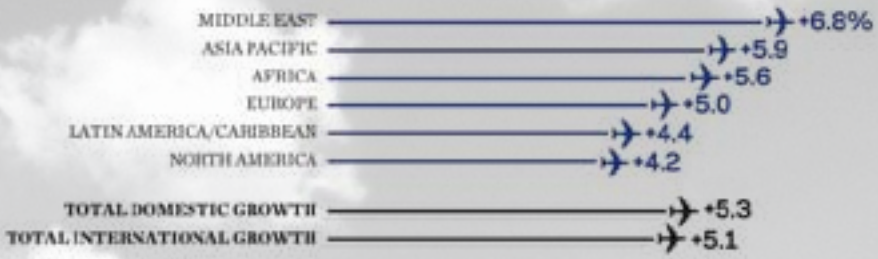


FIGURE 2
AVERAGE ANNUAL GROWTH RATE PER INTER–CONNECTED PAIR OF REGIONS
For the period 2007 to 2011 Source: IATA 2007

on the assumption that demand growth will be weakened by slower global economic growth, but at the same time boosted by the further liberalisation of markets and the emergence of new routes and services. Furthermore, a significant growth in national connectivity is expected in the Chinese and Indian domestic markets: in these markets domestic passenger numbers are forecast to grow at an AAGR of 5.3% between 2007 and 2011, higher than the average rate of 4.4% seen between 2002 and 2006.

These aggregate growth trends obfuscate major regional differences in expected growth rates (FIGURES 1 AND 2). The latter will largely reflect differences in regional economic growth and the structure of each regional market. According to a recent IATA report,

the Middle East, developing economies in Asia and, to a lesser extent, Africa will be boosted by strong GDP growth, along with significant new capacity and new routes. European growth will be close to the average, though Eastern Europe will see a more rapid expansion. Relatively low Latin American growth reflects lower demand growth on key markets to North America and within the region itself. North America is expected to be the slowest growing region, reflecting both mature markets and cyclically slower growth in the US economy. Strong growth in Asia Pacific will see its share of global passenger traffic increase from 23% in 2006 to 27% of the global total of 2.75 billion passengers in 2011. This is equivalent to a 279 million increase in annual passengers within the Asia Pacific region over the five years. It will have a higher share of the global market than the US domestic market, though it will still be slightly smaller than the North American market as a whole. Taken together, over the next five years, developing economies will make a greater contribution towards air traffic growth. The increase in disposable incomes for a large population within China and India will boost the demand for air travel. However, because incomes are growing from relatively low levels, air traffic growth may initially be focused on domestic and short–haul travel with long–haul travel developing over the medium to long–term.

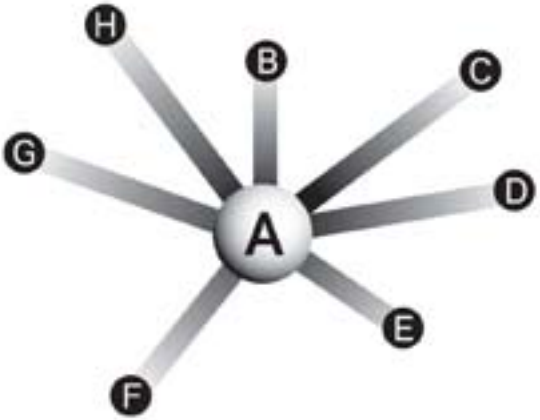
Major Contemporary Processes: Deregulation and Environmental Sustainability

MOST RECENT ACADEMIC AND PUBLIC DEBATE CONCERNING AIR transport has been centred on the consequences of two intertwined issues, i.e. (i) questions surrounding the environmental sustainability of the air transport industry at large, and (ii) the consequences of globalisation and the associated deregulation of worldwide air transport. Recent research into the issue of 'environmentally sustainable aviation' suggests that this may well be a contradiction in terms. The main environmental problems created by air transport are noise from aircraft engines, atmospheric pollution and the excessive fuel use. Technological improvements to reduce both noise and emissions have been implemented, but they are being offset by growth trends of the industry at large. More recently, the growing awareness of the significant environmental problems associated with air transport has led to a set of schemes that seek 'carbon–neutral' air transport through internalising the environmental externalities associated with this mode of transport.

For the present discussion, however, the most important feature of contemporary changes is that air transport networks are being reshaped dramatically by myriad globalisation processes. This is, of course, essentially a two–way relationship, in that globalisation results in dramatic increases in air transport, while at the same time being facilitated by the possibilities offered by worldwide airline networks. The most dramatic feature of the globalisation of the airline industry is the continuous deregulation of the worldwide marketplace for aviation. Historically, at the international scale, air service provision between countries was controlled by bilateral agreements negotiated by pairs of governments which governed the so–called 'freedoms' of civil aviation. Since domestic airline deregulation in 1978, however, the US government has pursued a global policy to liberalise international bilateral agreements. Most recently, it has sought so–called 'open skies' agreements, allowing unrestricted market entry for every carrier. The logical outcome of full open skies will be the replacement of bilateral with multilateral agreements, in which groups of like–minded countries permit any airline virtually unlimited access to any market within their boundaries. In this context, deregulation involves the exposure of air transport to free–market forces achieved through the removal of most regulatory controls over pricing, while permitting carriers to enter and leave markets at will. While this has occurred within regional markets such as the EU and the North American Free Trade Area (NAFTA), the provision of both passenger and freight air transport between these blocs and many individual countries still remains constrained by bilateral agreements.

This trend towards evermore deregulation has significant impacts on the industry at large. For instance, to circumvent remaining regulatory constraints, airlines have sought to establish strategic global alliances (such as Star Alliance, OneWorld and SkyTeam), while the need for efficiency and economies of scale in a global marketplace have led to new rounds of mergers and acquisitions. Deregulation, in turn, has led to new forms of air transport such as the well–known low–cost carriers. In the context of the present discussion, however, the most interesting trend induced by recent changes in the airline industry is a series of shifts in the organisational geography of airline networks, a process that will be discussed in the next paragraph.

Point–to–Point vs. Hub–and–Spoke Models



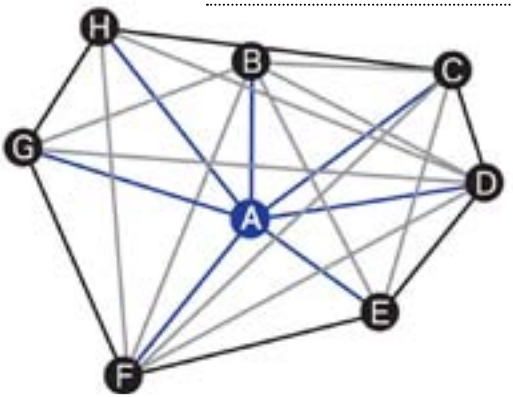
THE INTERPRETATION OF URBAN connectivity in terms of airline networks may seem obvious: after all, the (inherently plausible) assumption is that the connectivity of a major city is directly reflected in its ability to attract a lot of passengers. However, it should be noted that while airline passenger networks have indeed traditionally been oriented towards major cities, there is a continuous shift towards a more complex organisation. This is because some cities are gaining prominence in air transport networks through their role as 'hubs' rather than as origins and/or destinations in their own right. Hubs are hereby defined as places where passengers requiring multiple flights to get to their final destination change planes. While hub functions have always been important to connect distant and/or less important cities, it has become even more important in recent years. More specifically, the mounting importance of specific switching points in global airline networks can be traced back to the adoption of the hub–and–spoke model as primary strategy for organising route structures. The hub–and–spoke model hereby refers to the image of a bicycle wheel with a core component (the hub) and many subcomponents (the spokes). When airlines adopt this model, they establish one or more central switching points where passengers can change planes. Spoke flights via the hub take passengers to their final destinations. FIGURE 3 presents an example of an 'ideal' hub–and–spoke network and an 'ideal' point–to–point network.

Although the hub–and–spoke model may involve the disadvantage of a longer overall travel time, its benefits are obvious: there are fewer routes to service, which in turn yields the possibility of higher flight frequencies, higher loadfactors and the possibility to create economies of scale using bigger aircraft. The reason for the mounting success of

FEWER ROUTES TO SERVICE & HIGHER FLIGHT FREQUENCY

FIGURE 3
HUB–AND–SPOKE VS. POINT–TO–POINT NETWORKS

www.lboro.ac.uk/GaWC/rb/rb187.html



the hub–and–spoke model, therefore, is that it allows airlines to exploit important productive efficiencies due to the presence of economies of traffic density. The growing relevance of the hub–and–spoke model has, however, equally been fuelled by 'external' trends. For instance, the previously described deregulation pacts in Europe and the US were a major force in the transition towards hub–and–spoke models. Indeed, most major US carriers have adopted the hub–and–spoke model after the *Airline Deregulation Act* in 1978, while major European airlines have increasingly been moving in the same direction since the deregulation of the European market in the period 1988–1997. Although it can be expected that the further liberalisation of air traffic will once again reinforce the trend towards hub–and–spoke networks, there are at the same time some powerful countertendencies at work. The most important countertendency is the mounting success of low–cost carriers, which are notorious for their use of a point–to–point organisation. The ensuing reinstatement of large–scale point–to–point models challenges the gradual shift towards hub–and–spoke networks, and this is likely to gain further pace as low–cost carriers continue to increase their market shares. It is difficult at this stage to predict how the total share of both organisational networks will evolve, but it is obvious that both schemes will continue to co–exist: in practice, the route structures of major airlines exhibit a mixture of both organisation forms, with (i) direct connections between major cities, and (ii) a hub–and–spoke network to ensure that every city is connected to the overall network. In the context of this chapter, the most important point is that we should be able to make the distinction between the 'real' origin/destination connectivity of a city and its connectivity due its role as switching point for air traffic between other pairs of cities.

HIGHER LOAD FACTORS & ECONOMIES OF SCALE

CONNECTIVITY OF CITIES

Beyond Standard Airline Statistics

The analysis of the worldwide connectivity of major cities based on air transport statistics is centred on the idea that air traffic provides us with a pertinent indicator in this context. However, we have equally stressed that because of the widespread adoption of hub–and–spoke models, one has to distinguish 'real' origin/destination connectivity from 'hub connectivity'. Although standard airline statistics, such as those provided by IATA and other air transport agencies, may well provide a basic insight into the urban geography of air transport networks, they cannot be used for our specific purposes for two main reasons. First, standard statistics lack information on the *actual* origin/destination of passengers. This is because these statistics record the individual legs of trips rather than the trip as a whole. Thus, in the case of a stopover, a significant number of 'real' inter–city links are replaced by two or more links that reflect corporate strategy rather than relations between cities. Furthermore, this lack of origin/destination information makes geographically detailed assessments of the connectivity of cities at a global scale difficult, as direct connections become less likely as one deals with less important and/or geographically distant cities. According to the airline database used in this chapter, 28% of international passengers make one or more stopovers, which suggests that classical statistics are heavily biased. A second obstacle to translating mainstream air transport statistics into analyses of urban connectivity arises from the fact that these data sources incorporate a *state–centric bias*. That is, despite their global aspirations, most databases contain information on international flows. The importance and the rise of domestic connectivity in countries such as the US, India, and China suggests, however, that both national and international connectivity should be considered in a single, consistent framework.

MIDT–Data

Standard airline statistics are thus not always very well suited to present a detailed overview of a city's connectivity. In this chapter, we therefore make use of a dataset that is able to overcome these problems. Our MIDT (Marketing Information Data Transfer) database contains information on bookings made through so–called Global Distribution Systems (GDS) such as Galileo, Sabre, Worldspan,

Amadeus, Topas, Infini, and Abaccus. GDS are electronic platforms used by travel agencies and airlines to manage airline bookings (i.e., the selling of seats on flights offered by different airlines), hotel reservations, and car rentals. With the cooperation of an airline, we were able to obtain a MIDT dataset that covers the period from January to August 2001, and contains information on a total of 3.7 million trips. Each MIDT record is made up of an entire airline trip, and comprises information on the IATA–airport codes of origin/destination, the air carrier, the connecting airports (if any), and the number of passengers. Airlines purchase the MIDT database for a variety of reasons, the most important of which is its ability to forecast demand. It is also a helpful tool for assessing the market share and the competitive position of an airline in a specific geographical area. In the context of our research, however, the database is used to construct inter–city matrices that can be used to assess urban connectivity from a number of different perspectives. Because of the way in which airline bookings are recorded in this dataset, we are able to circumvent the problems identified in the previous paragraph: (i) the actual route of passengers allows us to distinguish between real origin/destination connectivity on the one hand and hub connectivity on the other hand, while (ii) national and international connectivity is analysed in the same way.

To obtain our urban connectivity measures, we transformed this dataset in a number of ways. First, because we are mainly interested in the total volume of passenger flows between cities (rather than between airports *per se*), we relabelled airport codes into city codes. These city codes are needed to compute meaningful inter–city measures because a number of cities have more than one major airport. The particular airport used by a passenger is not important in this context because, for recording the London–New York relation, it is irrelevant whether a flight goes from London Heathrow to New York JFK or from London Gatwick to Newark. After having summed the directional information into a single measurement detailing the total volume of passengers between any pair of cities, we created two global inter–city matrices that focus on the most important cities in the world economy. The first dataset focuses on the actual origins and destinations of passengers (irrespective of the actual spatiality of their travel pattern, i.e. a direct connection or via a hub), the second on the networked function of cities in their role as transfer points for passengers. Accordingly, the overview of our results will focus on both features of a city's connectivity.

2,750,000,000 ANNUAL GLOBAL AIR PAX

Our selection of cities consists of a combination of two indicators. First, we omitted key holiday destinations and less important cities by drawing on the tentative world city list compiled by the Globalisation and World Cities research group and network (GaWC). This list contains 315 cities and includes the capital cities of all but the smallest states and numerous other cities that have an obvious global economic importance. Second, we complemented this inventory by adding all Metropolis member cities that do not feature in the GaWC list. A number of cities were excluded either because they had no airport (e.g., Bonn and Kawasaki) or because the airport was not serviced in the period under consideration (e.g. Kabul). FIGURE 4, which summarises the actual routes employed on the Paris–Seattle and Miami–Seattle connections, reveals the possibilities of our dataset in this context. The most popular way of flying from Paris to Seattle is via London, closely followed by a direct connection between both cities. Other popular hubs for this connection are New York, Copenhagen and Pittsburgh. Miami and Seattle, in contrast, have fairly well developed direct connections: 17,665 passengers took a direct flight opposed to 24,342 passengers that made use of one or more hubs. St Louis, Dallas and Atlanta are the most important hubs for this particular connection.

FIGURE 4
NUMBER OF DIRECT/INDIRECT PASSENGERS ON THE PARIS–SEATTLE AND MIAMI–SEATTLE CONNECTIONS

Source: www.lboro.ac.uk/gawc/rb/rb152.html

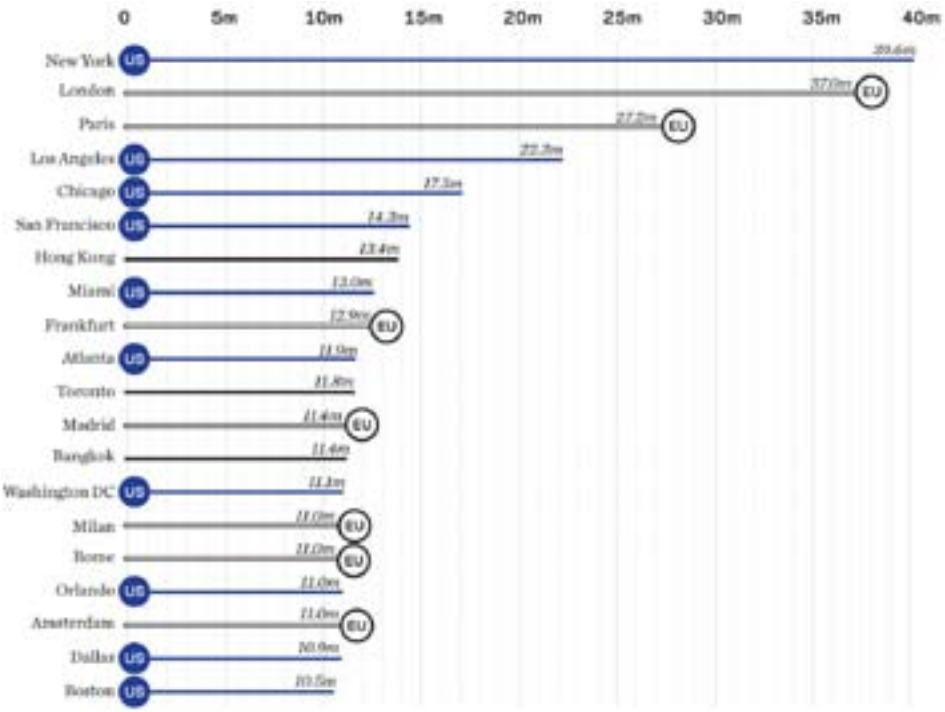
PARIS—SEATTLE			MIAMI-SEATTLE		
	VIA HUB	PASSENGERS		VIA HUB	PASSENGERS
1	London	7,031	1	St Louis	4,766
2	Copenhagen	2,935	2	Dallas	4,462
3	Pittsburgh	2,641	3	Atlanta	2,612
4	New York	2,211	4	Houston	2,310
5	Toronto	2,197	5	Chicago	2,219
6	Amsterdam	2,178	6	Denver	2,182
7	Washington	2,082	7	Minneapolis	810
8	Charlotte	1,683	8	Charlotte	775
9	Cincinnati	1,611	9	Phoenix	678
10	Chicago	1,582	10	Memphis	451
	DIRECT	**6,078**		**DIRECT**	**17,665**

76.6M

TOTAL INBOUND /OUTBOUND NEW YORK & LONDON PAX

FIGURE 5
TOP 20 MOST CONNECTED CITIES
In terms of origin/destination passengers

Source: www.lboro.ac.uk/gawc/rb/rb152.html



Origin/Destination Connectivity

FIGURES 5–6 AND FIGURE 7 GIVE AN OVERVIEW OF URBAN CONNECTIVITY in terms of origin/destination flows. FIGURE 6 details the most important cities in the world economy in terms of air passenger connectivity (it includes all Metropolis members and the non–Metropolis members that feature in top–30 in terms of origin/destination connectivity); FIGURE 9 presents the 20 most

FIGURE 6
MOST IMPORTANT INTER–CITY CONNECTIONS
In terms of origin/destination passengers

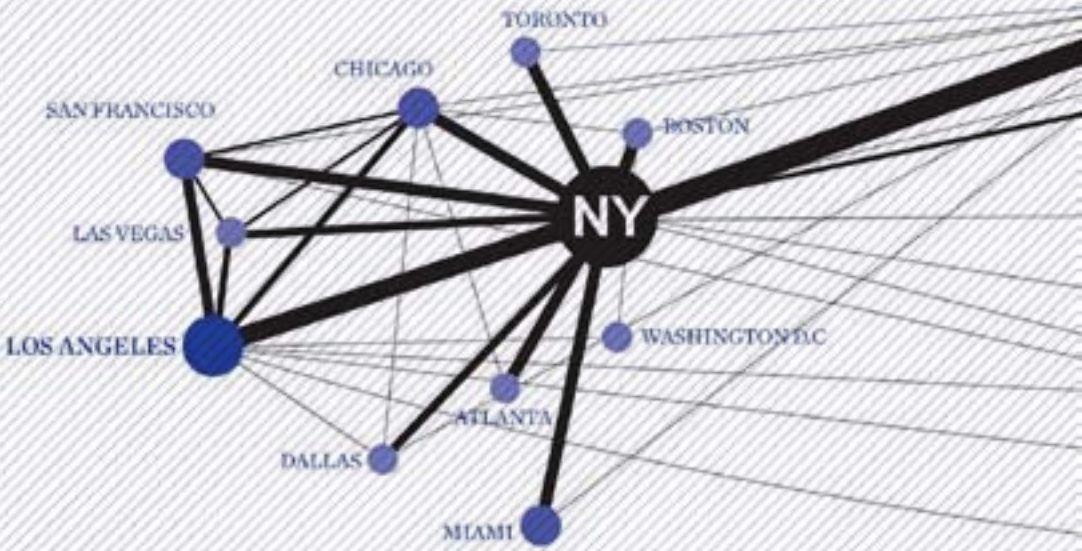
Source: www.lboro.ac.uk/gawc/rb/rb152.html

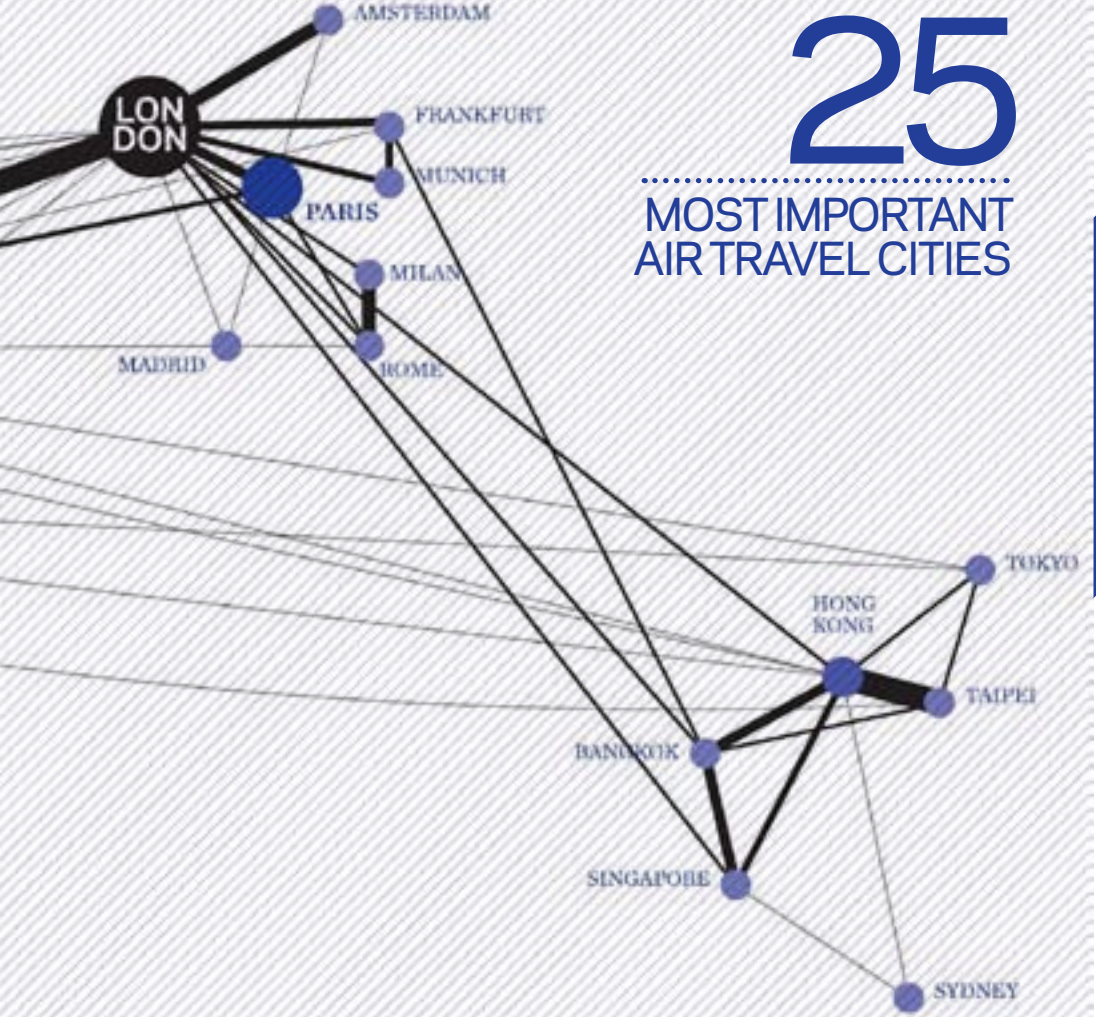
4TH

SYD–MEL FOURTH HIGHEST INTERCITY AIR ROUTE

FIGURE 7
MOST IMPORTANT CITIES AND LINKS IN THE WORLD CITY NETWORK

Source: www.lboro.ac.uk/gawc/rb/rb152.html





25

MOST IMPORTANT AIR TRAVEL CITIES

important inter–city relations in the dataset; and FIGURE 7 depicts the connections between the 25 most important cities in terms of total passenger flows. The size of the nodes varies with the total number of incoming or outgoing passengers; the size of the edges varies with the number of passengers flying between two cities. For reasons of clarity, only the most important links are shown.

FIGURE 6 gives a straightforward overview of the main hierarchical tendencies in the urban networks as created by worldwide air transport linkages. The most obvious feature of the figure is that it is (still) dominated by cities from OECD countries in general, and by US cities in particular. The early deregulation of the US aviation market and the general lack of alternatives such as high–speed trains (perhaps with the exception of the Boston–New York rail connection) have historically boosted the airline connectivity of US cities, but—as we have stressed in the introduction—key cities from other world regions have been catching up rapidly in the last few years in terms of origin/destination flows, a trend which is expected to continue in the years to come. As a consequence, a number of cities from the erstwhile 'Third World' assume an increasingly important role as origins and destinations

FIGURE 8
FIVE MOST IMPORTANT HUB CITIES PER REGION

Source: www.lboro.ac.uk/gawc/rb/rb187.html

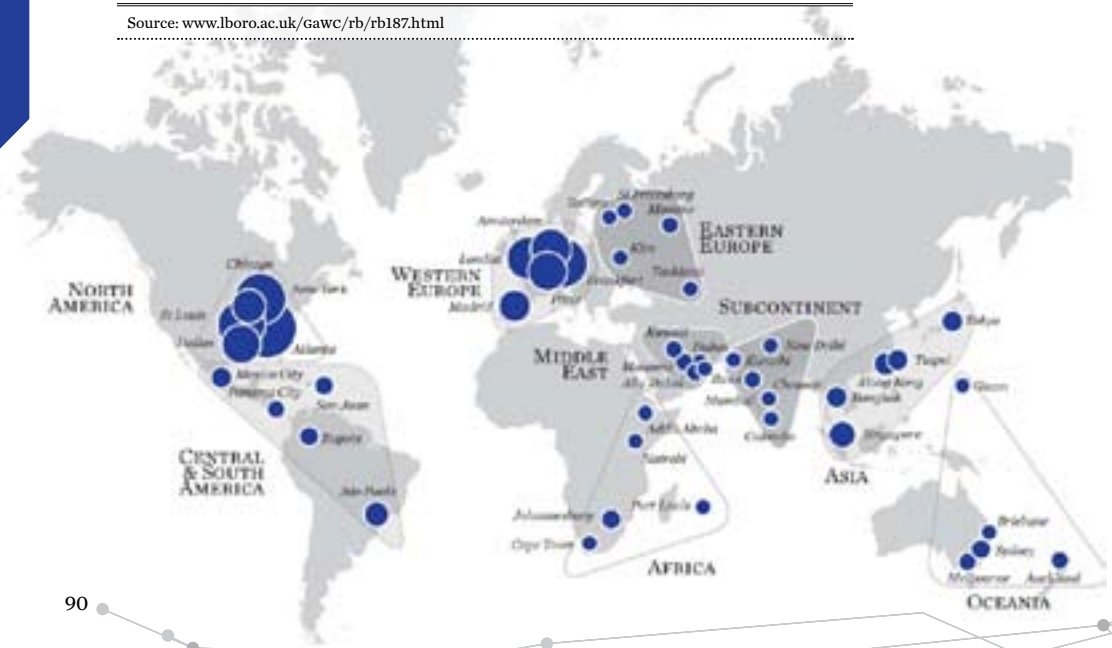
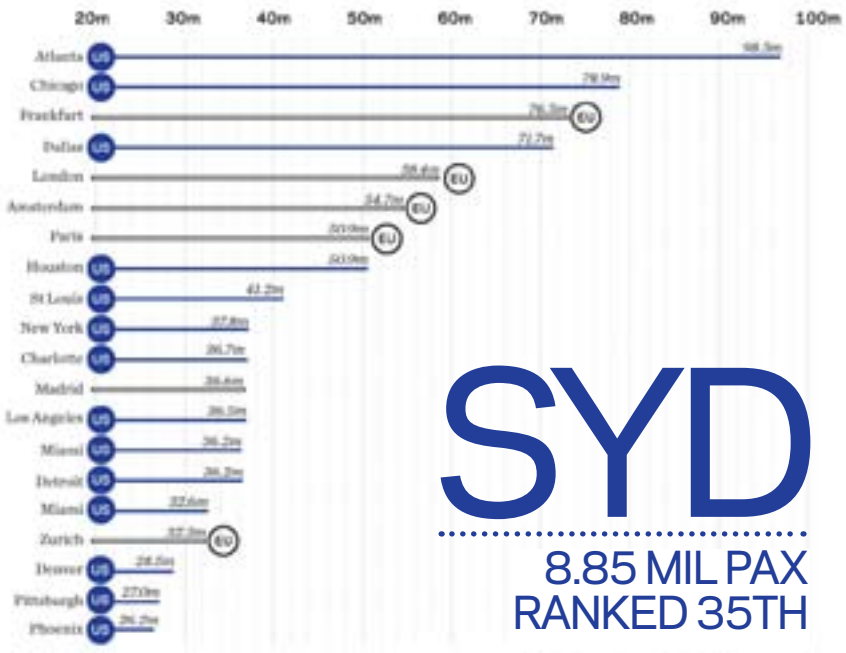


FIGURE 9
MOST CONNECTED CITIES
In terms of hub passengers

Source: www.lboro.ac.uk/gawc/rb/rb187.html



in worldwide airline connections, as can be seen from the important connectivity of cities such as Bangkok, Mexico City, and São Paulo.

In terms of the geography of inter-city linkages, FIGURE 6 and FIGURE 7 reveal a threefold pattern. First, although airline connections are often assumed to be clear-cut signposts of the global connectivity of cities, it can be seen that national connections dominate the picture. In addition to a large number of US city-pairs, the list primarily consists of national connections such as Melbourne–Sydney, Milan–Rome and Johannesburg–Cape Town. Second, these important inter-city connections within states are complemented by a number of 'regional' connections, especially—but not exclusively—in the EU and Asia Pacific. Examples include the importance of the Bangkok–Hong Kong, Amsterdam–London and Paris–London

connections. And third, a number of worldwide origin/destination pairs are entering the picture as well. The most obvious example is the London–New York connection, which boasts a connectivity comparable to that of the New York–Los Angeles and Sydney–Melbourne connections. The absolute and relative importance of the London–New York connection can be thought of as a key example of how the fate of main cities around the globe is increasingly influenced by their worldwide connections to other cities.

Hub Connectivity

Apart from being important origins and destinations in their own right, major cities around the globe also derive a substantial part of their connectivity from their role as switching points for travellers. The absence of major cities such as Dubai and Singapore in figures 5–6 can—at least partly—be attributed to this observation: their chief role in airline networks consists of connecting other city–pairs (particularly cities in Europe and the Asia Pacific region). In this concluding paragraph, we will therefore present an overview of the hub connectivity of major cities around the globe.

figure 9 features the most important cities in terms of the number passengers that make use of a city as a switching point. Similar to figure 5, it includes all Metropolis members and the non–Metropolis members that feature in top–30 in terms of hub connectivity. Perhaps unsurprisingly, the figure reveals that major nodes in the global airline network also function as major hubs in the airline network as a whole (perhaps with the exception of Tokyo, and, to a lesser degree, New York). There is a notable regional focus in this 'global' hierarchy: 24 of the 25 most important hubs in absolute terms are located in North America or Europe. The only exception here is Singapore, which is ranked 23rd. The figure suggests that hub–and–spoke connectivity is particularly important to North American and European cities. However, figure 6, which presents an overview of the five most important hubs per world region, clearly shows that this does not imply that urban networks in other regions are characterised by the *absence* of hubs: the lack of cities from other parts of the world in figure 9 merely hints at the fact that the volume of traffic through these hubs is at present too small to feature prominently in rankings based on transnational data. Once again, however, the steady rise of the hub connectivity of cities such as Dubai, Abu Dhabi and Singapore will, in conjunction with the above–average growth of the traffic in the markets they serve, likely change this picture in the years to come.

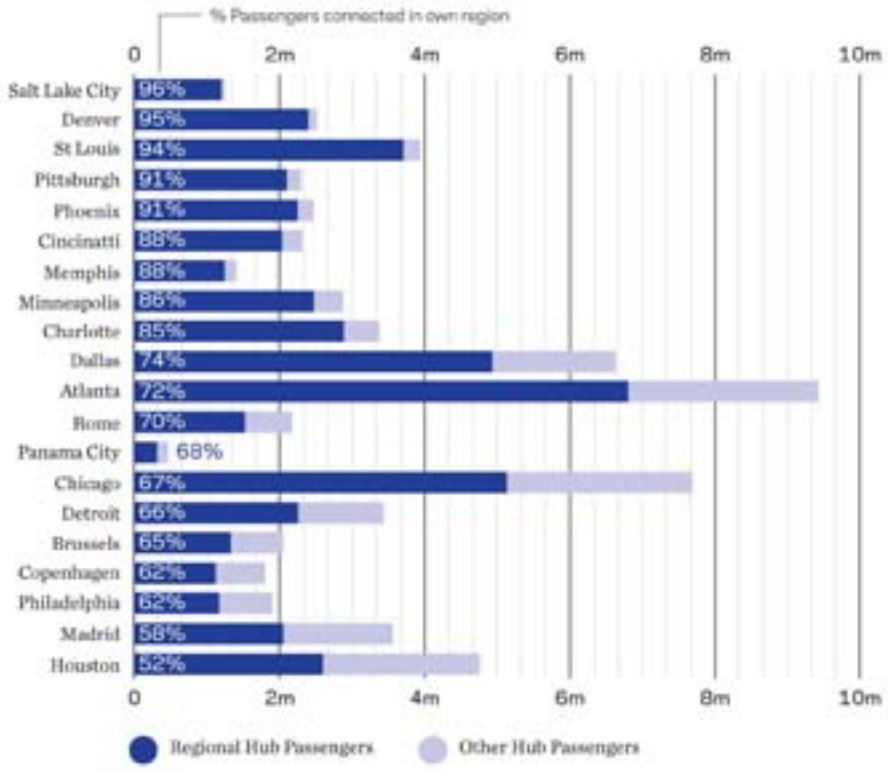


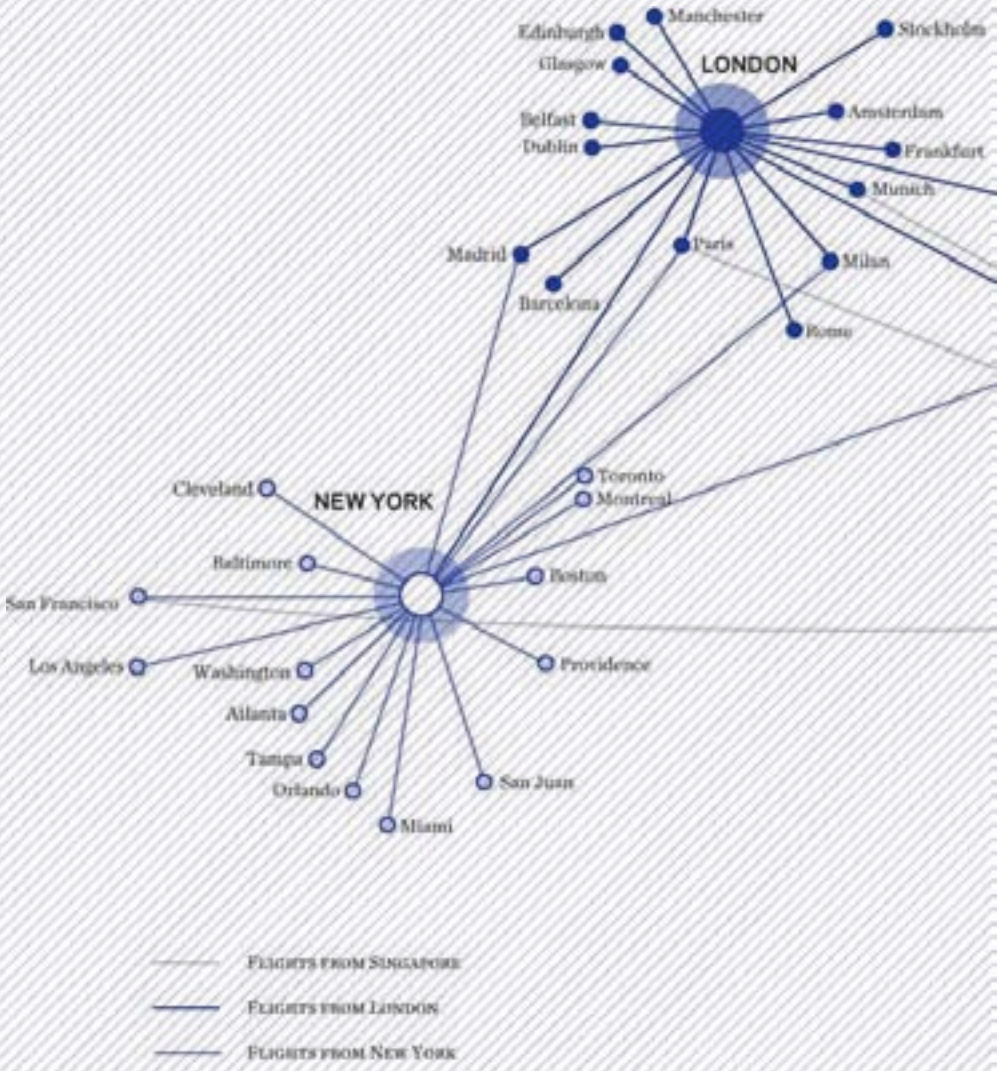
FIGURE 10
PERCENTAGE OF PASSENGERS CONNECTED
In the own region for a number of major hubs

Source: www.lboro.ac.uk/gawc/rb/rb187.html

This overview of major hub cities in air transport networks does, however, not provide us with an insight in the spatiality of a city's hub function: it is a 'de–spatialised' measure in that it simply focuses on the number of passengers/cities that use a node as a switching point. In parallel with FIGURE 6, we will therefore complement the rankings in FIGURE 9 and FIGURE 8 with an assessment of some key spatial characteristics of hubness: we assess to what degree hubs connect extra–regional passengers, and complement this ranking with a more detailed examination of some notable examples.

FIGURE 11
TWENTY CITIES THAT MAKE THE MOST INTENSE USE OF NEW YORK, LONDON, AND SINGAPORE AS HUB

Source: www.lboro.ac.uk/GaWC/rb/rb187.html



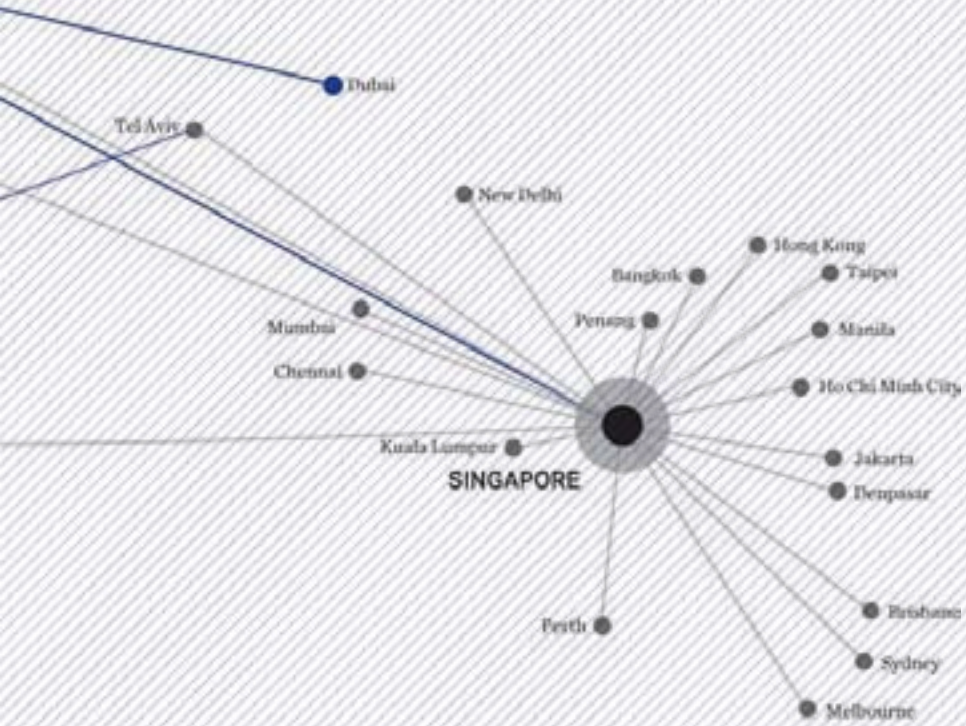
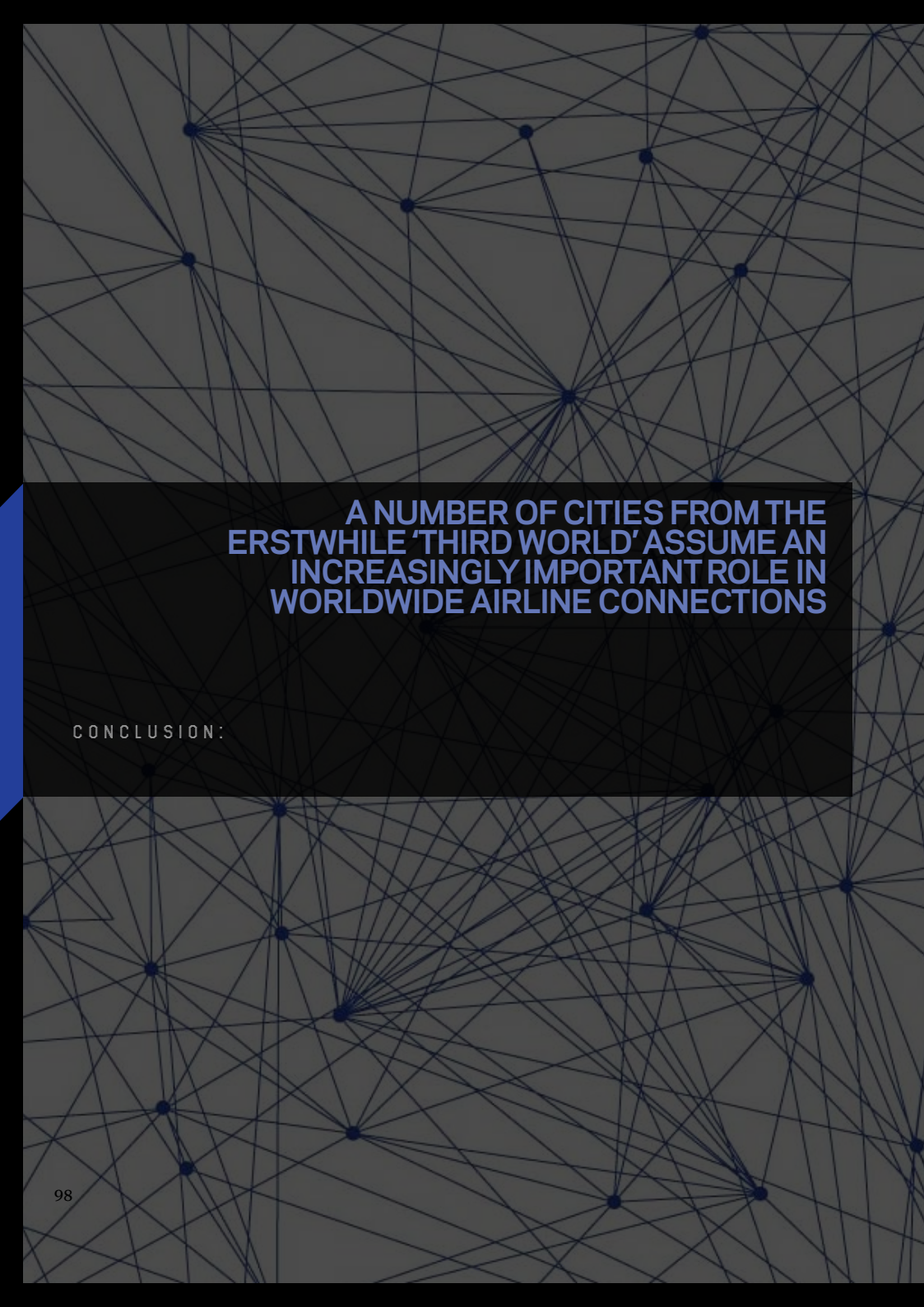

Dubai
Tel Aviv
New Delhi
Hong Kong
Bangkok
Taipei
Mumbai
Penang
Manila
Chennai
Ho Chi Minh City
Kuala Lumpur
SINGAPORE
Jakarta
Denpasar
Brisbane
Perth
Sydney
Melbourne

FIGURE 12
TWENTY CITIES THAT MAKE THE MOST INTENSE USE OF ATLANTA AND MIAMA AS HUB

Source: www.lboro.ac.uk/GaWC/rb/rb187.html

FIGURE 10 ranks a number of major hubs on the basis of the percentage of hub passengers connected *within* the same region. Cities such as Salt Lake City, St. Louis, Denver, Cincinatti, Pittsburgh, and Memphis almost exclusively connect passengers that travel within the US. This dominance of designated *regional* hubs is particularly well–developed in the US. Indeed, with the exception of New York, Miami and Los Angeles, most US hubs have a regional focus. This regionality is far less clear–cut in the case of European cities, although Copenhagen, Brussels and Rome can be designated as 'European hubs'. Singapore, London, Miami, Amsterdam and Manama are the most 'international' among the important airline hubs, for example, only 5% of the passengers making an onward connection in Miami travel between two North American cities: as a hub, Miami functions almost exclusively as a gateway for passengers travelling from or to another region. To assess the spatiality of this hub function in more detail, FIGURES 11 & 12 reveal the spatiality of the hub function of London, New York, Singapore, Atlanta and Miami. For each of these cities, the figures show the 20 cities that make the most intensive use of this node as hub.

FIGURE 12 clearly reveals that the extra–regional hub function of Miami primarily consists of connecting cities in North America and Latin America. The hub function of London and New York, in turn, is also fairly international, albeit that the dominant feeding flows chiefly emanate from North America and Europe (with the exception of San Juan and Tel Aviv for New York). Singapore's position is even more international, with an important gateway function for cities in Asia, Australia, and Europe (in addition to San Francisco). The 'internationality' of London, New York and particularly Singapore is in sharp contrast with Atlanta, whose dominant resource cities are all located in the US. Thus, although Atlanta connects a larger number of passengers than New York, its hub function is far more restricted from a geographical point of view. Its most important non–US feeding connections are San Juan (ranked 21), London (ranked 45), and Nassau (ranked 54). As a consequence, and in parallel with the threefold scalar geography in origin/destination linkages noted above, there seems to be a *scalar* differentiation among cities: cities with a similar hub connectivity may be very different in their geographical focus.

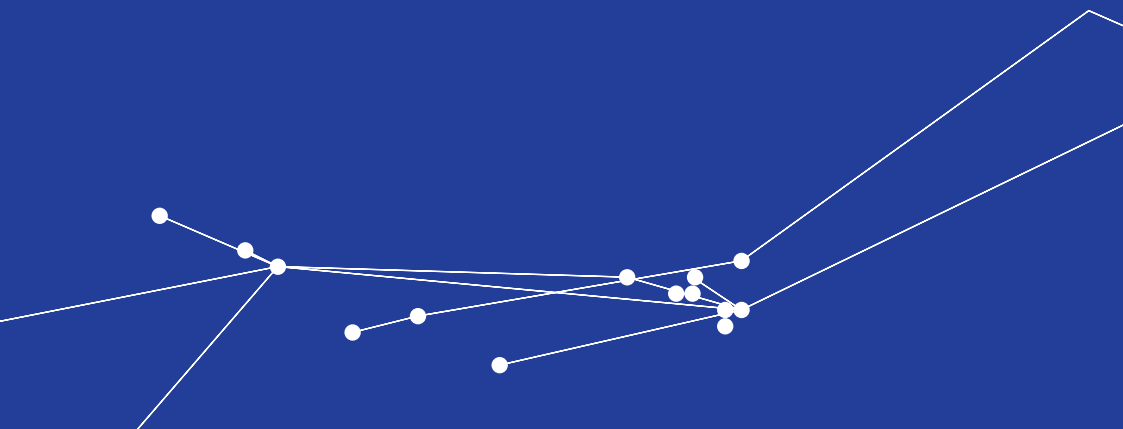


A NUMBER OF CITIES FROM THE ERSTWHILE 'THIRD WORLD' ASSUME AN INCREASINGLY IMPORTANT ROLE IN WORLDWIDE AIRLINE CONNECTIONS

CONCLUSION:

In this chapter, we have explored the main features of the worldwide urban geography of air passenger connections. Air transport links and their associated infrastructures are at the same time an important component and the most visible manifestation of a city's aspiration to world city status, while the importance of these physical transport infrastructures is further bolstered by the fact that the association between globalisation and the emergence of transnational urban networks is essentially a two–way relationship: globalisation results in dramatic increases in air passenger transport, while at the same time being facilitated by the possibilities offered by these very connections. Although there is a general growth pattern in the airline industry, these growth rates have a very uneven geography, with anticipated huge increases in connectivity for cities in the Middle East, developing economies in Asia and, to a lesser extent, in Africa.

While air passenger networks have traditionally been oriented towards major cities, there is a continuous shift towards a more complex organisation in which selected cities such as Dubai and Singapore are gaining prominence in these networks through their role as switching points rather than as origins and/or destinations in their own right. Consequently, our overview of the most connected cities has distinguished between origin/destination connectivity and hub connectivity. In spite of a number of remarkable differences between these two rankings, they are both (still) dominated by cities from oecd countries in general and us cities in particular. The important domestic market and its early deregulation has historically boosted the airline connectivity of us cities, but key cities from other world regions have been catching up rapidly in the last few years, both in terms of origin/destination flows and hub connectivity. As a consequence, a number of cities from the erstwhile 'Third World' assume an increasingly important role in worldwide airline connections, as can be seen from the important connectivity of cities such as Bangkok, Mexico City, and São Paulo.



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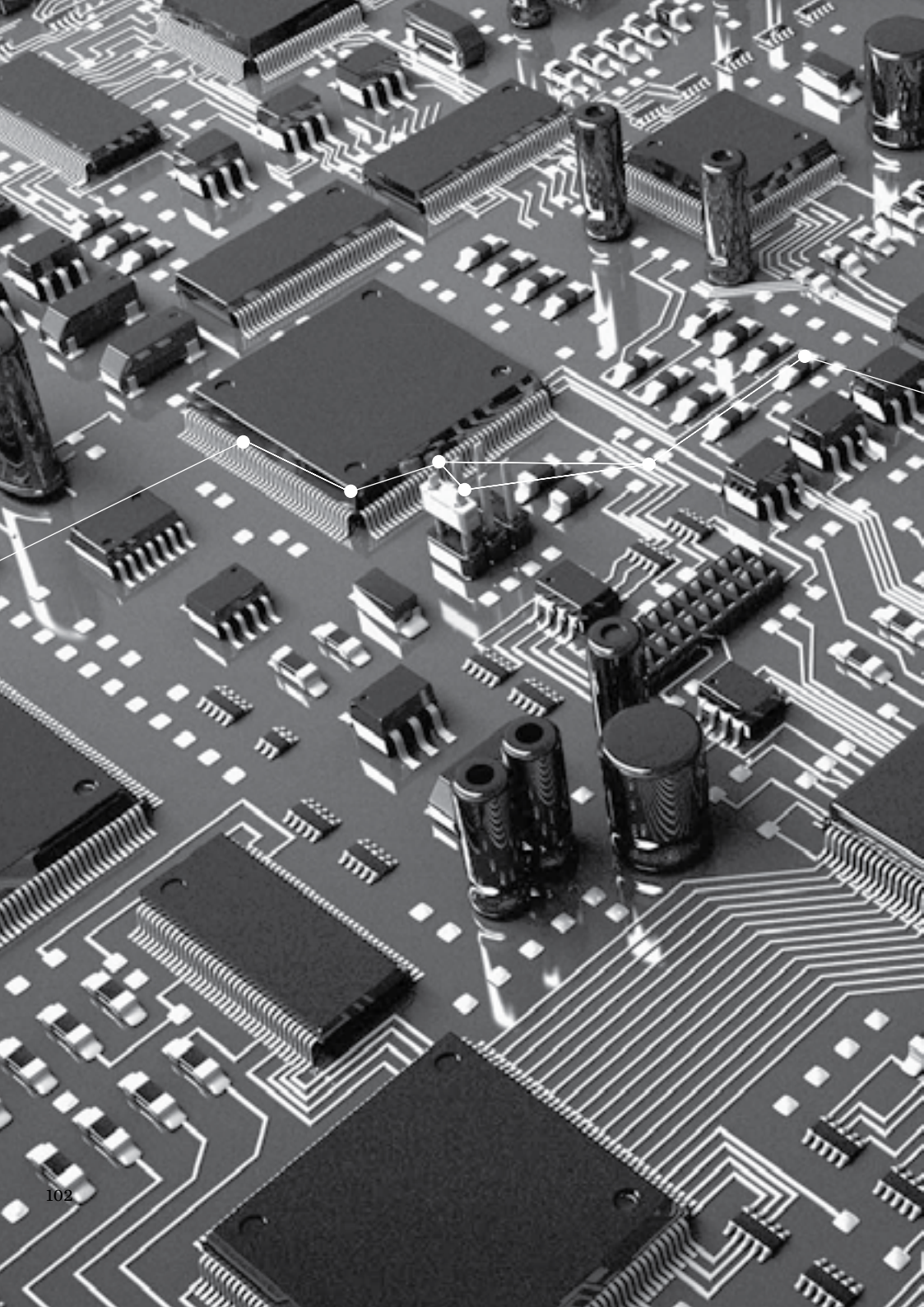
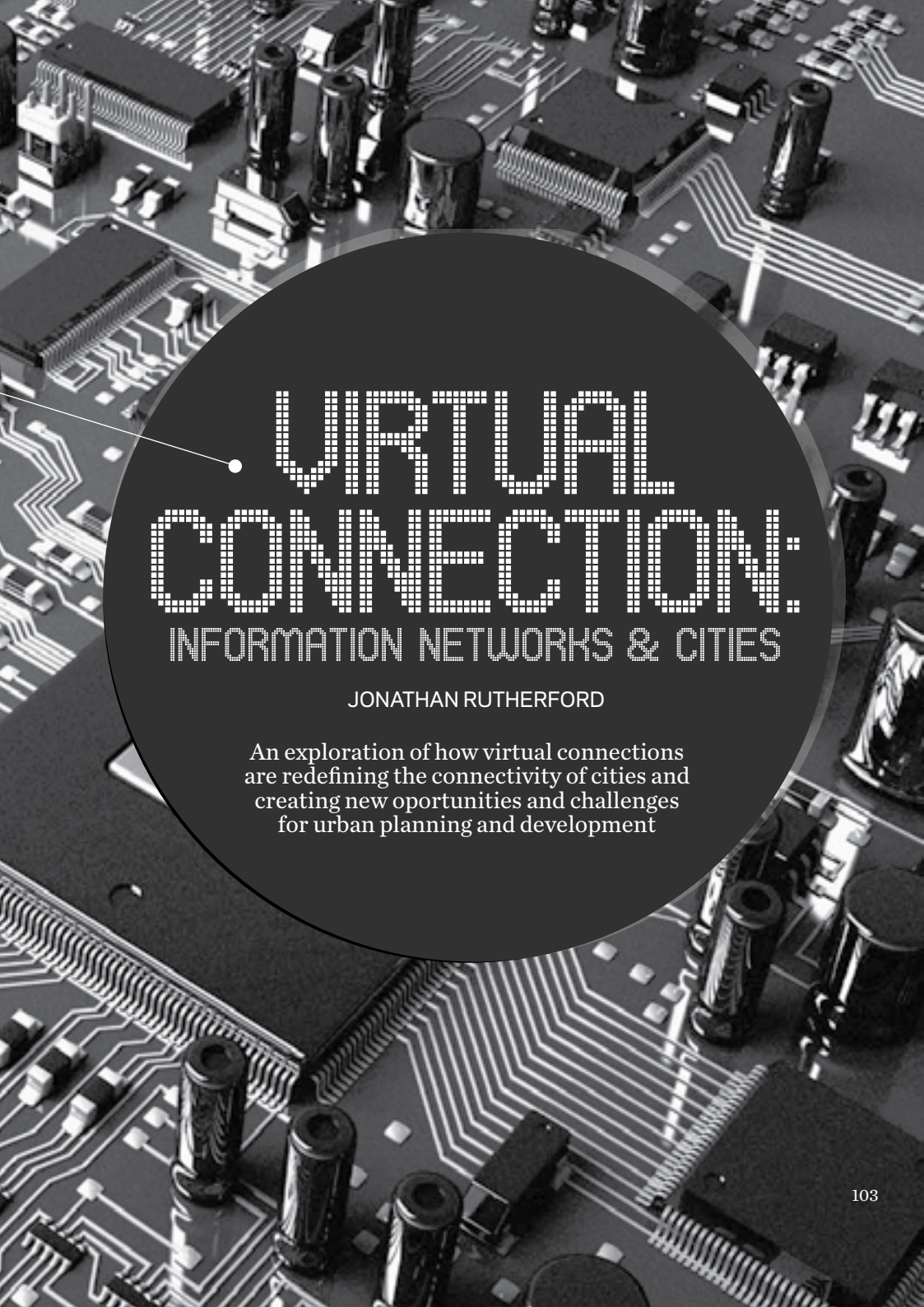




VIRTUAL CONNECTION:

INFORMATION NETWORKS & CITIES

JONATHAN RUTHERFORD

An exploration of how virtual connections are redefining the connectivity of cities and creating new oportunities and challenges for urban planning and development

THE FLOW AND EXCHANGE OF information has always been a sine qua non for cities. As such, cities have always benefited from information infrastructures linking them to other places, from horseback messengers and various forms of postal service to today's 'information superhighways' based on the global internet. In many ways, the only change has been the rapidly diminishing timescale over which information has been able to be sent from one place to another—it took weeks for letters to traverse continents in the eighteenth or nineteenth centuries, whereas now real–time communications offer near instantaneous access to information almost anywhere in the world.

Traditional views of the impacts of information and communications technologies (ICTs) on cities have often been dominated by prophecies and hype based around anticipations of a dissipation of cities and a death of the pertinence of distance with an increasing ubiquity of information, the key raw material of post–industrial times. The emergence and growth of new technologies from the telegraph at the end of the eighteenth century to wireless internet access at the beginning of the 21st Century has

NOW REAL-TIME COMMUNICATIONS OFFER NEAR INSTANTANEOUS ACCESS TO INFORMATION ALMOST ANYWHERE IN THE WORLD

been seen to have inherent liberating effects, unchaining us from the need for urban concentration and location and from the friction of distance over which people communicate and exchange. The utopian vision present in these accounts assures us that on one level we will soon be able to locate anywhere and remain in constant touch with friends and colleagues on the other side of the world, and that on another level traditional geographical differences and diversities are being 'flattened' with the potential for reducing the trenchant social and economic inequalities that currently polarise cities and regions across the planet.

Such accounts are plagued however by technological determinism, a belief that new technologies can lead more or less *directly* and unproblematically to certain generally desirable social consequences. An opposing current of research views instead the relations between technologies and cities as more complex and co–evolutionary with the two in permanent interaction and mutual constitution. In this perspective, not only does virtual connection in no way revoke the raison d'étre of cities, but it actually reinforces their statute as centres of agglomeration and economic productivity. More broadly too, far from flattening geographical differences the widespread centrality of ICTs to the functioning of the global economy tends to reinforce the economic importance of particular urban centres and to contribute to a relative bypassing of other cities. In other words, there is no simple relation between the development of information networks and the development of cities. While the former certainly allow a better integration of the latter into the global economy, the exact configuration of this integration always builds on a series of contextual and geographical specificities particular to individual cities. This report focuses, however, on the development and the implications of the physical network connections between cities which make up the information infrastructure over which the global informational economy now primarily functions. This vast planetary infrastructure web is arguably now the main tool supporting firms and organisations of all sizes in the conduct of their business. This is especially the case with regard to the sectors of the 'new economy' which have developed in sync with the internet, but it can also be said to be the case for most business sectors which equally depend on high–quality fixed line and mobile voice, data and image communications.

INFORMATION AND COMMUNICATIONS TECHNOLOGY AND GLOBALISATION

Technological changes are largely responsible for the nature and extent of the economic globalisation of recent decades and its anchoring in certain metropolitan regions in particular. These changes took place in two steps. First, new, highly reliable forms of information technologies transformed the social and spatial organisation of information processing activities, which, in turn, have become more and more central to urban economies because economic production, distribution and management is increasingly dependent on knowledge generation, information exchange and information handling (and therefore on skilled informational labour). Second, the pivotal moment in many ways came though when multimedia convergence and digitalisation allowed information technologies to be linked to ever faster telecommunications to promote intensive global networking and exchange. Information could now not only be processed more rapidly but could also be sent around the world in a continuously shorter time frame. The means by which ICTs promoted both the overcoming of the distance between two places and the more rapid movement of flows of capital around the globe signified a new logic of 'time–space compression'.

Yet the spatial logics resulting from these transformations are not homogeneous. Information–intensive firms (for example in banking, insurance, business and legal services, central administration...) have been able to restructure and diversify their production systems and locational strategies according to the means and capacities of ICTs. The internal organisation of these firms has become more hierarchical, splintered and flexible or vertically disintegrated. Information technologies have promoted flexible production techniques, while technological convergence with communications networks has allowed greater intra–firm networking to keep operations coherent and efficient. Multinational companies create competitive advantage therefore by information exchange and

management across their structures. Nevertheless, the idea of totally footloose enterprises being able, via ICTs, to locate all their units anywhere is something of a myth. The decentralisation of some activities reinforces the need for a concentration of others, particularly tactical, coordinating or strategic activities which remain heavily dependent on advantages of agglomeration such as face–to–face interaction or co–presence, tacit knowledge and inter–firm synergies (which represent a more intensive, scarcer and valuable set of information inputs), e.g. in financial centres, technology clusters or industrial districts.

This geographical reorganisation of the operations of information–intensive firms has important consequences for urban and regional development. The most dominant metropolitan regions have reinforced their competitive advantages in terms of the traditional benefits of agglomeration and proximity. These cities (and indeed the main business districts within these cities) are reinforced as the sites of information production (most recently including that of the internet content market) and informational decision–making. They become the clearing houses for global information transactions. Crucially, it is the process of new technologies facilitating dispersal of some activities that allows the centralisation of other activities. Nevertheless, the global informational economy is not restricted to an elite handful of top–level cities. New technopoles have also emerged in smaller urban areas drawing on more particular assets such as the presence of higher education establishments or innovative enterprises (compared with Silicon Valley near San Jose in California, Sophia Antipolis in southern France or Adelaide's Multifunction Polis). Still other cities and regions have also been able to gain economically from the geographical division of labour in the information age by underlining their locational attractiveness for the decentralisation of other functions in the production process. This may involve a move either to smaller urban regions where operating and workforce costs are lower or to suburban areas of larger cities thus also privileging labour and market accessibility.

The global informational economy is thus founded on a network structure, or more precisely, on a structure of numerous interconnected networks. These techno–organisational networks might be specific to individual firms or individual sectors, or they might interlink multiple groups and organisations. They do tend, nevertheless, to share a common inter–urban logic, due to the location of economic actors primarily in cities.

THE DEPLOYMENT OF INTER-CITY INFORMATION INFRASTRUCTURE

Information is now principally transmitted and exchanged electronically, just as the physical materials and goods of the industrial age were long primarily distributed and traded via transport networks. As information production activities concentrate overwhelmingly in urban regions, the electronic circulation of information via the internet takes place to a large extent within and especially between these urban regions. Availability of ICT infrastructure has thus been seen by some writers to be as crucial for contemporary cities as the development of the railway was for industrial cities in the nineteenth century.

Whilst internet access can be achieved via a number of different technologies or technical networks (dial–up modem through the basic copper pair, cable, ISDN, DSL, satellite, and mobile), the backbones supporting this access are hundreds of deployed terrestrial and submarine fibre–optic cable networks. Wireless technologies are not excluded from this reliance on fibre backbones. Indeed, this reliance will augment substantially as wireless is used increasingly to transmit data communications. The majority of telecommunications traffic now flows over these fibre networks which are each capable of transferring the equivalent of several movies every second. Globally, more than 70% of traffic concerns internet communications, just over a quarter is private exchanges, with only 1% represented by traditional voice traffic. These 'fat pipes' thus serve the increasingly voluminous and bandwidth–intensive data communication needs of Internet Service Providers, technology companies and large corporations with widespread office locations. The concentration of this demand in cities has meant that operators have focused their network roll–out strategies in inter–urban meshes, stretching fibre across the sea bed between continents or along intercity rail lines. The presence of multiple networks offers firms direct access to the globally integrated networks and services of the biggest operators, offering higher quality and more secure infrastructure, and faster data communications. As a result, not only is the most bandwidth capacity present in and between major cities, but the most competition between providers is also there, resulting in lower prices and more tailored solutions. The internet can then be defined primarily as a global network of metropolitan nodes.

In this context, the ultimate goal of telecommunications providers is to be able to offer comparable, seamless end–to–end services to

their private and wholesale clients wherever they are located. In this strategy 'seamless' means that local urban spaces are totally assimilated into their global infrastructures. One of the results of this common strategy has been the deployment in some cities of numerous parallel networks covering the same major business and commercial areas. This was the outcome of the mid– to late–1990s period, when the hype about the internet and its revolutionary potential was at its highest and when many national telecommunications markets were opened up to competition. Dozens of telecommunications companies invested millions of dollars, obtained primarily from venture capital funds, in rolling out large–scale, cross–border fibre optic backbone networks. Companies sometimes collaborated on these deployments, particularly on expensive undersea cable laying, co–investing in a large capacity and mutually beneficial infrastructure between two or more strategic cities over which they could run their individual services. Terrestrial, intra–continental networks were more often constructed on an individual basis, creating many parallel direct connections between the major urban centres of Europe and North America. All this speculative infrastructure development was justified by the exponential growth in internet use and the near daily emergence of new innovative applications which were to require ever increasing amounts of bandwidth. Some companies made a business simply out of leasing fibre on their networks to other telecommunications companies.

By 2001 these cities and the connections between them had become the main action scene for innumerable competing networks to such an extent that there was a clear glut of fibre–optic capacity, which sent prices tumbling and forced smaller companies out of business. The dot.com crash brought infrastructural investment to a complete halt and drastically cut the number of active carriers and operators. The vast numbers of parallel networks remain, but the proportion of international bandwidth being used on some routes has tumbled to a very small percentage of total capacity, although this still represents an incalculable number of communications. In recent years, the market has come out of its slumber, rejuvenated by the explosion of broadband and renewed demand for high bandwidth, not just from businesses but also from the general popularity of downloading music and films and video share sites such as YouTube and Dailymotion. Telecommunications companies are, for example, currently concentrating infrastructure deployment between Asian cities and linking these cities to the rest of the world to meet demand

Figure 1
Largest global telecommunications voice routes

Source: TeleGeography Research, 2008 (www.telegeography.com)

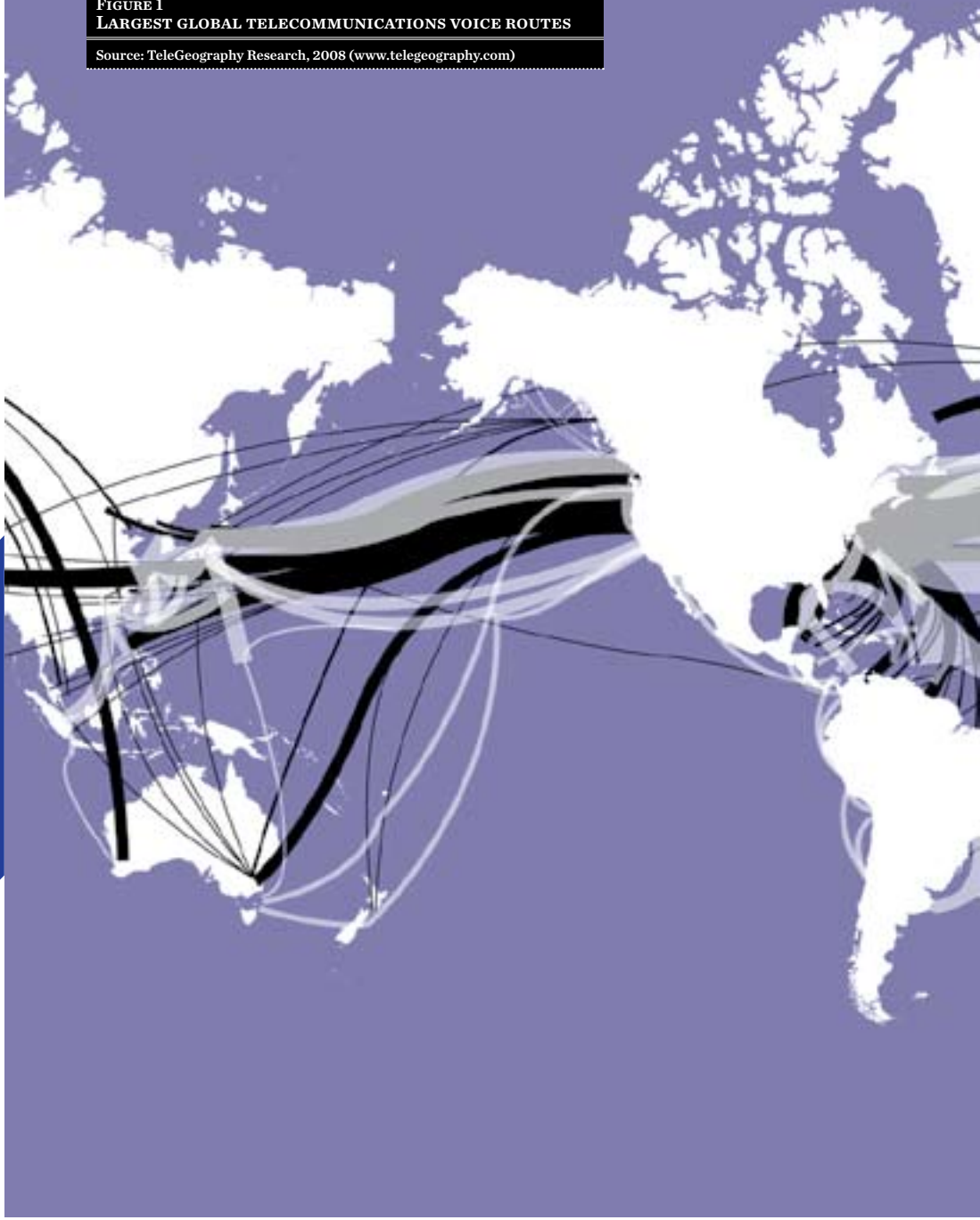


FIGURE 2
GLOBAL SUBMARINE FIBRE OPTIC CABLE CAPACITY

Source: TeleGeography Research, 2008 (www.telegeography.com)

from the fastest growing internet markets and from the intensive outsourcing of IT services.

Obtaining any kind of reliable data or detailed knowledge of the extent and coverage of information infrastructure is extremely complicated, particularly in such a competitive and fast–moving market. Furthermore, any data that can be obtained commonly cover only parts of the global infrastructure such as Europe or North America, so it is difficult to adopt a world perspective on the development of intercity ICT networks. In the absence of fully comparable data on global intercity virtual connectivity, we summarise here the main points that emanate from a network analysis of the topologies of backbone infrastructures to explore their geographical coverage and accessibility.

THE GEOGRAPHY OF INFORMATION INFRASTRUCTURE: NETWORK CORES, REGIONAL CAPITALS AND GATEWAY CITIES

On a global level, whether we are talking about voice traffic (figure 1) or fibre optic cable capacity (figure 2), it is clear that trans–Atlantic and trans–Pacific links dominate global virtual connectivity. In other words, looking at figure 2, the biggest demand for information infrastructure capacity occurs for links between New York and/or Washington and London on the one hand, and between Tokyo and west coast North American cities on the other hand. The capacities of links between cities in other regions of the world are relatively paltry by comparison with much smaller cables serving South America, Africa, the Middle East and Australia. For example, in 2007 the total internet capacity deployed between European and North American cities was almost forty times that deployed between European and African cities. This situation merely replicates to a large extent the geography of global business and finance. But it does not mean that smaller capacity links do not have importance within the larger architecture of global virtual connectivity. Any London or New York–based firm with an office or a plant in Sydney for example will obviously depend for their interoffice communications on the fibre optic cables linking Australia to North America and mainland Asia.

Beyond this first level of long–distance global submarine cables which permit inter–continental communications, terrestrial

information infrastructure has been deployed between cities on an intra–continental level. It also follows an economic logic of serving cities of high demand in the first instance and 'secondary' cities and regions only after this and to a lesser extent. On a European scale, for example, the largest number of networks and the inter–city links with the highest bandwidth capacity are focused on a highly concentrated zone roughly delimited by London, Paris, the German Ruhr and Hamburg. FIGURE 3 lists the 12 main inter–city bandwidth routes in Europe with the highest available capacity as of 2003. The major trend is a German dominance with no fewer than seven intra–German routes among the densest in Europe for bandwidth links. These inter–city connections tend to be short–haul routes as companies are keen to maximise bandwidth between important, fairly proximate city regions, rather than deploy it along longer routes at greater cost and risk of remaining under–used. In Australia, the intercity fibre optic network of Optus, the second largest Australian telecommunications provider, runs only from Perth to Brisbane via Adelaide, Melbourne,

FIGURE 3
THE TOP TEN EUROPEAN CITIES FOR BACKBONE LINKS TO OTHER CITIES

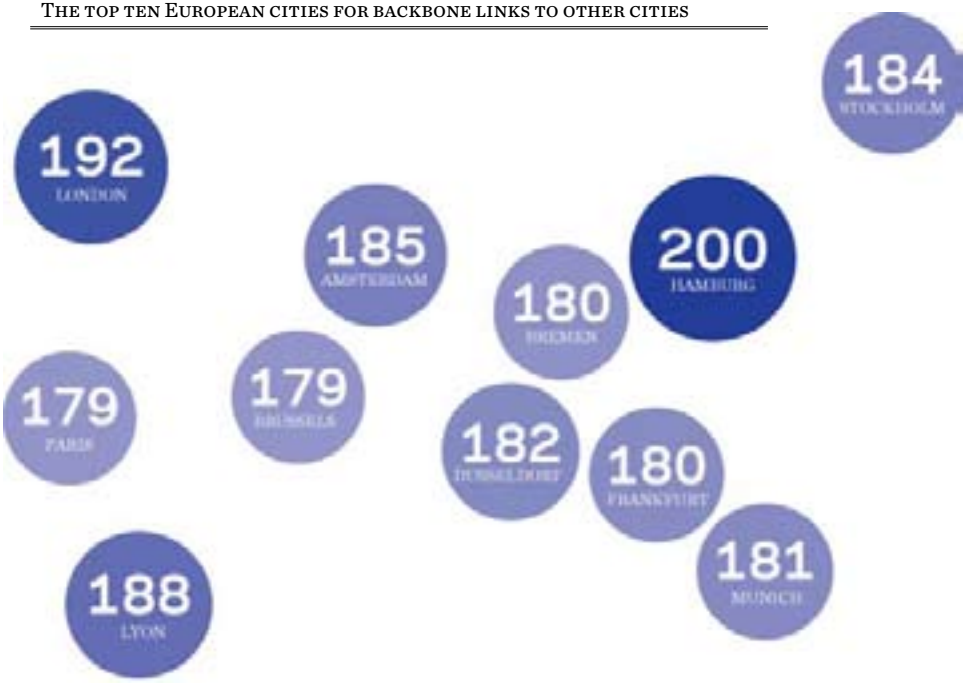
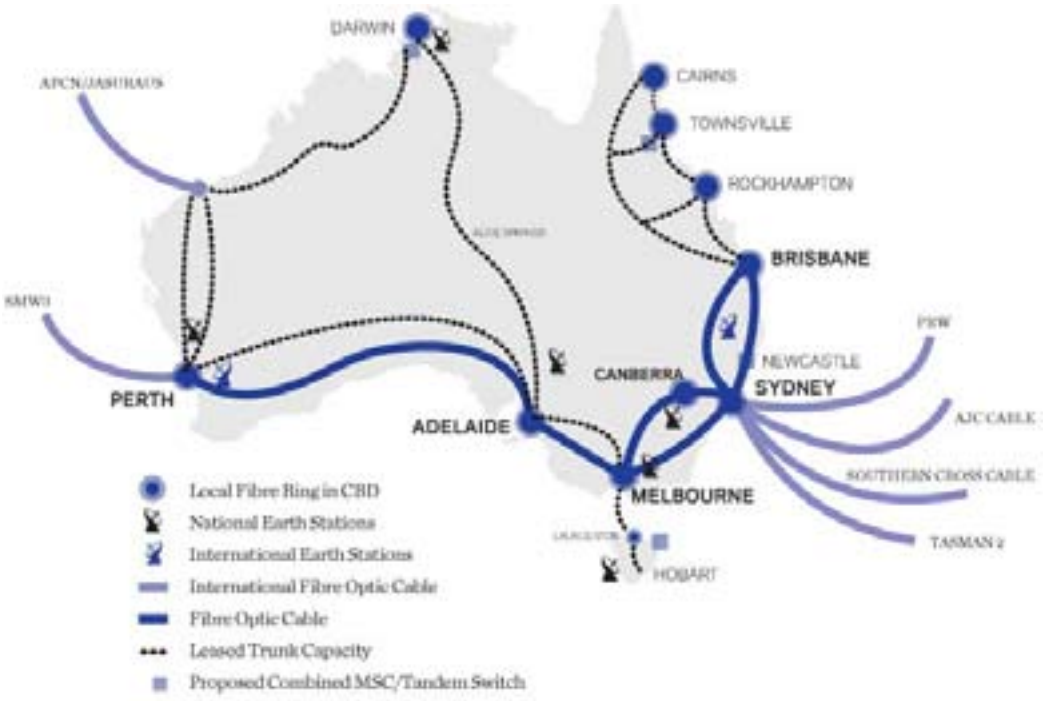


FIGURE 4
OPTUS INTER–CITY TELECOMMUNICATIONS NETWORK IN AUSTRALIA

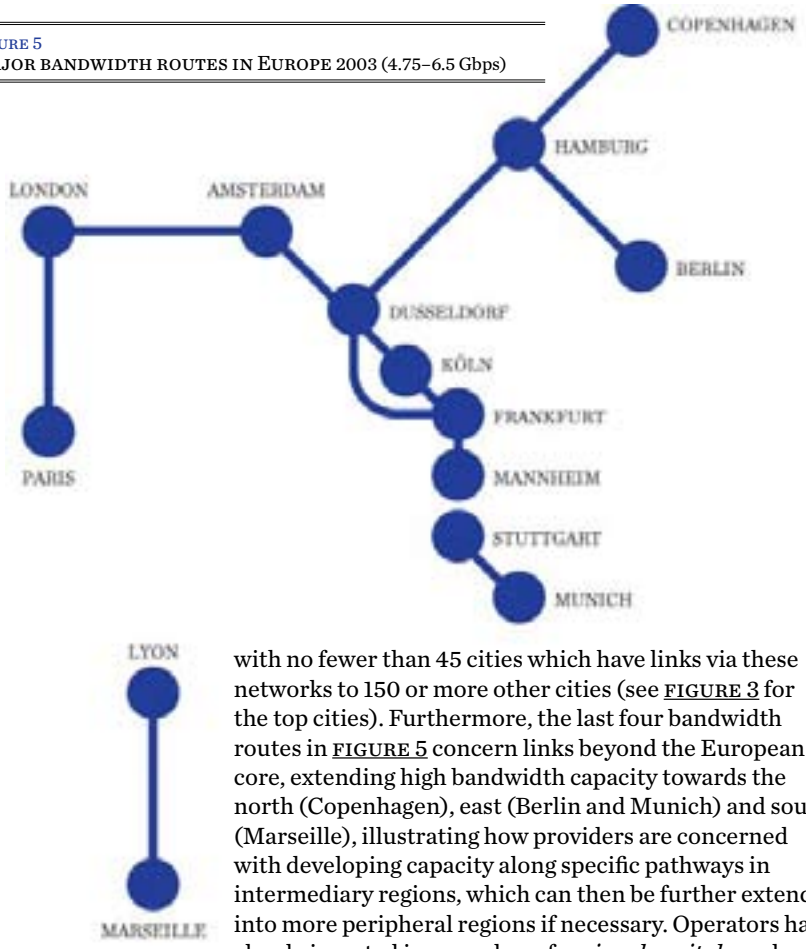
Source: Optus website, www.optus.com.au



Canberra and Sydney (FIGURE 4). Although Optus has leased capacity on links to other cities in the north and the interior, it has not rolled out its own network here. In short, the major southern Australian cities rank much higher than the likes of Darwin and Cairns in terms of virtual connectivity strategy.

Thus, the most important connections (in terms of bandwidth) are to be found between the major urban (and business) centres in each region. Again, however, more extensive links to other cities remain important for the development of the overall infrastructure. While there are spatial differences between European cities in backbone access, Internet infrastructure is nevertheless quite well distributed

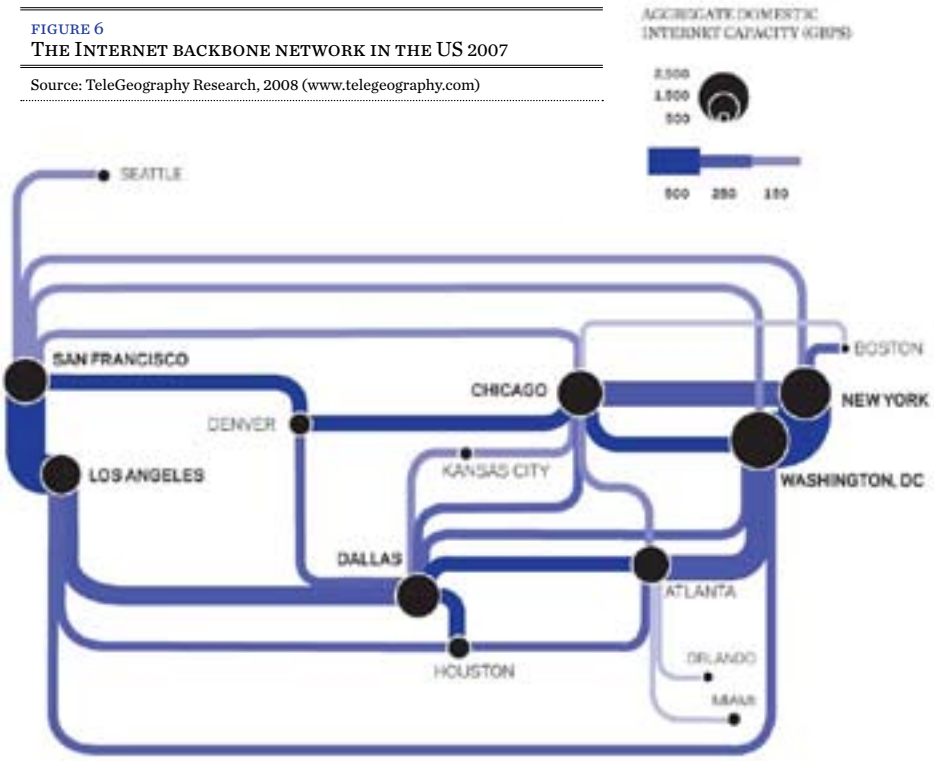
FIGURE 5
MAJOR BANDWIDTH ROUTES IN EUROPE 2003 (4.75–6.5 Gbps)



with no fewer than 45 cities which have links via these networks to 150 or more other cities (see FIGURE 3 for the top cities). Furthermore, the last four bandwidth routes in FIGURE 5 concern links beyond the European core, extending high bandwidth capacity towards the north (Copenhagen), east (Berlin and Munich) and south (Marseille), illustrating how providers are concerned with developing capacity along specific pathways in intermediary regions, which can then be further extended into more peripheral regions if necessary. Operators have clearly invested in a number of *regional capitals* such as Madrid, Stockholm and Vienna, which can be seen as the leading urban centres for telecommunications in part of the European territory. These and other cities (including Prague and Budapest) are clearly viewed as new or potential nodes capable of generating international traffic. Furthermore, there is an obvious role for some strategically located cities as *gateway cities* for high–bandwidth backbone connections, in the way in which they act as links between core areas of demand and more

FIGURE 6
THE INTERNET BACKBONE NETWORK IN THE US 2007

Source: TeleGeography Research, 2008 (www.telegeography.com)



peripheral areas (of emerging or future demand). This illustrates the way in which bandwidth concentrates at funnel points. Copenhagen does this for many of the pan–European networks which come from Germany and are destined for Scandinavia. Vienna and Prague have good network presence and quite large bandwidth connections because they act as gateways between the core area of western Europe and the relatively new telecommunications markets of eastern Europe. Similarly, in the US the importance of cities such as Atlanta and Dallas on backbone infrastructure is held to be related to their gateway geographies linking the economically vibrant cities of the west and east coasts (FIGURE 6).

Following the dot.com crash, however, cutbacks in investments and network deployments put a hold on any infrastructure extension

strategies into more peripheral areas. In 2003, only a handful of networks with relatively limited capacity extended to the European periphery for example. Having relatively limited accessibility to the high–bandwidth networks of Internet backbones, these areas suffer from the 'end of track' phenomenon identified for cities in Florida in similar US research. Other smaller cities or peripheral regions are subject to what has been termed a 'tunnel effect', meaning that they are literally bypassed by networks. Long distance information infrastructure deployed along motorways or high–speed rail lines might pass through regions, but without connecting nodes, because they have been customised to link two particular cities and not the places in between—for example, transatlantic networks being run from the USA into London do not connect cities in the south of Wales or western England. In the US, there are numerous networks connecting the west and east coasts, but few if any of these pass directly through the smaller cities of middle and Midwestern America. In this way, they are more like high speed trains or airline networks in terms of their network configurations than roads.

When discussing the state of information infrastructure, another factor to be taken into account along with actual network presence and availability is the amount of bandwidth which those networks have on them. Bandwidth refers to the amount of data that can be moved on the network at any one time and is measured in terms of bits per second. It is a similar measure for communications to the number of lanes on a highway/motorway for transport. Digital information moves quicker and more freely the higher the bandwidth between two cities. This means that distance is often subordinated to the amount of bandwidth between places in the routing of Internet traffic. Before the construction of high bandwidth backbone networks in Europe, for example, it was not uncommon for Internet traffic between two European cities to pass via New York, because it was quicker and / or cheaper to do so.

Bandwidth distribution is more concentrated in major cities than network connections. Links to and from London alone account for nearly 5% of the total bandwidth in Europe, while the top five cities in bandwidth connections accumulate over one fifth of European bandwidth, and the top ten cities over one third. When compared to similar studies for the US, however, it is clear that the top European cities do not concentrate nearly as much total bandwidth as do the top US cities. FIGURE 3 showed that major bandwidth routes concerned quite a large group of cities in Europe, whereas in FIGURE 6 the 'fattest'

pipes are located on the New York–Washington and San Francisco–Los Angeles links. The domestic capacities of Chicago and Dallas are constituted by the amalgam of a number of relatively 'thin' links to other cities. The European Internet infrastructure appears therefore to be founded on a larger group of 12 to 15 cities than the six or seven regularly cited for the United States (New York, Washington, Chicago, Atlanta, Dallas, San Francisco, Los Angeles: compare FIGURE 6). This is partly the result of the continuing importance of national territories in the European telecommunications market. Market liberalisation in Europe may have removed some of the boundaries to competitive and trans–national network and service provision, but the particular institutional and political structures, regulatory practices, geographies and socio–economic environments of individual countries remain very much in place. Even the deployment of long–distance, trans–national internet backbone networks between the 'world cities' of Europe is affected by national contexts. For a company to deploy a network point of presence in a European city, in order to serve its clients located there, all these intertwined factors must be taken into account (and in varying ways and extents in different cities). In the rapidly developing information infrastructure market of the Asia Pacific region, these factors will also be important in shaping network developments and in offering strategic, enabling or regulatory roles for local, municipal and national authorities.

OPPORTUNITIES AND CHALLENGES: CONTRIBUTING TO MULTI-LEVEL *RELATIONAL* URBAN POLICY

The availability of high bandwidth, low cost and multi–choice telecommunications services is of considerable importance to the economic development of cities and regions across the globe. It is unlikely that a city or region without access to this infrastructure would be able to attract substantial economic investment, because major companies are unlikely to locate there. Given this, it is rather paradoxical that local, urban and regional authorities have, in theory, relatively little effective leverage with which to shape their own infrastructures. In the context of today's liberalised markets, the bulk of the world's information infrastructure has been deployed by private telecommunications operators. The sheer cost and state–of–the–art technical knowledge required to build and maintain such networks has taken this activity beyond the realm of the public sector. Furthermore, on a more pragmatic level, developing a policy agenda and allocating public resources for something which cannot always be seen and which does not appear to have a significant 'impact' on the urban landscape can be problematic. With networks tucked away underground, some authorities even have problems just to know what infrastructure is deployed on their territories. One major challenge for urban policy makers in this context is thus to merely forge for themselves an influential role in the development of ICTs in their cities.

This type of challenge does not mean, however, that urban policy and planning should (or even can) ignore the ICT domain. Indeed, in a context in which the functional limits of cities are becoming more and more blurred, ICT–related challenges can be viewed as contributing to what might be termed as a more relational urban policy. The issues or stakes can be outlined on two intertwined levels.

On a first level, there are relational urban policy challenges or opportunities on an 'intra' urban level. The rapid uptake of broadband by households as well as business, for example, has succeeded in bringing ICTs back into the public authority realm as concern for ensuring universal availability and overcoming digital divides becomes widespread. Part of the challenge here lies in the necessity for both public and private actors to be pulling in the same direction within an overall territorial strategy. There may, for example, be potential conflicts between an ICT policy based on cohesion objectives and operator strategies based on short–term demonstrable profitability. Similarly, any municipal policy must be coherent for

a variety of users. The ICT needs of large businesses are entirely different from those of ordinary households. The overall goals of an ICT policy oriented towards economic development might therefore conflict with those of a digital divide or social cohesion policy.

On a second level, there are challenges or opportunities for developing a more relational urban policy in terms of inter–city connections. Arguably the most important point to make here is that cities are not all aiming for the same levels or types of virtual connection. There is not one exportable (or desirable) information city model that can be developed the world over. Information infrastructure development should not be considered as a zero–sum game of inter–city competition in which cities are always aiming to leapfrog their neighbours in an urban information hierarchy. If it were, then it would be highly ironic for urban economic development and competitiveness to be dependent on a city having multiple links with its 'competitors'. Indeed, by focusing specifically on *inter–city* ICT connections, we highlight that the development of networks is very much dependent on 'club effects' whereby each city benefits from the connection of other cities to the networks. If anything, this logic points towards the potential for more collaborative than competitive forms of urban economic development. Mutual connection to these networks creates or reinforces *interdependencies* between cities. What has changed in the global age is that where once the most important interdependencies were formed between geographically contiguous places, now these interdependencies develop as much between places which are located far from one another. Importantly, this focus on collaboration and interdependencies can open up room for manoeuvre for local and municipal authorities to avoid bowing excessively to the dominant liberal logic of the informational economy. It is the ICT firms who compete with each other for new and existing urban markets across the global scale. In contrast, policymakers in these urban markets have the opportunity to influence and steer this competition for the social and economic benefit of their cities (and, indirectly, others). Many cities can draw benefit from their location (e.g. as gateways to other regions) or from the specific make–up of companies, industries and services present. In other words, configuring virtual connectivity is highly related to the wider factors supporting agglomeration and economic development in each city.

The implications of virtual connectivity for cities overlap heavily with those for world city network connectivity. This is not that surprising for two reasons. First, in methodological terms, the 'potential working flows' which make up the connections between service company offices measured by the latter take place most intensely via ICT networks. Second, more concretely, both connectivities rest essentially on the locational strategies of private companies, and the advanced producer service companies behind world city network connectivity happen to be some of the major customers of telecommunications companies.

THE OUTCOME OF THE UNEVEN GLOBAL GEOGRAPHY OF WORLD CITY NETWORK CONNECTIVITY IS INEVITABLY AN UNEVEN GLOBAL GEOGRAPHY OF VIRTUAL CONNECTIVITY

CONCLUSION:

The latter will therefore deploy their networks and ICT services in cities with market demand to which a heavy density of producer service companies (and their corporate clients) evidently contributes. Nevertheless, the outcome of the uneven global geography of world city network connectivity is inevitably an uneven global geography of virtual connectivity as telecommunications companies deploy an information infrastructure that replicates to a large extent inter–city office connections.

Having said this, the meaning of virtual connectivity differs somewhat from that of world city network connectivity. If the world city network offers 'an organisational framework for economic globalisation', then ICT networks can be viewed as the driving fuel for this organisation and for globalisation as a whole. It is primarily over these networks that economic globalisation is shaped and organised through the exchange and circulation of information, knowledge, capital, digital goods, etc. Virtual connection between cities *supports* the flows of globalisation, but also *structures* them by defining at least to some extent where, how and in what form information, knowledge, capital, digital goods, etc. are communicated between cities. In an ideal world, it would be these actual communications flows that would be predominantly analysed to map the relations between cities in globalisation.

Finally, the stakes of this information infrastructure development offer a challenge or opportunity for policy–makers to adapt or reconfigure their own notions and practices of territorial planning and development, as well as perhaps of those to whom they are accountable. ICT–related policies are difficult to place within both set and bounded policy domains and delimited administrative territories, as their inherently relational nature makes them relevant to multiple disciplines and fields of territorial management. For municipal authorities more traditionally used to intervention in transport and land use planning, this may be difficult (and straining on often tight resources). Information infrastructure planning requires different knowledge and arguably an even broader understanding of how networks and territories can be shaped together in urban development which now takes in global as well as local scales.

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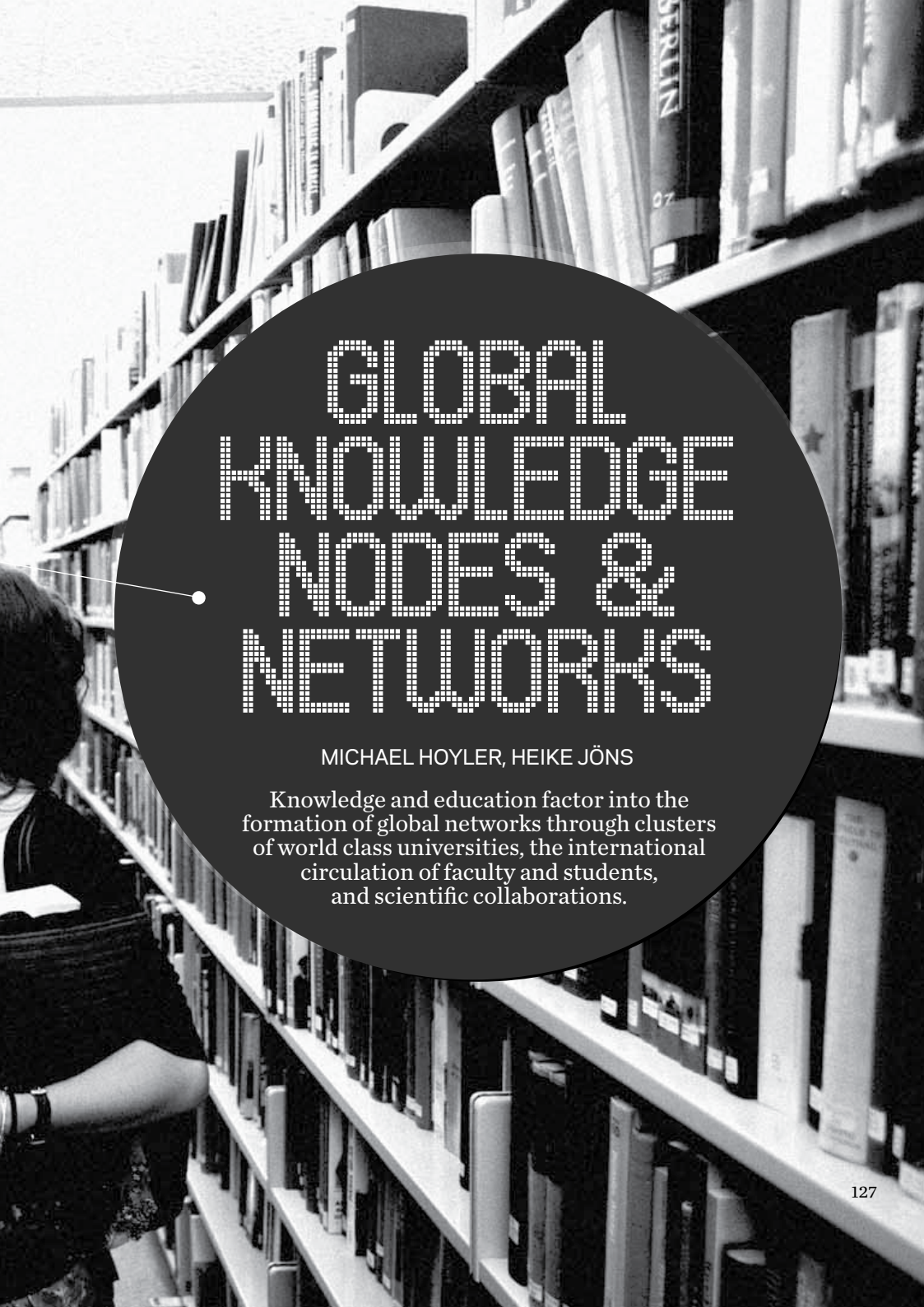


GLOBAL KNOWLEDGE NODES & NETWORKS

MICHAEL HOYLER, HEIKE JÖNS

Knowledge and education factor into the formation of global networks through clusters of world class universities, the international circulation of faculty and students, and scientific collaborations.

KNOWLEDGE AND EDUCATION ARE widely viewed as crucial resources in a globally operating economy. Cities and institutions, national governments and supranational organisations are all keen to attract innovative companies, promising students and competent researchers in order to position themselves favourably as 'knowledge hubs' within the global flows of professional expertise and learning. Higher education and research play a significant part in this process, as universities are not only seats of scientific and scholarly innovation but also educate future decision makers in business, public service and politics.

DEMAND FOR AUSTRALIAN HIGHER EDUCATION WILL INCREASE MORE THAN NINEFOLD FROM 2000 TO 2025, TO ABOUT ONE MILLION STUDENTS

In the past two decades, the globalisation agenda has led many governments and institutions of higher education to develop explicit strategies of 'internationalisation' as means of strengthening their (national or institutional) position as globally competitive knowledge nodes. These strategies include international research collaborations, the internationalisation of the curriculum, international student and staff exchanges, attracting promising young scholars and international star scientists, and forming international research and teaching consortia with institutions of similar disciplinary orientation and reputation. More recently, a number of universities have established branch campuses abroad to deliver offshore education in emerging centres of the global economy such as China and the Arab city states. Studies by IDP Education Australia suggest that the demand for Australian higher education will increase more than ninefold from 2000 to 2025, to about one million students. International onshore higher education in Australia is predicted to account for slightly more than half of this total demand, while the other 44% will be provided through offshore campuses and distance education.

In this chapter, we examine recent trends in the formation of global knowledge nodes and networks within higher education and research by focusing on three dimensions: first, institutional nodes as identified by world university rankings; second, the circulation of students and faculty; and, third, international collaboration in the natural and technical sciences. The analysis highlights the concentrated nature of higher education and research, whose leading centres are clustered within a relatively small number of countries in the richest regions of the world. We currently witness a process of dynamic restructuring in the global landscape of higher education and research that leads to the formation of new central nodes, and shapes flows of students and faculty as much as collaborative linkages across the world.

WORLD CLASS UNIVERSITIES

'World class universities' can be regarded as central nodes in global knowledge networks. They are usually defined as institutions that excel in research and teaching and enrich the cultural, intellectual and public life of the wider society. Identifying 'world class universities' is not straightforward, as most institutions of higher education contribute, often in highly specialised ways, to the creation of new knowledge, and many aspire to the 'world class' label. Since 2003, several attempts have been made to identify world class universities in annually published world university league tables that are based on a range of specific performance indicators. Drawing the attention to the most successful universities in the world (in terms of the indicators measured), these rankings have captured the attention and ambition of university managers, academics, employers, policy makers and the wider public. Universities that do well in these rankings advertise their positions in press releases and on their websites, while other universities adjust their strategic plans in order to join the club of world class universities in the future. Despite a variety of criticisms on the selection and weighting of the underlying ranking criteria, global university rankings provide important insights into the geographies of global higher education and research.

Mapping the locations of the Top 500 universities in the Shanghai Ranking for 2006 reveals striking global disparities between the Global North and the Global South. There are four major regional clusters of world class universities in North America, Europe, East Asia and Australia, and two minor regional clusters in South America and South Africa. Large parts of South America and Africa are without any university that scores on the main performance indicators as defined above, thus reflecting the well–known deep–seated asymmetries in the global economy.

Examining the locations of the Top 100 universities in comparison to the four subsequent tiers of 100 institutions, these global disparities become even more evident. There is no Top 100 university

in South America and Africa and also none in continental Asia. Within North America, clusters of Top 100 world universities concentrate in the northeast, the middle west and the south west, while the locations of world class universities in Europe are characterised by a centre–periphery structure. The Top 100 universities cluster in the south of England, in and around Paris, in southwest Germany and in northern Switzerland, while Spain, the south of Italy and east central Europe accommodate universities mainly ranked between 300 and 400.

Out of the 25 top ranked institutions, nineteen are located within the USA, four in the UK and two in Japan (FIGURE 1). The Top 500 universities in the world are located within 375 cities. Forty–five of these cities accommodate two institutions ranked in the Top 500 universities, 11 cities host three and 10 are home to four or more world class universities. Most of these institutions are located in Paris, Tokyo, London and New York, which corresponds well with the first tier of global cities as the command centres of the global economy (FIGURE 2). Hong Kong and Seoul are important intellectual nodes in Asia; Houston, Boston/Cambridge and Philadelphia are also significant agglomerations

How the Shanghai Ranking is made

Academic Ranking of World Universities, compiled by Shanghai Jiao Tong University since 2003, publishes a list of the Top 500 out of around 8,000 universities world–wide. The ranking is based on six indicators that aim to measure an institution's quality of research and education. In order to determine a university's ranking position, these indicators are added according to the following weights:

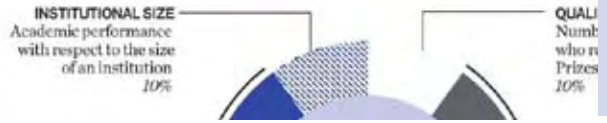


FIGURE 1

TOP 25 INSTITUTIONS IN THE SHANGHAI RANKING 2007

Source: Academic Ranking of World Universities 2006, Shanghai Jiao Tong University www.arwu.org

19 OF TOP 25 UNIVERSITIES ARE IN THE USA


No.19
TOKYO
UNIVERSITY
46.2%
No.17
UNIVERSITY OF
WASHINGTON
48.5%
No.18
UCFC
47.7%
No.4
BERKLEY
72.1%
No.6
CALTEC
66%
21
19
18
17
3
4
6

FIGURE 2
TOP 10 CITIES IN THE SHANGHAI RANKING 2006

Source: Academic Ranking of World Universities 2006, Shanghai Jiao Tong University www.arwu.org/

of world class universities in the USA, while Stockholm stands out as the third ranked urban centre of world class university clusters in Europe.

As the leading world class universities are closely associated with the most important business hubs in the world, it can be assumed that shifts in global economic power are mirrored in changes in the geographies of higher education and research. Accordingly, the growth of the Chinese economy goes hand–in–hand with the aspiration of Chinese universities to perform as well as the leading US research universities. In this context, it seems to be no accident that the first ranking of world universities was published by Shanghai Jia Tong University, as the global perspective helps Chinese universities to position themselves in relation to their global competitors and to identify areas in which academic performance could be improved.

An alternative world university ranking published by the Times Higher Education Supplement since 2004 (in the following: Times Higher Ranking) includes a peer review score that is based on annual surveys among academics. The latter are asked to rank the most prestigious universities in their region, which results in relatively high scores of universities across the world. The highest scoring institution was assigned a score of 100, while the score of all other institutions are

expressed as percentage of the top score. In China, Beijing University received by far the highest score (70%), followed by Tsing Hua University, Fudan University, China University of Science & Technology, Nanjing University and Shanghai Jiao Tong University, which received peer review scores between 45% and 31%. Beijing University is ranked second in the wider region together with the National University of Singapore and only topped by Tokyo University (72%).

In comparison with current citation practices, however, there is a considerable gap between the peer review and the citations per faculty scores in all universities of South East and East Asia (FIGURE 3). While the scientific performance at these universities is highly valued within the wider region, scientific articles produced in Japanese, Chinese and Singaporean universities are not as frequently cited internationally as work produced in American and European universities. This may

WORLD CLASS UNIVERSITIES ARE CLOSELY ASSOCIATED WITH THE MOST IMPORTANT BUSINESS HUBS IN THE WORLD

FIGURE 3
COMPARISON OF REPUTATION AND CITATIONS
Per Faculty Scores in Selected Universities in the Times Higher Ranking 2006

Source: Times Higher World University Rankings 2006, QS Quacquarelli Symonds Ltd. www.timeshighereducation.co.uk

2006 RANK	INSTITUTION	COUNTRY	PEER REVIEW SCORE	CITATIONS PER FACULTY SCORE
1	HARVARD UNIVERSITY	USA	93	39
8	UNIVERSITY OF CALIFORNIA, BERKELEY	USA	92	39
6	STANFORD UNIVERSITY	USA	82	55
14	BEIJING UNIVERSITY	CHINA	70	2
28	TSING HUA UNIVERSITY	CHINA	45	1
116	FUDAN UNIVERSITY	CHINA	39	2
16	AUSTRALIAN NATIONAL UNIVERSITY	AUSTRALIA	72	13
22	UNIVERSITY OF MELBOURNE	AUSTRALIA	72	7
35	UNIVERSITY OF SYDNEY	AUSTRALIA	65	8
19	NATIONAL UNIVERSITY OF SINGAPORE	SINGAPORE	70	8
61	NANYANG TECHNOLOGICAL UNIVERSITY	SINGAPORE	40	3

partly result from the type of measurement that uses citation data as recorded in Thomson's *Essential Science Database* but can also be attributed to different degrees of integration into the scientific citation circuits. However, as a similar gap can also be observed in Australian universities, it can be argued that the discrepancy between a high peer review score and a modest citations per faculty score in Chinese, Singaporean and Australian universities reveals their status as emerging world class universities in the sense that the citation rates are beginning to catch up with a growing reputation of these universities.

This argument is supported by a comparison of the scores for published scientific articles with those for highly cited researchers in the Top 500 universities of the Shanghai Ranking 2006: highly cited researchers are concentrated in a much smaller number of universities, as it takes time to build up the expertise and reputation to become a highly cited researcher. The discrepancy between scores is highest in the emerging Chinese world class universities, where academics have started to publish frequently in indexed journals but not many have yet emerged as highly cited scientific stars.

The analysis of 'world class universities' thus reveals the geographically uneven distribution and regional clustering of elite

knowledge nodes across the world and reflects long–term historical patterns in the establishment of the modern research university. The extent to which contemporary global higher education and research is characterised by changing power–geometries between the large and well–known universities in North America and Europe and the emerging world class universities in Asia will be further examined in the next section.

CIRCULATION OF STUDENTS AND FACULTY

In the second half of the 20th century, the USA was widely regarded as the world's largest magnet for highly skilled professionals. Up until today, the country attracts the highest number of international students in the world (590,167 in 2005) with a market share of 21.6%. Followed by the UK (318,399; 11.7%), Germany (259,797; 9.5%) and France (236,518; 8.7%), these four leading destination countries attract more than 50% of all international students. With India and China not included in these OECD figures, the countries that have raised their market share of international students considerably since 2000 are Australia, New Zealand, Canada, France, Russia and Japan, thus indicating a wider shift of student flows towards the Asia–Pacific region.

An analysis of the origin of these international students clearly reveals China's and India's growing importance in international academic exchange (FIGURE 4). Both countries provide the highest number of international students in the USA and the UK, while China also heads the ranking of sending countries in Germany and Australia. Apart from the increasing predominance of China and India, the geographies of sending countries in the six most important destination countries for international students are shaped by political, socio–economic, geographical and postcolonial relations. In the USA, most international students come from Asia and North America. In the UK, all ten most important sending countries are located in Asia, comprising mostly former British colonies, while France receives international students mostly from former French colonies in North Africa. After Morocco and Algeria, China is the third most important sending country for international students

INTERNATIONAL STUDENTS

17%
AUSTRALIA

3%
UNITED STATES

FIGURE 4

Top 10 sending places of origin & percentage of total international student enrolment

For top host destinations

Source: Institute of International Education (IIE), Atlas of Student Mobility, www.atlas.iienetwork.org

USA (2007)	
INDIA	14.4%
CHINA	11.6%
STH KOREA	10.7%
JAPAN	6.1%
TAIWAN	5.0%
CANADA	4.9%
MEXICO	2.4%
TURKEY	2.0%
THAILAND	1.5%
GERMANY	1.5%

UK (2007)	
CHINA	27.0%
INDIA	14.2%
MALAYSIA	8.8%
HONG KONG	5.9%
INDONESIA	5.1%
SINGAPORE	4.7%
STH KOREA	3.3%
THAILAND	2.8%
TAIWAN	2.2%
JAPAN	2.0%

GERMANY (2006)	
CHINA	11.0%
TURKEY	9.0%
POLAND	6.1%
BULGARIA	5.2%
RUSSIA	4.8%
UKRAINE	3.5%
MOROCCO	3.3%
ITALY	2.7%
FRANCE	2.4%
AUSTRIA	2.4%

FRANCE (2004)	
MOROCCO	13.8%
ALGERIA	9.4%
CHINA	4.8%
TUNISIA	4.1%
SENEGAL	3.5%
GERMANY	2.8%
CAMEROON	2.1%
ITALY	2.0%
LEBANON	2.0%
ROMANIA	1.9%

AUSTRALIA (2006)	
CHINA	13.3%
INDIA	6.4%
USA	5.9%
GERMANY	4.6%
FRANCE	4.5%
IRELAND	4.3%
GREECE	4.3%
MALAYSIA	3.2%
NIGERIA	3.0%
HONG KONG	2.6%

CHINA (2006)	
STH KOREA	30.7%
JAPAN	11.3%
USA	7.2%
VIETNAM	4.5%
INDONESIA	3.5%
INDIA	3.5%
THAILAND	3.4%
RUSSIA	3.1%
FRANCE	2.4%
PAKISTAN	2.0%

in France, and the European countries Germany, Italy and Romania are also included in the Top 10 sending countries. A more distinct European profile of international students can be found in Germany, where China is followed by Turkey (including second generation immigrants), a number of eastern European countries and the European neighbours Italy, France and Austria. China's international students mainly come from Asia and the United States, while Australia displays the most international profile with sending countries from Asia, North America, Europe and Africa among the Top 10.

Compared to the size of the total student body, Australia and New Zealand also have the highest shares of international students, followed by the European countries UK, Switzerland, Austria and France (FIGURE 5). Australia's share of international students of 17.3% compares to a much lower 3.4% of international students in the USA. Within the Top 200 world class universities as defined by the Times Higher Ranking 2006, 11 of 12 Australian universities are among the 50 most international institutions. The most international student body, however, is to be found at the London School of Economics, followed by the School of Oriental and African Studies (London), Curtin University of Technology (Perth), Ecole Polytechnique Fédérale de Lausanne, RMIT University (Melbourne), University of Wollongong (Wollongong, Australia), Cranfield University (Cranfield, UK), Geneva University, Imperial College London and Nanyang Technological University (Singapore) (FIGURE 3). The most international world class university in the USA is CALTECH in Los Angeles on rank 24. Most US universities have rather low international student scores and are dominated by high numbers of domestic students.

FIGURE 5
PERCENTAGE OF INTERNATIONAL STUDENTS ENROLLED IN TERTIARY EDUCATION
OECD countries, 2005

Source: OECD, Education at a Glance 2007, Table C3.1., www.oecd.org/edu/eag2007
Note: Missing data for Canada, Czech Republic, Germany, Iceland, Italy, Korea, Luxembourg, Mexico, Poland, Portugal, Turkey.

TABLE 4: PERCENTAGE OF
IN TERTIARY EDUCATION

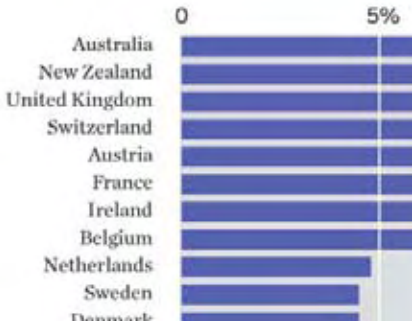


FIGURE 6
Top 10 Institutions of International Students in the Times Higher Ranking 2006

Source: Times Higher World University Rankings 2006, QS Quacquarelli Symonds Ltd. www.timeshighereducation.co.uk

2006 RANK	INSTITUTION	COUNTRY
1	LONDON SCHOOL OF ECONOMICS	UK
2	SCHOOL OF ORIENTAL AND AFRICAN STUDIES	UK
3	CURTIN UNIVERSITY OF TECHNOLOGY	AUSTRALIA
4	ECOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE	SWITZERLAND
5	RMIT UNIVERSITY	AUSTRALIA
6	UNIVERSITY OF WOLLONGONG	AUSTRALIA
7	CRANFIELD UNIVERSITY	UK
8	GENEVA UNIVERSITY	SWITZERLAND
9	IMPERIAL COLLEGE LONDON	UK
10	NANYANG TECHNOLOGICAL UNIVERSITY	SINGAPORE

International students are potential future academics and professionals. Whether they stay in the destination country of their studies, return to their country of origin or move to a third country, they are likely to establish transnational linkages and act as multipliers of international relations in their subsequent careers. A high share of international students thus indicates dynamic processes with potential future significance for the economy and wider society, particularly under conditions of contemporary globalisation. The high shares of international students in Australia, Singapore and Europe can thus be evaluated as a positive sign of internationalisation that also contributes to providing an international experience 'at home' for domestic students in these places. Equally important for establishing international linkages are the Chinese and Indian students that go to North America, Europe and Australia to study in one of the global centres of higher education and research. As many of these international students later return to their home countries to start academic and professional careers, they may in the long–term contribute to making their universities and companies more central players in the world economy.

For the USA, for example, Michael Finn shows in a study of stay rates of foreign doctorate recipients that 68% of those who received science and engineering doctorates in 2000 were still in the USA in 2005. Studies by AnnaLee Saxenian on Chinese and Indian–born engineers working in Silicon Valley reveal the complex transnational linkages of foreign–born highly skilled professionals who were educated in the USA. She argues convincingly that these individuals contribute to the development of information technology industries in their home countries by building entrepreneurial networks between firms in Silicon Valley and those in emerging technology regions across the world. Comparing data on Australia, Canada, the UK and the USA for 2002, the number of international students, who potentially provide such positive effects in their future careers, was highest in the metropolitan areas of New York and London as the leading global cities, followed by Los Angeles, Melbourne, Sydney, San Francisco, Boston, Washington, Chicago and Brisbane (FIGURE 7). Based on these and previous findings, it can be argued that international students reinforce the central status of global cities but also contribute to the formation of new central nodes in the world economy.

Another important strategy of internationalisation in higher education has long been the transnational exchange of faculty, whether this relates to temporary stays of less than one or two years, or to more permanent arrangements. Both visiting academics and foreign–born and/or foreign–educated academics with permanent posts provide international views and experiences to the majority of students that do not themselves study abroad. Some of the emerging world class universities in Asia and Australia stand out by their recruitment of international faculty, which is sometimes but not always related to their large number of international students as an important staffing source (FIGURE 8). According to the Times Higher Ranking 2006, the ten most international universities in terms of the percentage of international faculty are Macquarie

INTERNATIONAL STUDENTS REINFORCE THE CENTRAL STATUS OF GLOBAL CITIES BUT ALSO CONTRIBUTE TO THE FORMATION OF NEW CENTRAL NODES IN THE WORLD ECONOMY

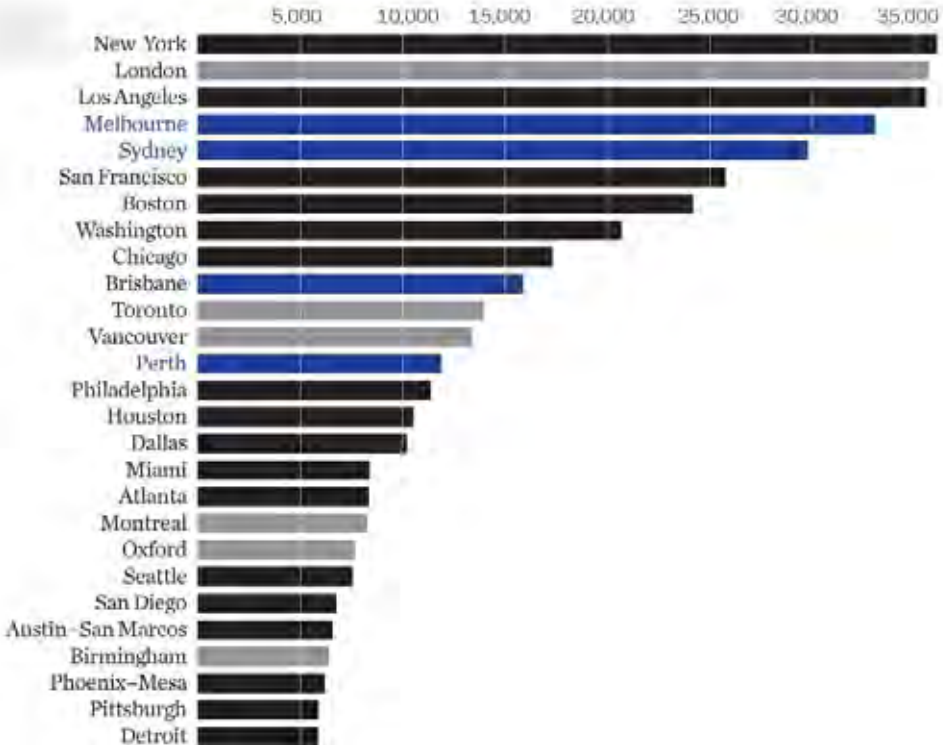


FIGURE 7
INTERNATIONAL STUDENTS IN METROPOLITAN AREAS
In Australia, Canada, UK and USA, 2002

Source: K. O'Connor (2005) International Students and Global Cities, GaWC Research Bulletin 161, www.lboro.ac.uk/gawc/rb/rb161.html

University (Sydney), Otago University (Dunedin), London School of Economics, ETH Zurich, University of Hong Kong, National University of Singapore, Nanyang Technological University (Singapore), Basel University, City University of Hong Kong and Hong Kong University of Science & Technology (FIGURE 8).

The recruitment of international faculty also helps to raise the global visibility of universities in terms of research performance indicators and international research collaborations as international scientists and scholars bring their academic expertise and contacts to the new institutions. The recruitment of international faculty has therefore been identified by several younger academic institutions as an important strategy for raising their position in world university

FIGURE 8
Top10 Institutions of International Faculty in the Times Higher Ranking 2006

Source: Times Higher World University Rankings 2006, QS Quacquarelli Symonds Ltd. www.timeshighereducation.co.uk

2006 RANK	INSTITUTION	COUNTRY
1	MACQUARIE UNIVERSITY	AUSTRALIA
2	OTAGO UNIVERSITY	NEW ZEALAND
3	LONDON SCHOOL OF ECONOMICS	UK
4	ETH ZURICH	SWITZERLAND
5	UNIVERSITY OF HONG KONG	HONG KONG
6	NATIONAL UNIVERSITY OF SINGAPORE	SINGAPORE
7	NANYANG TECHNOLOGICAL UNIVERSITY	SINGAPORE
8	BASEL UNIVERSITY	SWITZERLAND
9	CITY UNIVERSITY OF HONG KONG	HONG KONG
10	HONG KONG UNIVERSITY OF SCIENCE & TECHNOLOGY	HONG KONG

rankings that are dominated by the established universities in North America and Europe. Universities UK, the representation of the executive heads of all UK universities and some colleges of higher education, even speaks of 'Talent Wars' in their study on the international market for academic staff conducted in 2007. This policy briefing reveals that non–UK nationals accounted for 19.1% of all academic staff at UK universities in 2005–06; among the newly appointed staff this figure rose to 27%. Graduates represent one of the main sources for newly appointed academic staff (34%; other sectors UK: 42%; employed abroad: 21%), which highlights the significance of international students for the reproduction of academic staff in British higher education and research.

The reasons for a growing share of international faculty in Britain are manifold. Academic migrants are attracted by the academic reputation of UK universities, a favourable working environment, and long–term career prospects based on tenure–track positions. From the perspective of British higher education and research, international recruitment contributes to a globally competitive position based on high–quality staff but is also important for maintaining the current staff/student ratio as many UK graduates prefer financially more attractive positions outside the university system. British higher education and research is also influenced

by demographic change, although the consequences of the aging of faculty are less pressing than in the USA and Canada. In addition, the Labour government aims to raise the share of university students to 50% of the 18 to 30–year–olds by 2010. As the number of international students worldwide has been estimated to increase threefold from 2004 to 2025, the growing number of university students in Britain (and elsewhere) will not only require the filling of vacant academic posts but also the creation of new positions.

Sydney has the 5th highest number of international students

The geographies of international recruitment of faculty at British universities are shaped by strong linkages within Europe and the Commonwealth and with the USA. The most important countries of origin for international academic staff in the UK are Germany, Ireland, the USA, China, Italy, France, Greece, India, Australia and Spain (FIGURE 9). The majority of these academics are at an early stage of their career, and their shares vary significantly between different subjects (FIGURE 10). The highest share of international academic staff can be found in languages, physics, mathematics, computer science, engineering and the social sciences. While the advantages of lecturers from abroad are obvious in language studies, the SET disciplines (Science, Engineering, Technology) have been characterised by English as the *lingua franca* in the second half of the 20th century, a fact that makes international academic mobility easier in these subjects, which have seen a decline of interest by British graduates. As observed in previous statistics, the particularly large inflow of Chinese researchers to the UK at an early stage of their career mirrors the rapid economic and scientific advancement in this country during the past two decades.

The number of international academic staff at British universities is higher than the number of British academics leaving for permanent jobs abroad, which can be regarded as a positive sign for the international standing of British academia (2005–06: +4,220 academics). However, even British universities, many of which are ranked among the top 100 world class universities, are embedded within asymmetrical global power relations. Due to prestigious and highly attractive professorships at the leading research universities in the USA, the outflow of academic staff surmounts the inflow at the levels of both senior lecturers/senior researchers and professors (2005–06: –1,045).

Based on the study by Universities UK, the internationalisation through academic staff appears to be an important strategy for ensuring the international competitiveness of higher education

FIGURE 9

MAJOR NON–UK NATIONALITIES OF ACADEMIC STAFF IN UK HIGHER EDUCATION INSTITUTIONS

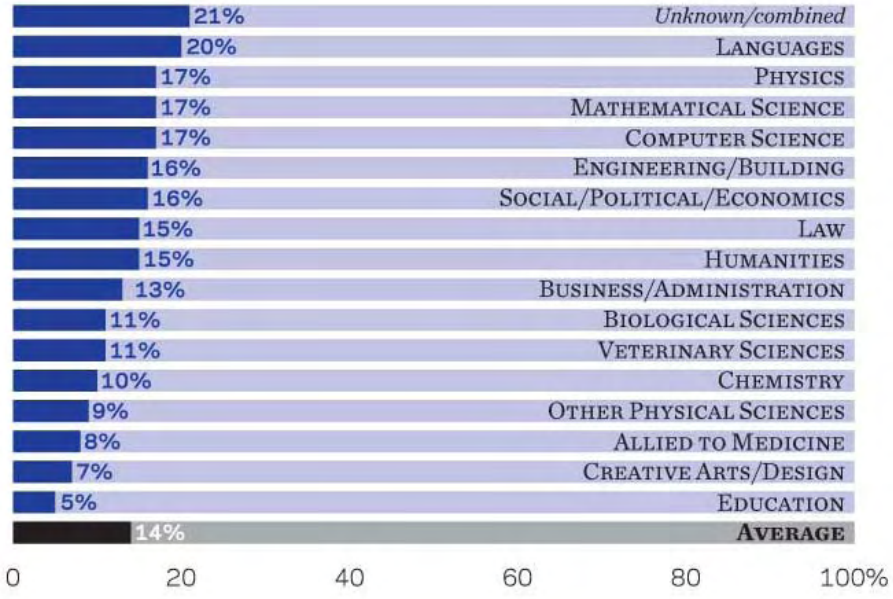
By career stage, 2005–06

Source: Universities UK (2007) Talent Wars: The International Market for Academic Staff, London (Policy Briefing), p. 8–9.

	TOTAL	RESEARCHERS	LECTURERS	PROFESSORS
GERMANY	3130	1070	920	210
IRELAND	2410	560	900	220
USA	2380	510	720	350
CHINA	2280	1450	410	40
ITALY	1870	750	490	80
FRANCE	1850	900	400	40
GREECE	1610	570	520	70
INDIA	1330	570	360	60
AUSTRALIA	1270	440	310	180
SPAIN	1170	490	300	20
CANADA	930	230	320	90
NETHERLANDS	790	320	190	90
RUSSIA	620	340	120	60
JAPAN	440	200	100	NO DATA
NEW ZEALAND	430	140	120	50
MALAYSIA	410	170	120	NO DATA
POLAND	360	190	90	NO DATA
SWEDEN	310	160	NO DATA	20
PORTUGAL	290	150	NO DATA	NO DATA

FIGURE 10
NON–UK NATIONALS AMONG PERMANENT UK ACADEMIC STAFF BY SUBJECT, 2004–05

Source: Universities UK (2007) Talent Wars: The International Market for Academic Staff, London (Policy Briefing), p. 11.



and research. However, as academics with roots in other countries might well return to these places, particularly if research conditions improve in the long run, it seems to be equally important to encourage national graduates to pursue an academic career, either in the country of origin or abroad. As many countries are currently reforming their systems of higher education and research in order to make them internationally more compatible and attractive, the competition for international students and academic staff is likely to intensify in the near future. A sensible strategy for academic institutions therefore seems to lie in balanced exchanges of incoming and outgoing undergraduates, postgraduates, post–docs, lecturers and professors in terms of temporary academic mobility (study abroad, research stays, visiting professorships) and permanent recruitment. Despite

FIGURE 11

OUTPUT OF SCIENCE AND ENGINEERING ARTICLES AND INTERNATIONAL CO–AUTHORSHIP, 1996–2000 AND 2001–2005

Source: J. Adams, K. Gurney and S. Marshall (2007) Patterns of International Collaboration for the UK and Leading Partners: A Report Commissioned by the UK Office of Science and Innovation, Leeds: Evidence Ltd, p. 10.

COUNTRY	1996-2000				2001-2005				CHANGE	
	OUTPUT		INTER–NATIONAL CO–AUTHORS		OUTPUT		INTER–NATIONAL CO–AUTHORS		OUTPUT	INTER–NATIONAL CO–AUTHORS
	1000s	%	1000s	%	1000s	%	1000s	%	% 96–00	% 96–00 to % 01–05
USA	1,262	**35**	245	**19**	1,352	**34**	335	**25**	**7**	**5**
JAPAN	329	**9**	54	**16**	361	**9**	77	**21**	**10**	**5**
UK	338	**9**	98	**29**	359	**9**	145	**40**	**6**	**11**
GERMANY	310	**9**	107	**34**	341	**8**	147	**43**	**10**	**9**
FRANCE	230	**6**	82	**36**	245	**6**	108	**44**	**7**	**8**
CHINA	102	**3**	26	**25**	210	**5**	54	**26**	**107**	**1**
CANADA	167	**5**	55	**33**	184	**5**	76	**41**	**10**	**8**
AUSTRALIA	101	**3**	31	**31**	117	**3**	47	**40**	**16**	**9**
INDIA	76	**2**	n.d.	**n.d.**	99	**2**	n.d.	**n.d.**	**30**	**n.d.**
WORLD	3,603	**100**	n.d.	**n.d.**	4,019	**100**	n.d.	**n.d.**	**n.d.**	**n.d.**

its evident significance, the international circulation of students and staff does not provide the only path to scientific excellence as the case of Japanese universities illustrates: Characterised by low scores of international students and faculty, Japanese universities are well represented among the Top 200 world class universities and even constitute the second most important urban agglomeration of world class universities in Tokyo (FIGURE 4).

INTERNATIONAL SCIENTIFIC COLLABORATION

Global knowledge networks in higher education and research are specifically well–researched in regard to international co–authorship in the natural and technical sciences. This is because science citation databases offer comprehensive data on joint publications in mostly English–speaking internationally peer–reviewed journals. Most of these data are analysed on the national level and thus reflect an aggregation of collaborative linkages between world class universities and other research institutions as discussed in the first section of this chapter. The following data refer to international collaboration in the natural and technical sciences, including clinical sciences, health and related subjects, biological sciences, environmental sciences, mathematics, physical sciences, and engineering. The emerging collaborative patterns thus concentrate on one particular type of international scientific collaboration, namely co–authorship of journal articles, and on the SET disciplines.

The worldwide output of research papers has increased by more than 10% between 1996–2000 and 2001–05 (figure 12). Among the nine countries with the most productive scientists, the growth of research output was highest in China, India and Australia, thus supporting the previously developed argument that these are highly dynamic places in the contemporary landscape of higher education and research. Between 2001–05, international collaboration accounted for 21% of the journal articles produced in Japan and 40% of the journal articles produced in the uk. Scientists based in smaller countries tend to engage more in international collaboration as those in larger countries (usa, China) as the latter have more opportunities to cooperate with colleagues at institutions in their own country. Even if China's share of internationally co–authored articles scarcely rose, the doubling of research output means that the number of internationally co–authored journal papers doubled as well. This immense increase in international scientific linkages of China is inextricably linked to the formation of world class universities and the intense transnational circulation of Chinese academics.

The dynamic changes in the amount of research output have a considerable impact on the global geographies of knowledge networks. For example, China provided 2% of international co–authors of US scientists and engineers in the periods 1981–85 and 1991–95. By 2001–05 this share had risen to 6.1%, making the country the sixth most important place of international co–authorship.

a) 1991–95

COUNTRY	USA	JAPAN	UK	GERMANY	FRANCE	CHINA	CANADA	AUSTRALIA
USA		8	10	10	8	2	10	3
JAPAN	40		7	7	4	4	5	2
UK	23	3		8	7	1	4	4
GERMANY	22	3	7		8	1	3	2
FRANCE	20	2	8	10		1	5	1
CHINA	28	11	7	9	5		6	3
CANADA	41	4	8	5	8	2		3
AUSTRALIA	29	4	16	7	4	2	6	

b) 2001–05

COUNTRY	USA	JAPAN	UK	GERMANY	FRANCE	CHINA	CANADA	AUSTRALIA
USA		9	13	13	8	6	12	5
JAPAN	40		9	10	6	11	5	4
UK	30	5		14	11	4	6	7
GERMANY	30	5	14		11	4	4	3
FRANCE	25	4	14	15		3	6	3
CHINA	38	16	10	10	5		7	7
CANADA	51	5	12	9	9	5		5
AUSTRALIA	34	6	21	9	6	8	8	

FIGURE 12
PATTERNS OF INTERNATIONAL CO–AUTHORSHIP IN SCIENTIFIC AND TECHNICAL RESEARCH 1991–95 and 2001–05 (percentages of total)

Source: a) National Science Board (ed.) (1998) Science and Engineering Indicators 1998, Arlington, VA: National Science Foundation, Appendix table 5–54; b) J. Adams, K. Gurney and S. Marshall (2007) Patterns of International Collaboration for the UK and Leading Partners: A Report Commissioned by the UK Office of Science and Innovation, Leeds: Evidence Ltd, p. 13.

This trend is likely to continue, thus potentially preparing a long–term shift of academic hegemony away from the USA. In the past two decades, the most important source countries for co–authors of US international articles have been Germany, the UK and Canada, while the collaborative links with the USA were considerably strengthened in all of the most productive countries except Japan between 1991–95 and 2001–05 (FIGURE 12). Scientific and technical research in Japan became rather more closely linked to China and Australia, thus contributing to the formation of an Asia–Pacific collaborative space. Within Europe, scientific collaboration between the UK, Germany and France grew considerably, thus reflecting the coalescence of universities in an emerging European higher education area.

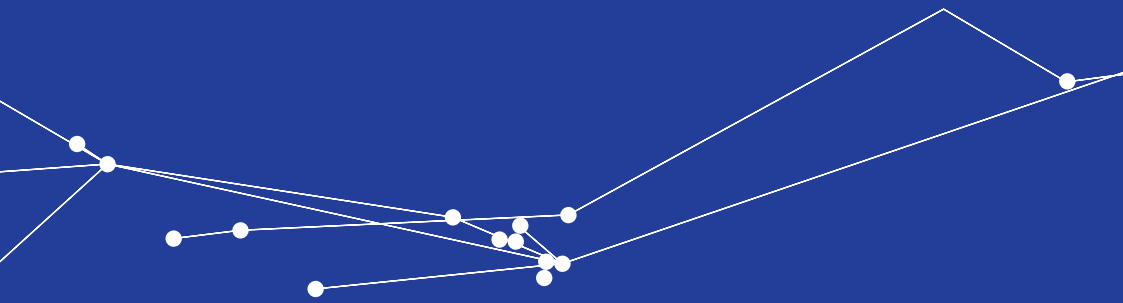
CITIES AND METROPOLITAN AREAS THAT STRIVE TO DO WELL IN THIS CONTEST, NEED TO BE WELL NETWORKED AT DIFFERENT LEVELS, INCLUDING THE INFLOW AND OUTFLOW OF INTERNATIONAL STUDENTS AND FACULTY AT DIFFERENT STAGES OF THEIR CAREER

CONCLUSION:

Global knowledge nodes and networks in contemporary higher education and research cluster in the richest places in the world located in North America, Europe, South and East Asia and Australia. They correspond well with the network of global cities and economically leading metropolitan areas. Universities in South America and Africa are much less central in global networks of science and research that are defined by Anglo–American publication cultures in the natural and technical sciences. When researching the global knowledge economy, it is therefore important to remember that world university rankings and citation data only reflect practices highly appreciated in certain disciplines and places. Academic work in the arts and humanities and in other languages than English is most often underrepresented and thus undervalued in these global rankings.

The analysis of world class universities as identified by two prominent world university rankings, of the transnational circulation of students and faculty, and of international scientific collaboration between the scientifically most productive countries has revealed a dynamic process of restructuring in global higher education and research that can be characterised by a tension between the established centres of research excellence in the USA and Europe and emerging central knowledge nodes in China, India and Australia. Japanese universities belong to the long–established research centres but are at the same time part of growing linkages between emerging world class universities in Asia–Pacific. In the context of a growing internationalisation of higher education and research across the world, regional knowledge networks within Asia–Pacific and Europe have been strengthened in the past decade.

A striking feature of the current process of restructuring in global higher education and research has been the rise of Chinese universities. Trends in academic mobility of students and staff and international co–authorship hint at a possible long–term shift of academic hegemony away from the USA that will enhance international competition for students, qualified researchers and academic resources. Institutions, cities and metropolitan areas that strive to do well in this contest, need to be well networked at different levels, including the inflow and outflow of international students and faculty at different stages of their career. In the long–term, a potential problem for US research universities might result from a comparatively small academic diaspora abroad. Studies have shown that these academic diasporas provide important linkages for the transfer of knowledge and technology between different nodes in the knowledge economy, thus fostering the formation of new knowledge centres and keeping established centres up–to–date.



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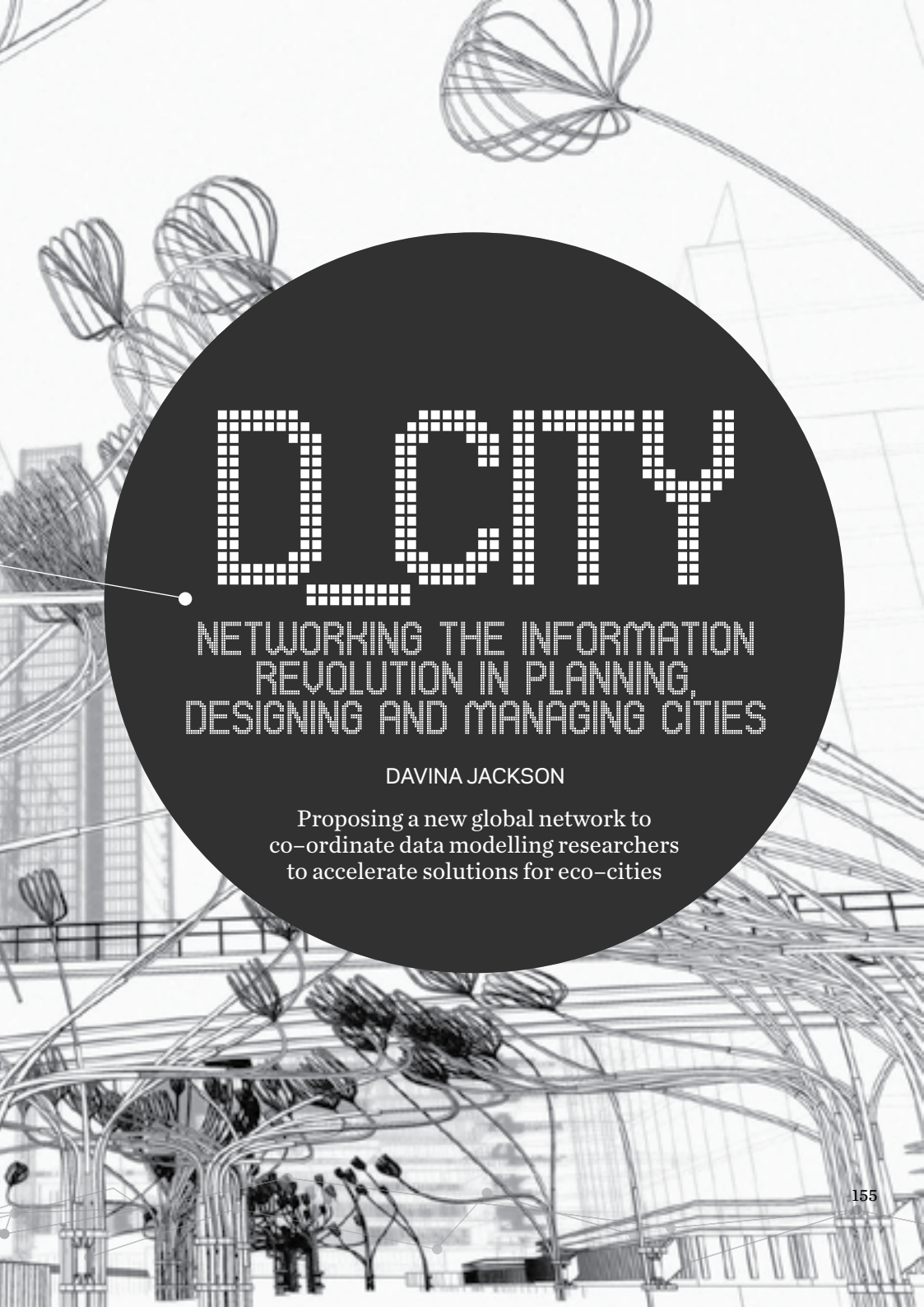
Sunlands: A proposal by London architect Alex Haw (Atmos) for an installation at Canary Wharf, mapping sunlight data from weather stations around the world.



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

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.

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

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.

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

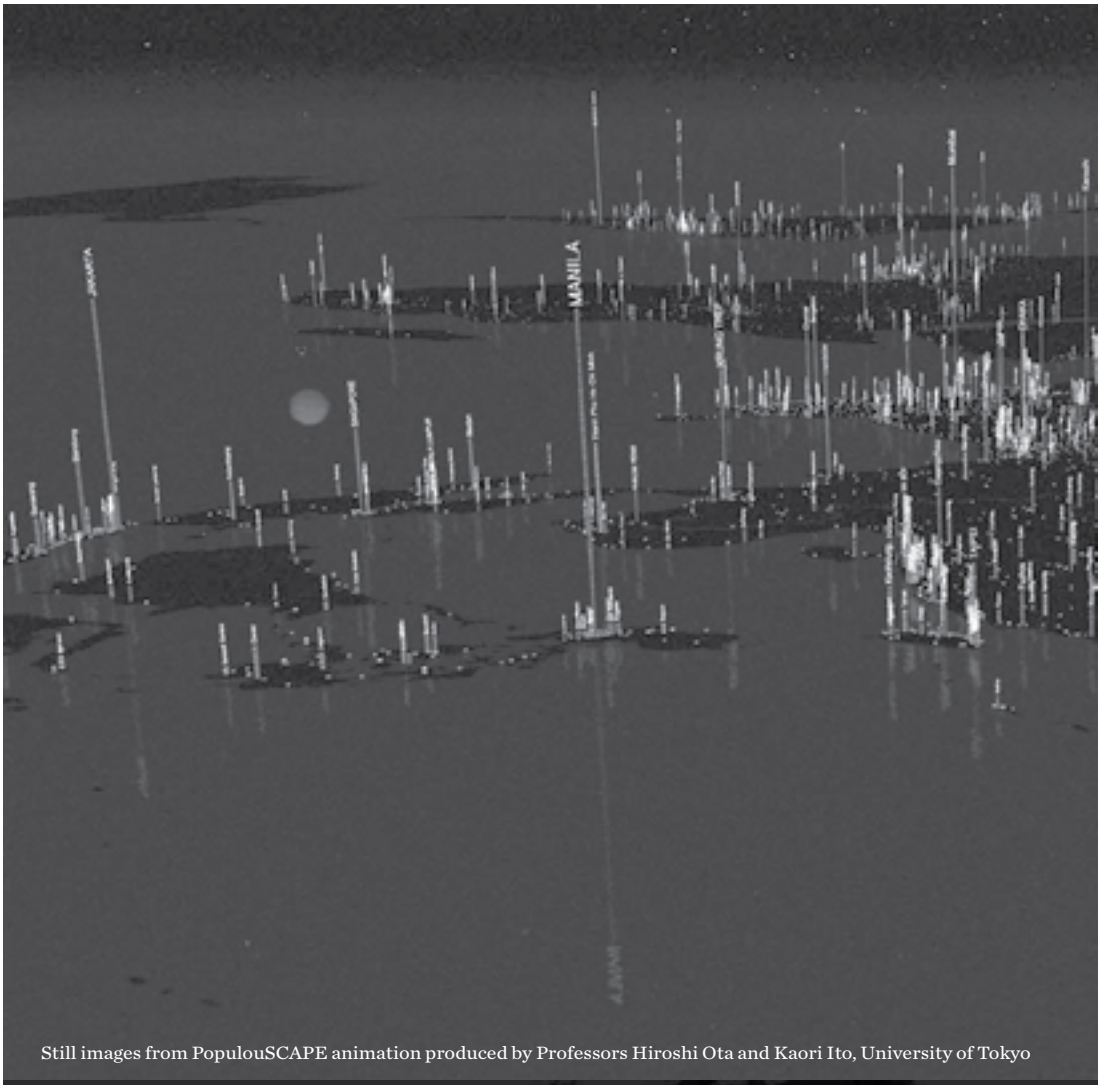
±2.5%
BIDS WITHIN PLUS OR MINUS 2.5%

80%
REDUCTION IN COST ESTIMATING TIME

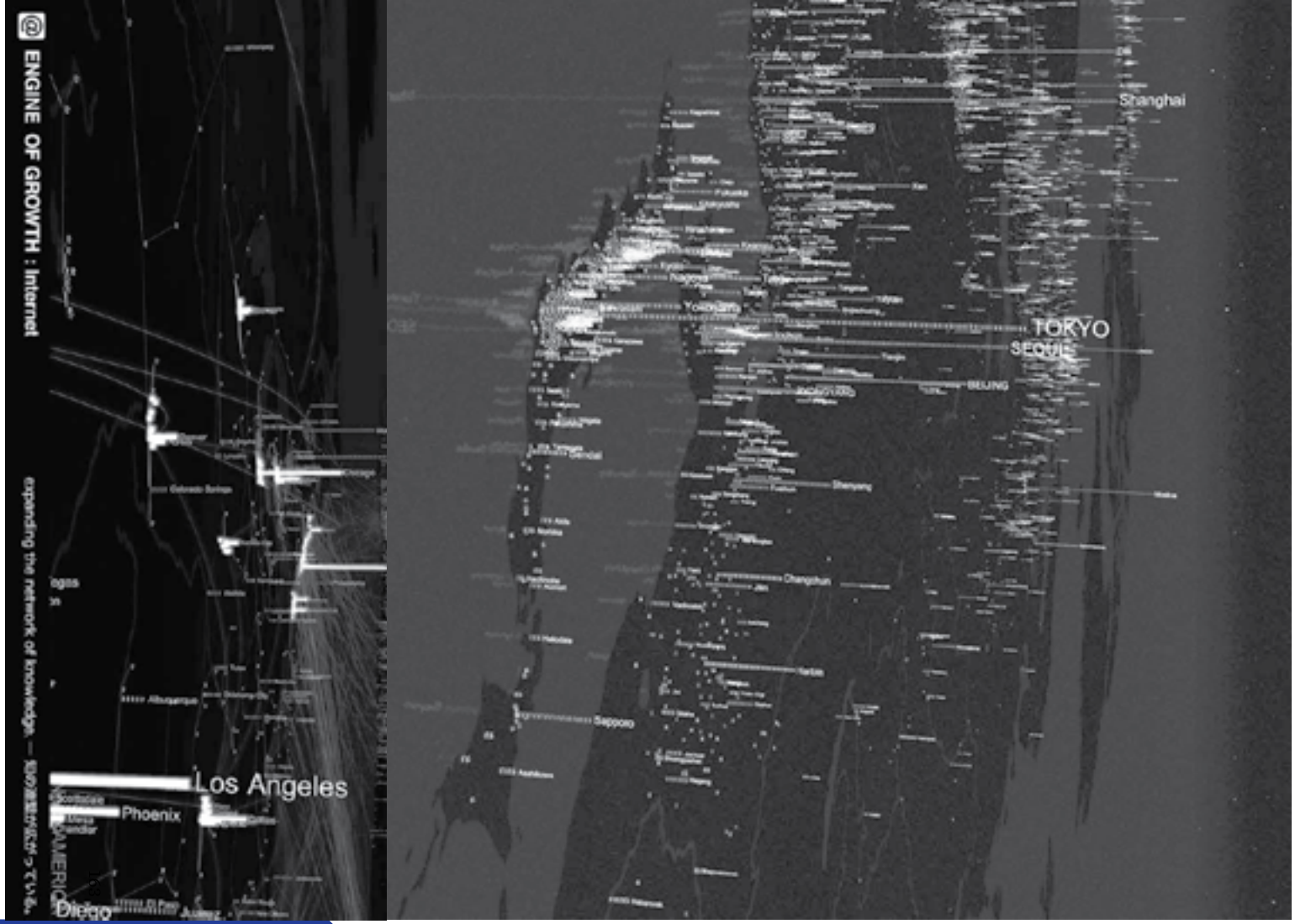
5-10x
RETURN OF INVESTMENT OF THE VIRTUAL MODEL

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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BEYOND BIM TOWARDS DATA CITIES

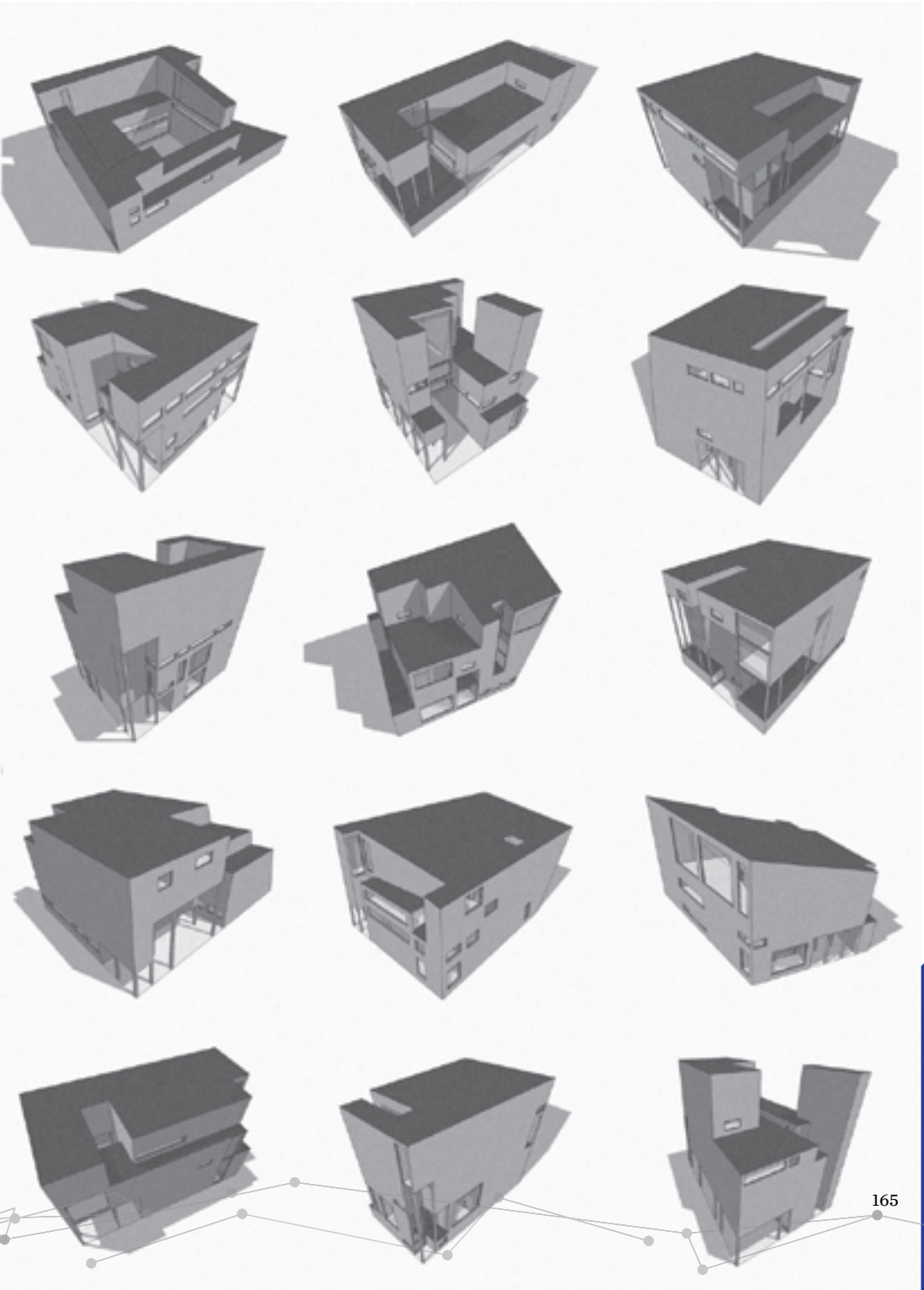
BIM IS ONLY PART OF THE CURRENT REVOLUTION IN MODELLING SYSTEMS destined to reform the planning, design and management of future cities. One key to this phenomenon is today's global mobility of information, communications, capital, goods and services—forecasted at the dawn of the commercial internet 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.

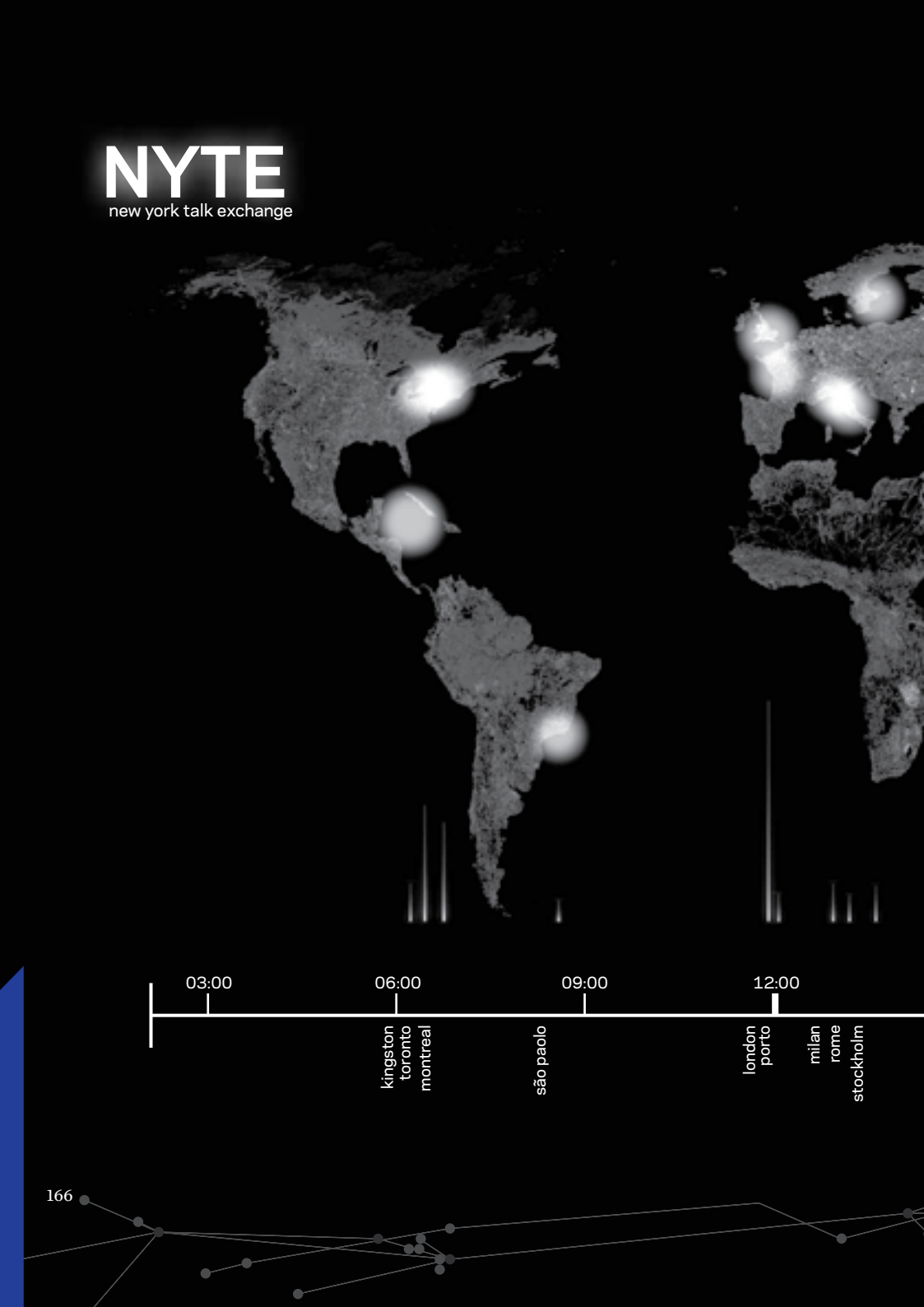
Experiments and discoveries by these and other leaders of the cybernetics movement, combined with common access to wireless and web technologies, now are forcing a conceptual reversal from understanding cities as static buildings and streets (the traditional architecture mindset), to a perspective (derived 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.

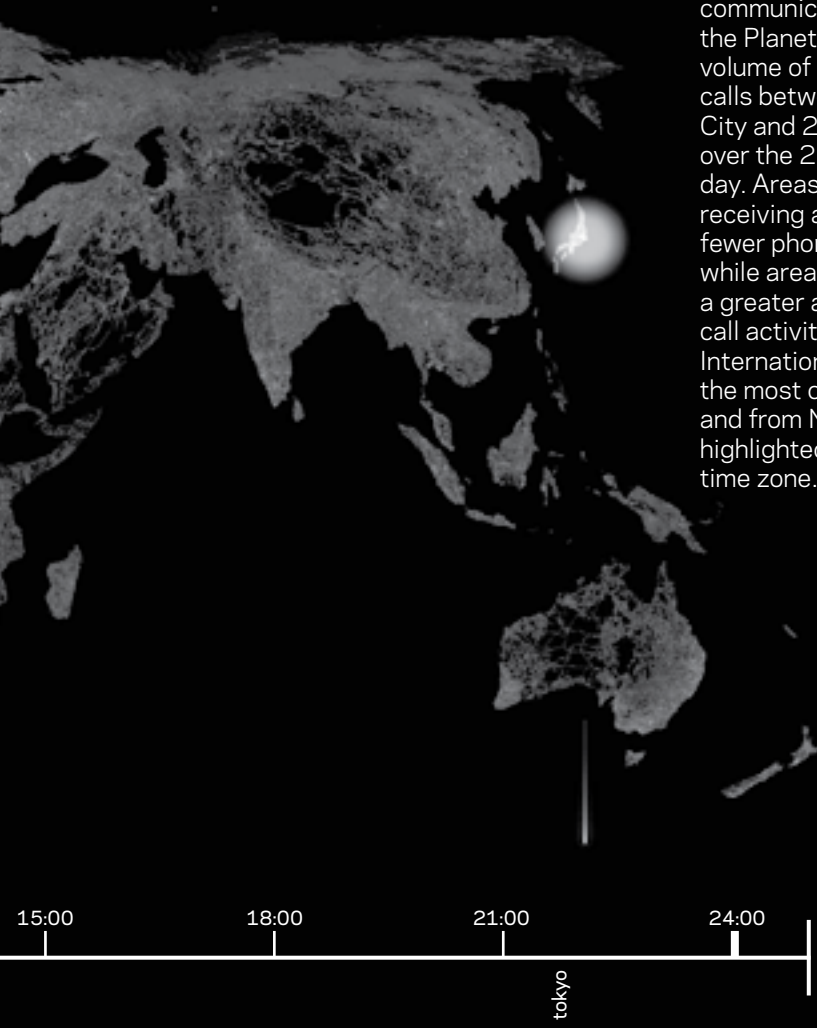
Right: Concepts for buildings can now be algorithmically generated to evolve automatically on screen—a technology which is radically changing architectural practice. Example by Patrick Janssen.



NYTE
new york talk exchange



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 easily grasped 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.


Second Life
Second Nature Member
Smithee Bertrand
Say
napshot
Search
Build
Mini-Map

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.

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

NYTE
new york talk exchange

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

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

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

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 AND METROPOLIS

At the 'Connecting Cities' Metropolis Congress in Sydney in October 2008, a long–term collaboration between Metropolis and the D_City global network is being proposed to facilitate research, development and new systems offering governments more precise knowledge in planning, designing and managing dynamic urban systems.

D_City aims to work with Metropolis to develop a series of international research programs to help deliver important improvements in planning and managing cities during the next decade/s.

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.

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