

WHY FACE-TO-FACE STILL MATTERS: THE PERSISTENT POWER OF CITIES IN THE POST-PANDEMIC ERA

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I THE STORY SO FAR

We witness today enormous displacements of economic forces, migrations of capital and human labor such as no other age has ever seen. We observe that certain regions rapidly grow poor in human beings and capital, while others become saturated. We see in metropolitan centers great masses conglomerate, seemingly without end.

Alfred Weber¹

FOREWORD

That this book *exists* is a testament to the power of face-to-face, and the fact that for work of a certain complexity, meetings can accomplish things that no amount of phone calls, friendly emails, and plans to collaborate via Dropbox can. That this book was *finished* is a testament to the power of communications technology to substitute for face-to-face when we need get things done without meeting up at all. The rest of this book is about unpicking that apparent contradiction. We started on this journey nearly eight years ago—although the ideas, we felt, were timeless—but we finished it as the UK emerged from lockdown, a process that ‘stress tested’ our ideas, sometimes almost to destruction, but brought some of them into much sharper focus by providing us with a chance to go back to our interviewees for *their* experiences and intuitions about the future. At the root of it all, though, remains the shared interest by the fact that, although we are both devotees of modern mobile technology, we’ve been struck by the extent to which place—and the opportunities that it presents for meeting up in person, be it in a boardroom or a bar, to talk shop—still matters to work in the 21st century.

REPORTS OF MY DEATH ARE GREATLY EXAGGERATED

This is a book about cities, and people in cities. It can be difficult to remember just how dire the situation for cities—especially those built on the Anglo-American model—was in the 1970s when “Ford to City: Drop Dead” dominated the New York news and some cheeky estate agents advertised on a billboard “Will the Last Person to Leave Seattle Please Turn Out the Lights?” Across the Atlantic, London seemed in terminal decline: its population had fallen far below the high-water mark of 8.5 million, set in 1939, and rioting in deprived inner-city areas dominated the British press. As we finish this, decline seems once again on the cards: estate agents (realtors, for those of you raised in North America) are reporting early signs of a rush for the exits by the mobile upper-middle class.

Demand for suburban-style housing has surged, particularly for houses with large gardens and access to the great outdoors, while a shared pad in Hackney or Williamsburg looks rather less enticing.

But in between, our most global cities—New York, London, Paris...—became playgrounds of consumption that are, increasingly, the preserve of a moneyed elite while the poor are ever more impoverished or suburbanised. New York's crime rate is the envy of any American city, and in January of 2015 the population of London surpassed the 1939 total² with no signs of a slowdown. And it's a similar story elsewhere, with the oft-repeated mantra of the UN that more than 50% of humanity now lives in urbanised areas.³ This is, of course, partly a story about changing preferences: of people deciding that there was something about cities that they valued, be it the economic opportunity, the diversity, or the (then) good deals on property and the public transit options.

At the same time, however, the spread of mobile telecommunications breathed life into the 'death of distance' hypothesis and, at least for politicians and captains of industry, the anywhere-anytime nature of work was supposed to erase the dominance of these historical centres of trade and industry. So the rise and rise of cities in the early 21st Century presents something of a paradox: weren't we all supposed to be telecommuting from the countryside by now? Wasn't distance, well, dead? And weren't our cities supposed to have died with it?

Clearly, there is another story here and, as we will argue in this book, it is partly about the rising complexities and costs of coordinating a global trade in all manner of goods and services; it is partly about the fact that, increasingly, the most valuable thing that we trade in is knowledge itself and *that* still seems to prefer frequent, direct contact between human beings; and it is also about the infrastructure of telecommunications and mobility that supports all of this. We think that the story so far is about flexibility, not freedom, and that the technological transformations of the past 20 years—working from home, free international calling, video-conferencing, and smartphones, to name just a few of the most obvious—seem likely to reinforce the dominance of 'world cities' such as London, New York and Shanghai but that there are also opportunities for secondary and tertiary cities to reinvent themselves if they think carefully about their connections to the global hubs and what they can bring to the table.

There are no easy answers. Not every town with an historic centre is a new SoHo (or Soho), nor—for reasons that we hope to make clear—is it likely to attract global finance or foster a world-class group of artists. But saying that "it won't be easy" is not the same as suggesting that it's impossible and the hope is that this book will give you food for thought—as a businessperson, a mayor, a policy-maker, or a concerned member of the public—and tools with which to think about the future for *your* town, city, region, or mega-city. If you never make it past the *Introduction*, just remember this: each region faces its own challenges, there is no *one* answer, and there is no *easy* answer.

THE PROBLEM OF PERSPECTIVE

This is a book that seeks to look behind the apparent contradictions. We think that the problem is principally one of perspective: we are so easily seduced by the visions of technologists that we fail to see the more mundane changes to daily life, and we are so

focussed on ‘the now’ that we fail to heed the lessons from history. That is why, whether it is Porter’s ‘clusters and the new economics of competition’⁴, or Richard Florida’s ‘technology, talent & tolerance’⁵, the search is always on for the next silver bullet that will ‘solve’ a city’s decline or ‘future-proof’ it against tomorrow’s threats.

The advice offered by planning and economic consultancies is often framed in terms of industrial location; that is, in terms of where businesses choose to build and maintain offices and factories, and ultimately about what cities and regions can do to attract and retain them. But the longer history of industrial location *theory* is often lost on the road to city hall and, in the pursuit of employment growth the focus often shifts from identifying what firms *need*, to giving firms what they *want*—which is how we end up with expensive tax abatements, land assembly through the exercise of eminent domain and compulsory purchase, and ‘light touch’ regulatory regimes, none of which seem to make much of a difference in the long run. London and New York are still the places ‘to be a part of it’. Blackpool retains the dubious distinction of having more deprived neighbourhoods than any other city in Britain⁶, and Flint, Michigan, has long been one of the USA’s poorest towns⁷.

Our argument is that there are structural forces in play that individuals and governments need to understand in order to avoid the very worst of the ruins that haunt the post-industrial landscape. We believe that it is worth framing our thinking in terms of ‘centrality’—that some places occupy privileged places within larger networks—an idea that is both very much of its moment thanks to network science, and also possessed of a long and controversial history thanks to its connections to the German geographer, and wartime planner, Walter Christaller⁸. However, linking the world that we live in now to the longer history of location theory serves to highlight the extent to which ‘the more things change, the more they stay the same’.

We also think that the Covid-19 pandemic tweaks, but does not fundamentally disrupt, the power of places, and of urban places in particular. What we believe—and hope to convince you of—is that the pandemic has moved the goalposts but not changed the game: technologies *like* Zoom have been around for some time and no one was so immediately convinced of the alternatives that we stopped having face-to-face meetings. What *has* happened is that a lot of inertia—we are creatures of habit after all—was swept away by the *necessity* of doing things differently, and businesses have seen that a lot of their workers don’t need to be in the office every day in order to get things done. Quite aside from the continuing *risk* associated with face-to-face at the moment, we think that the pandemic has forced a rethink about why, how, and when these types of encounters will happen, but we will still need, and want, to meet up.

FACE-TO-FACE: CHANGE AND CONTINUITY

Across this book we will home in repeatedly on the vital role that face-to-face (f2f) contact plays in the life of cities. It’s always been an essential part of what cities can offer, but it’s also always in flux: people and businesses are continually having to respond to new economic or social pressures, and they are, too, responding within a wider and wider range of communication possibilities, as the reach of digital technologies extends and deepens. So ‘face-to-face’, and what it means for business and culture, is constantly

changing too; we aim to explain how, despite these changes, it will remain at the heart of urban life. So we will necessarily look, too, in more detail at the implications of the 2020 coronavirus pandemic for how cities will work in the future, and explore how players across a range of industries have experienced it and what they now expect. Our own view is that the pandemic and lockdowns are an accelerant to already-existing trends, but do not create new realities: it may be the petrol, but it is not the fire.

Our intention is not to provide answers or recipes, but to provide ways of reasoning about what answers—for your own town or city—might look like. Economists would call it ‘identifying your comparative advantage’, but there’s no equation to be solved that will magically cure what ails those cities that are still in deep trouble, or that now find themselves in newly deepened waters. To be clear, this book is indebted to economists past and present—and it leans heavily on what they call ‘transaction cost theory’—but it is not an economic textbook: there will be no formulae or “from equation 3 it clearly follows that...” In our approach we are going back to the roots of economic *geography*, when works were intended to be read by both the academic and the layperson, and we want to continue in the vein established by our late friend and mentor, Professor Sir Peter Hall, of writing for a wider audience from an historical perspective. We would also invite you to disagree: we hope that this book will stimulate critical thought, and prompt you to ask the difficult questions that need to be asked on all sides—corporate, civic, academic, and institutional—when the big decisions about the future are being taken.

STRUCTURE OF THE BOOK

The book is organised in a kind of pyramid: we start with the basics of infrastructure (Chapter 2) and how it un-levels the playing field, making distant places ‘close’ and near places ‘far away’. We then move on to the factors guiding industries to select actual locations from amongst the enormous range of possible ones (Chapter 3), and how the nature of an individual firm’s activities influence this choice (Chapter 4).

We turn next to people and the ways in which their needs for accessing information and exchanging knowledge shape neighbourhoods and their roles (Chapter 5), and focus on how real people frame their decisions (Chapter 6).

And we conclude with our own thoughts on the present and possible futures not only of ‘world cities’, but also of all the cities and towns that make up our complex urban world (Chapters 7 & 8).

So Chapter 2 is titled **Moving Stuff Around**: how do infrastructure networks, both singly and in combination, create a ‘surface’ across which choices are made. Computer- and telecommunications-networks, with their potential to reach into all sectors of the economy and society, are obviously a focus for this section, but so too are transportation and other, less glamorous, networks. The ongoing growth in demand for power, logistics, and mobility infrastructures suggests that these are the true conditioners of access to markets which are the subject of Chapter 3: **Making Markets**.

Chapter 4 turns the focus to the where & who of **Doing Deals**; how do businesses as decision-making entities make choices about which locations are more or less desirable for a new shop, office, or plant? Given the sea changes of the past forty years, why do firms still pay almost any price for the ‘right’ location? What are the underlying reasons why the

stratospheric rents of Mayfair or Midtown Manhattan haven't driven more companies to the cheaper—if not more cheerful—towns of Watford or White Plains? In particular, it relates that to the perception and the reality that even in a digital age, many of them still can't or daren't operate without face-to-face contact.

This last dimension—contact—brings us to the *people* themselves. Because whilst it's important to analyse firms and their business decisions, things are changing fast. We have been struck by how, more than ever before, it's the decisions and choices of individuals which are driving key sectors of the modern economy. Flat hierarchies, freelancing, social networks... compared with a generation ago, young workers' life chances and choices are less about 'the company' and more about 'my gameplan'. So: what role does personal choice, and the cumulative impact of each individual choice *within* a firm, play in the ad-trade in Soho or the art-world in SoHo? We believe that the key issue here is the role of face-to-face interaction in the transfer of complex, uncertain knowledge in work and non-work contexts.

Chapter 5 **Talking Shop** will contend that the extent to which this is important varies by *industry* and, consequently, so too do the locational stresses. But we should highlight here that it is not simply the case that Drucker's 'knowledge workers'⁹ depend on face-to-face meetings while craftsmen or auto-workers do not; every type of work entails different types of interaction, all of them more or less amenable to replacement by information and telecommunications technologies.

Chapter 6—**Let's Talk**—looks at how these ideas play out in practice, incorporating the results of more than 40 interviews with junior and senior staff across a range of knowledge-intensive industries about their day-to-day practices and whether or how ICT (Information & Communications Technology) is changing these as well their own perspectives on location. The chapter's final section *Was This the Future?* reports on a follow-up survey of our original interviewees, during a global pandemic that very much put to the test our assumptions and arguments. With lockdowns and 'social distancing' as the 'new normal', and many workers furloughed or forced to work from home indefinitely, was this the moment that we'd discover that face-to-face wasn't quite so important as we and our interviewees had thought? We wanted to understand both the immediate effects in their sector and what it meant to be without F2F interaction, as well as what they judged to be the likely longer-term impacts on how business would be done in future.

We wrap up with some final thoughts in Chapter 7's **So What For 21st Century Places** and Chapter 8 **And In The End**. We look at what ICT, accessibility changes and the post-industrial economy will mean, mainly for Western metro areas. Where do we think face-to-face will still be key? And where will it not? What are the implications for developers and investors? And for policy-makers, what might they do to shape, accelerate or restrain these trends? Or is it actually a case of the much more challenging (for politicians at least) "don't just *do* something—stand there!"? We will try to bring this all together with thoughts on what the experience of living through a pandemic means for the future.

So this is a book about why face-to-face is *still* special, but also about why we can get a lot more done over Zoom, Teams, Skype, FaceTime... when the need arises and discover

that we could have been using it a whole lot more *before*. Cometh the hour, cometh the Zoom session. Ultimately, we aim to tell a clear and, we hope, convincing story about the continuing vitality and potential of cities in the 21st century: starting, in Chapter 2, with the essential underpinning of the networks which move all our ‘stuff’ around.

¹ Weber, Alfred (1909) *Theory of the Location of Industries* Chicago: University of Chicago Press, Materials for the Study of Business, 7th ed. 1969

² London Datastore (2015) *Population change 1939-2015* London : GLA
www.data.london.gov.uk

³ United Nations (2018) *68% of the world population projected to live in urban areas by 2050 says UN*
New York: Dept of Economic & Social Affairs 16th May 2018
<https://www.un.org/development/desa>

⁴ Porter Michael (1998) ‘Clusters and the New Economics of Competition’ *Harvard Business Review* November-December 1998 edition

⁵ Florida, Richard (2002) *The Rise of the Creative Class - and how it's transforming work, leisure, community and everyday life* New York: Basic Books

⁶ Lancashire County Council (2020) *Local authority profiles: Blackpool Unitary* Preston: LCC (section 2 ‘People & Communities’) <https://www.lancashire.gov.uk/lancashire-insight/area-profiles/local-authority-profiles/blackpool-unitary/>

⁷ U.S.Census Bureau (2019) *Quick facts Flint City Michigan* (table entry: median household income 2014–2018)
<https://www.census.gov/quickfacts/fact/table/flintcitymichigan/INC110218>

⁸ Christaller, Walter (1933) *Central Places in Southern Germany* 1966 translated edition, New Jersey: Prentice-Hall

⁹ Drucker, Peter (1999) *Management Challenges for the 21st Century* London: Butterworth Heinemann

2 MOVING STUFF AROUND

The technology is important because without it, there would be nothing. Yet what is really crucial, as before in history, is not the basic infrastructure, but what that infrastructure enables.

Peter Hall¹

LIFE ON THE NETWORK

If the 21st Century has a dominant metaphor, it is the network. Network ways of thinking now pervade science to an extraordinary extent: it is how brain researchers envision our grey matter, how public health officials think about the spread of Ebola or Covid-19, how ecologists think about ecosystems, how we think about computers and devices, as well as how we think about society itself. Of course, in popular culture ‘networking’ used to mean little more than having after-work drinks, but thanks to the rise of always-on, Internet-enabled devices and the social media that they have enabled, we can now—at the click of a button—search our own social networks for long-lost friends (Facebook), someone able to make a key business introduction (LinkedIn), or stay abreast of breaking news (Twitter).

But there is not just *one* network for moving ‘stuff’ around, there are many: air, rail, road, sewerage and power, not to mention fixed and mobile... These overlapping, complementary and competing systems form the substrate upon which economic life grows, but as it grows the infrastructure responds: strengthening links here, pruning them there. When was the last time it struck you how miraculous it is that you can check local traffic before you get up from the breakfast table, use real-time services to time your departure from the house so that you arrive at the bus stop *just* before the airport express service arrives, pass through a toll plaza as if you have a magic wand, and then fly anywhere in the world with your *primary* concern—pre-coronavirus—being the length of the queue to have your passport checked?

We are adjusting very quickly to devices and services that would have seemed miraculous even 20 years ago. But let’s take a step back from the radical and ongoing changes in our pockets and purses. Have a look out the window and chances are that you will be staring at some kind of network for moving physical ‘stuff’—people or products—around. These other networks are much less ‘sexy’ and seem to change at a much slower rate than our phones and ‘phablets’, but they are no less important! Let’s remember too that this digital omnipresence does *not* mean that the personal touch has been relegated to

second place, but if we start with the networks then it will be easier to see what is, and is not, changing in the *role* of face-to-face contact.

“THIS TIME IT’S DIFFERENT”

What makes the telecommunications networks seem different from all of those other networks is that they can carry *anything* that can be encoded digitally: lines from a sonnet, our partner’s voice, our children’s faces, massive data sets, even designs for printing out new parts. This adaptability and instantaneity appears so dramatically different from the more mundane advances of, say, tarmac or the jet engine that, from our privileged position in the early years of the 21st Century we tend to think—like thousands of investors and pundits before us—that ‘this time it’s different’.

We spent 60 years—from the demo that had visitors talking at the 1964 World’s Fair—waiting for the videophone, only to take it almost completely for granted—to the point of being irritated by choppy video or poor sound quality—when it finally arrived in the form of Skype. And FaceTime. And Teams. And Zoom. And other services now long-gone. To rub salt in AT&T’s wound, now that all these choices are here, they are not just cheap, they’re basically free *except* when we want to connect to one of those boring old regulated legacy networks. If you were born as late as the 1980s did you ever think that, within 25 years you’d be able to access the Internet wirelessly almost anywhere in the world using a powerful computer the size of your hand?

When we look at it this way, where’s the transformation in the networks that move ‘stuff’ around? Where’s that flying car we were promised? Would you settle for a flying bus instead? Perhaps one branded EasyJet or Southwest, JetBlue or Ryanair? We may not have KITT (David Hasselhoff’s AI TransAm), but it’s increasingly obvious that some sort of self-driving car is parked just around the corner. So just because our *own* cars don’t yet drive themselves or fly us from A to B, doesn’t mean we shouldn’t recognise that there have been some pretty radical changes in transport recently, both in the networks themselves, and in how they are used.

ICT is, of course, the enabler of these changes, but you’ll note that their primary application has been in making it easier to move stuff around, not to save us from having to move it around at all. We keep thinking that digital telecommunications is somehow different from everything that came before. The seeming ‘placelessness’ of data—everywhere, and nowhere—looks to be a big contrast to the ‘grounded’ way that everything was before. And this, we suspect, is one of the reasons that the ‘death of distance’ is an idea that refuses to die. In the age of ‘big data’, we tend to forget that the massive growth of the airline network is driven by our persistent preference to ‘acquire’ data the old-fashioned way: in-person and face-to-face. So this chapter looks at the networks for transport and information—how they’ve changed, how they’re changing—and what this means for what we do and where we do it.

What we hope to do in this chapter is to show you why the Information Revolution is perhaps *less* dramatic than you think, and why all those planes, trains, and automobiles are a lot *more* exciting than you think. But in order to do that, we need to look a lot more carefully at what our infrastructure networks actually *do* and how we can put the physical and informational aspects of *all* networks into some kind of a relationship to their social

and economic functions. We tend to forget that even wireless networks have a physical structure—what experts term a ‘topology’—that affects where and when they can offer their services. Or, to put it another way: why do you get great 4G reception and free WiFi in New York, but not where you need it a whole lot more?

A QUICK LOOK BACK

First, though, some historical perspective. We’ve written as if all of these ideas about the importance of transport networks in relation to communications are new, but we could look a long way back and still see the impact of these networks on the growth of towns and cities. In fact, the urbanist Jane Jacobs argued that the earliest towns arose out of people’s need for somewhere convenient to meet and trade ‘stuff’ because each group had access to different natural resources². You wouldn’t want to arrive with your haul of onyx only to find that you’d just missed the fur traders, so someone might see an advantage in hanging around to act as a middleman for these trades. Before you know it, you’ve got the makings of a small town built on top of long-distance transportation and trading networks. It’s a pretty controversial theory that turns conventional economic thinking on its head—and for which the archaeological record is uncertain at best—but it makes a surprising amount of sense.

Let’s run the clock forward a bit and focus on the Neolithic settlements that have been found around the British Isles. From our 20th Century standpoint a place like Skara Brae, on the Orkney Isles just off the tip of Scotland, is pretty remote; who’d be crazy enough to travel there by sea when it’s slow, hard going, and often quite dangerous? But you need to flip all of that around in your head: imagine impenetrable, old growth forest full of large predators and people of doubtful friendliness; and then compare that to an ocean full of fish across which you can (if you’re lucky) travel in a straight line between A and B. Suddenly the ‘attraction surface’ of nodes (towns, though not yet cities) and links (routes between them) is inverted and we can see why a place like Orkney is more of a cosmopolitan crossroads than a backwater.³

WHY FINANCE & SHIPPING GO TOGETHER

The story of the next few thousand years is really the story of road and water networks in a mix of competition and mutual reinforcement. From Greek boats to Roman roads, it doesn’t seem to particularly matter if trade or military needs came first, towns that sat at a crossroads or confluence seem to have had a competitive advantage over those that merely controlled access to resources. Those that, like London or Paris, were places where *multiple* road and river networks intersected had an additional advantage: they grew as *entrepôt* towns—transshipment points—that traded not only in essential commodities, but also in news about those commodities. Faraway events with the capacity to affect local and global demand would give Jane Jacobs’ ‘middlemen’ yet another reason to stick around in those early towns.

It is far from coincidental that Fleet Street and the City of London* sat next to the now-vanished docks of the Pool of London. Nor is it chance that Wall Street sits so close to the confluence of the East and Hudson rivers – “the finest harbour in the Atlantic world”.⁴ When news travelled by horse and boat, to be ‘central’ was to be as close to those boats as possible so as to have access to, and be able to act on, market-making data first.

There’s a map in the Library of Congress, from the early days of the telegraph in America, that nicely highlights the ways in which some places became central not only for the trade in goods, but also for the trade in information: it shows telegraph cables radiating from Lower Manhattan like a spider’s web. Wall Street sits at the centre of this web, but there is a departing steamer “headed for Liverpool” transmitting that knowledge (and those commodities) into global relationships. For much of human history it was ships that carried both the latest commodities and the breaking news of the day.

<Figure: Telegraph Stations in the United States, Canada, and Nova Scotia; Detail from Barr 1853 about here>

THE ARRIVAL OF RAIL

Jump forward again to, say, the middle of the 19th Century and we witness the rise of the railway which had the chattering classes gasping in disbelief at the *Rain, Steam & Speed* of their fast-changing countryside. Some people thought that the high speeds of Britain’s new steam trains would leave passengers short of breath or even unconscious and, as the *Liverpool Courier* excitedly reported of the Rocket at the Rainhill trials in October 1829, “It actually made one giddy to look at it, and filled thousands with lively fears for the safety of the individuals who were on it, and who seemed not to run along the earth, but to fly, as it were, ‘on the wings of the wind’”⁵.

The early success of the Liverpool & Manchester line demonstrated that there was demand for a way to move people and freight between the factories of Manchester and the docks in Liverpool quickly and easily. The perceived demand to connect each and every town in Britain stimulated what the Victorians, whose new middle-classes were passionate investors, would come to call Railway Mania—itsself a ‘rehash’ of the Canal Mania of the 1790s—and the building of 10,000km of new rail links before the inevitable bust. In 1845-46 alone, Parliament received 560 railway bills, and passed 270 of them. The crusty old Scots advocate Lord Cockburn observed that “From Edinburgh to Inverness the whole people are mad about railways. The country is an asylum of railway lunatics.”⁶

DAWN OF THE OPEN ROAD

On into the first half of the 20th Century and it is the story of cars and trucks, and their freeways and motorways, spreading rapidly across the countryside and filling in around the existing rail and canal networks. Unlike Railway Mania, these were huge state investment programmes, urged by public actors: “the inadequacy of the roads of this Country to meet modern motor traffic is well known... We feel that the present trunk roads policy of the

* The ‘City of London Corporation’ is the historic financial district at the centre of London the city. It’s basically Wall Street, except that it has its own government and both individuals and corporations get to vote. It should not be confused with the Greater London Authority, which is what most people mean when they say ‘London’.

Government... must now be superseded by the planning of a new system of national motorways” thundered the Clyde Valley Regional Plan in 1949.⁷ The model was the USA, where interwar turnpikes were knitted together post-war into the national Interstate network via billions of Federal dollars.

Rail and canal networks always required large populations to make them viable, but high-quality roads—as opposed to the dirt-tracks that had pretty much been humanity’s lot since the fall of Rome—brought with them an entirely new kind of ubiquitous and flexible mode of transport. All this public money created huge private opportunities, and with them the freedom of the ‘open road’—its weird excitement celebrated in a thousand songs like Taj Mahal’s hymn to trucking on I-70, *Six Days on the Road*: “I was pullin’ out of Pittsburgh and headin’ down the Eastern Seaboard / Got my diesel wound up and she’s rollin’ like she never did before...”⁸

What makes the road network, and the highway network in particular, so different from its ‘competitors’ is that the cost of adding a new link or a new node—an intersection—is relatively modest. While not overlooking the amount of money invested in the Interstates, autobahns and motorways, they are networks that can be fairly quickly reconfigured, upgraded, redesigned, and filled-in in response to growing demand. Roadworks may be an ongoing annoyance of modern life, but the traffic usually keeps on moving; try saying the same about track work on Britain’s East and West Coast mainlines, or about New York’s L-train.

TOWARDS THE OPEN SKIES

And so into the air: the launch of the Boeing 707 in the late 50s heralded the dawn of the ‘Jet Age’ and of mass high-speed international movement for millions. Travel that was once the preserve of film stars and titans of industry—the original ‘jet set’—quickly became the province of package holidaymakers and multi-national businesses. But as our planes got bigger and faster, they also gained increasingly specific and extensive technical requirements, including ever-longer runways and two-level jetways... And it is not just a case of ‘if you build it they will come’, as the operators of Ciudad Real Airport, 160 km. south of Madrid, discovered at a cost of €1.1 billion,⁹ because geography still matters in the era of point-to-point airlines. No matter how lovely the airport, you *still* need to be close to a major population and business centre; in fact, you (ideally) need to be positioned near several major markets to attract and retain operators.

Global businesses—with the notable exception of logistics and manufacturing—may no longer take into account the location of ports or overland routes to faraway cities, but they do pay a great deal of attention to where the global hubs are. One academic suggested that we’re seeing the rise of the aerotropolis¹⁰—the city built around an airport—but you need only to look at the amount of money invested by the UAE in building its own airline network to see that this is hardly a straightforward proposition. The aerotropolis is not *just* about planes and logistics, it is *also* about face-to-face and making it easy for a globally mobile elite to fly in and out for meetings. The clustering of office buildings and office parks around Heathrow, Schiphol, Paris CDG, etc. is not coincidence.

VIRTUALLY FREE?

And then networks went digital. Enabled by the combination of technologies from micro-miniaturisation to mobile telephony and hypertext, and with the Internet at its core, the information revolution swept across society and the economy. This was the fastest change yet: a 1990 dictionary¹¹ doesn't have the word 'internet' in it; a 2000 almanac¹² devotes a whole page of careful explanation to it; and now you don't need to tell anybody... Those ten years saw the information networks break out from the academic and defence worlds to the whole of society, creating the e-world we now inhabit.

These changes didn't come from nowhere, of course: ICT *services* were already seen as a big deal by the 1980s when they were being applied as an improvement to firms' internal operations. However, at this time we were still dealing with 'islands of automation' and little outward linkage. The break out began, and began to be noticed, about twenty years ago; in 1995, a major US government study tentatively remarked that "...recently, a number of firms have begun offering merchants software that will allow customers to make online credit-card purchases via the Internet."¹³ Sounds like it just might work, eh?

Now, the ubiquity of ICT makes it difficult to remember life without it, or to distinguish the component parts that helped to create our e-world. They also make it hard to think in terms of 'central' places, because the network now seems to be always on and always accessible no matter where we are! In the IT world people now talk about computing being 'ubiquitous' or 'pervasive'—literally, everywhere. If, like an ever-larger proportion of humanity, you live in a city or its immediate surroundings then you probably have a choice of high-speed Internet Service Provider and you increasingly treat networked-enabled applications as an extension of daily life for everything from arriving at the bus stop just in time to finding a mate.

The same is not, however, true in rural locations. Travelling to the countryside can sometimes feel like travelling back in time: 4G services disappear; 3G becomes patchy; you might even find yourself dependent on satellite 'broadband'! People who advocated the 'death of cities' in the early, heady days of the first dot.com boom failed to distinguish between the 'pipes'—fibre, copper, 3G/4G/WiLAN, etc.—that carry the data, and the services built on top of those pipes. In principle, Internet-enabled services can be provided anywhere and you can run a teleconference from deepest, darkest Dorset, but in practice the aggregations of demand—and ability to pay—is greatest in cities, as is the historical legacy of interconnections with other networks.

London and New York are connected by *multiple* fibre optic cables, each capable of carrying Gigabits upon Gigabits of data per second, and each capable of handling as much—or more—data than the cables connecting up all of Africa. In February of 2012, a single ship dragging its anchor off of Mombasa cut off the Internet to six countries, something that would be unthinkable for *cities* in Europe or America, let alone countries! The divergence between the place-lessness of electronic *services* and the place-fulness of the supporting *infrastructure* is how we can finally get to grips with the fact that ICT can change both everything and nothing. It depends on where you are standing: the middle of a large city is definitely the best place to think that you can stop worrying about place.

WHY IT'S NOT SO DIFFERENT (YET)

We aren't suggesting that the era of 'ICT in everything' has had no effect on the movement of information and how and where it is processed; the effects have, of course, been dramatic. But in thinking that this is all somehow radically new, we may fail to see the ways in which it could also be seen as just a continuation of the telegraph and telephone revolutions that preceded it. We didn't need to wait for the Internet to happen for us to experience the magnitude of the psychological, social, and economic impact of not having to be next to someone to talk to them. There's a good reason that Tom Standage cheekily named his book¹⁴ on the telegraph age "The Victorian Internet" and it's why we should have been a lot better at predicting that the bandwidth mania of the late 1990s—when fibre-optic cable was being laid across continents far in excess of demand—would end in tears just like those earlier manias.

But the point is not that there's nothing new under the sun; rather, we want you to think about how radical *all* of these infrastructural transformations actually were. By treating ICT networks as 'different'—even the term 'high-tech' sets up an opposition with those boring 'low-tech' air and rail networks—we risk failing to see that all we're really talking about are waves of technological change which impact networks of mobility and communications selectively, differentially, and incompletely. Being able to move 1s and 0s around at near-light-speed doesn't stop us having to move other 'stuff' around. So the mobile phone and laptop don't—and, we hope to convince you, won't—replace our need for travel, but it *can* make taking the train more attractive than driving because we can 'get a little work done' on the way up to Edinburgh or down to DC.

Of course, even here technological and social change can move the 'decision boundary': it's been argued that (shared) Autonomous Vehicles (AVs) will be a boon for the environment because they move about more efficiently than human-driven ones. But consider the fact—and the evidence already collected from crashes during early trials—that fully autonomous cars would also no longer require us to focus on the road and risk a fine for fiddling with our phones: if AVs, especially in conjunction with pandemic illnesses that make public transport riskier, reduce the perceived costs of travelling by car then they could well *raise* our tolerance for long commutes or drives. So instead of reducing emissions, they could end up *increasing* vehicle miles and encouraging people to ditch public transit!

Indeed, historically it would seem that every technology-driven increase in our awareness of the wider world—and its many sights and products—has led to increase in network flows: we are travelling *and* shipping more 'stuff' to our front door more than ever before. The corollary of the UK's growing taste for e-commerce (online retail up from 12.5% of all sales in 2012 to 16.3% in 2017) is a steady increase in parcel traffic: nearly 2 billion items were delivered in the UK domestic market in 2017–18, up 11% on 2016–17¹⁵. That's an average of 75 items *per* household *per* year.¹⁶ That's a lot of vans to go with all that placeless ICT.

WHAT WE TALK ABOUT WHEN WE TALK ABOUT NETWORKS

Like any scientific discipline, the language of networks has a specialist vocabulary that can be a bit daunting at first. The basic building blocks of networks are 'nodes' and 'links':

in a social network *you* are a node, your friend is a node, and the relationship between you is a link. On a rail network, each station is a node and the tracks that connect them are a link. On a mobile network, each connected device—phone, laptop, or sensor—is a node and links are created every time two or more devices communicate... You can probably see how this way of viewing the overlapping web of technologies in which we're all enmeshed might quite naturally shift our attention from singular individuals and places, to the nature and structure of relationships *between* them.

CENTRALITY & COST

Of course, not all nodes are equally connected. Some people have lots of friends, and some have very few. Some stations are at the far end of a rural line with two trains a day, and some are called Grand Central or London St Pancras or Berlin Hbf. There's also a term to describe these hyper-connected nodes: they have 'high centrality' because, when you look at how you can get from A to B, you find that many of your potential routes pass through these nodes. In other words, from these highly connected urban nodes you can quickly reach a lot more of the network than you can from one of those marginal rural nodes.

But this is the point where our fascination with social networks—and the data that they generate—gets in the way of a deeper understanding of why place still matters. Sure, your friend is pretty popular (it has even been shown that, statistically, your friends are probably more popular than you!¹⁷) and has 'high centrality' on Facebook, but he or she doesn't have to transmit *actual* 'stuff' on your behalf and there's no cost to those friendships. You might have 500 or more friends on Facebook, but you probably only interact with many of them around key life events such as weddings, breakups, and the arrival of children... So even if someone appears to be 'central' on a graph of relationships, many of them may be surprisingly peripheral to your day-to-day existence.

Transport networks, however, are different: every new node or link implies a real, and constantly increasing, outlay on construction and maintenance. You don't build a rail link between two cities and then decide *not* to run trains on it, nor do you build a hub airport and then mothball it unless you've made a serious error of planning. What the successful great rail interchanges such as King's Cross, the Gare du Nord, or Grand Central, and the key global airport nodes—JFK, LAX, Heathrow, Schiphol, Singapore...—have in common is that their high centrality means that you invariably *have* to use them. The economics of hub airports are fairly well-understood: they allow airlines to aggregate demand from many smaller places so as to put enough bums on seats as to make it viable to serve them. So centrality directly affects the cost of getting from A to B via C. In fact, without 'C', travelling between A and B by plane might be impossible... unless you have your own!

THINKING MORE DEEPLY ABOUT NETWORKS

None of this is to say that cost, in the sense of price, is the single variable that explains everything. The term that economists often use is utility, and while that is partly about price, it is *also* about things like convenience, comfort, speed, reliability, and even pleasure. Some of these can be measured and treated 'rationally'—we'd probably all love to fly

business if we could, but most of us just can't afford to do so—but some will play out at a more instinctual level—do you love your car or do you hate driving—and so on.

We could spend a lot of time talking about what utility *really* means for economists, but the point of this section is to get you to stop and think about just how many trade-offs we each make, unconsciously, when we chose *this* time to visit the client in person instead of just picking up the phone. Both have a 'cost', and we don't just mean the direct, monetary one. The key idea is that determining the 'cost' of using a particular network is a complex process, subject to a range of important and, often, subjective factors. Our choices will be a sophisticated (even if unstated and sometimes irrational) evaluation of the characteristics required and of the trade-offs between them. We look at some of the components in turn.

SPEED

When it comes to networks, speed is what we notice most. Would you willingly go back to the days of dial-up modems or horse and carriage? Most obviously, air travel allows passengers and freight to be moved halfway around the world in under 24 hours; but below about 1,000km, the question of speed starts to get a little more complicated: planes are still the fastest way to get from A to B, but A and B are often 10 or 20km outside of town because people don't like airports near their homes. So for city centre to city centre travel high-speed rail suddenly starts to look 'faster', even though your speed once you're actually *en route* can't compete, because of the time saved on checking-in, waiting for your luggage to appear, and travelling to and from the airport. Eurostar estimated that by 2015 they were carrying over 75% of the London-Paris and London-Brussels traffic¹⁸. The more cynical person might think that airports have been getting nicer over the past few years partly to extract more money from your wallet, but we suspect that it's mainly to try to help you to forget that you're going nowhere fast most of the time.

BANDWIDTH

Telecoms, of course, are effectively instantaneous. E-mails and phone calls arrive as soon as you send them (well, mostly), and mobile technology means that there is not even a wait to communicate with those who are away from their desk at the moment. This kind of speed dazzles us, but just because a network is *fast* doesn't mean that you can push a lot of data across it. Bandwidth is, technically, the overall (data) capacity of a network over some arbitrary period of time and, as fans of the 'sneakernet' are fond of pointing out: you can transfer a DVD-quality film (about 5Gb) on a 1Mbps broadband connection in about 11 hours, or you can copy it to a recordable DVD and walk it round to your mate's place in under an hour. So the bandwidth of the second option is substantial—effectively 11Mbps—since the entire film is delivered in under an hour.

Many of the largest generators of 'big data'—CERN and the radio telescopes—often still rely on *tape* archives for storing and moving data that doesn't need to be instantly accessible. Recently, the first ever image of a black hole was produced by radio telescopes from around the world working in tandem to create a virtual telescope with the effective resolution of a planet-sized mirror. The petabytes' worth of data was collected in April of 2017, but the processing couldn't start until December of that year when the last of the

960 hard drives used in the research arrived from Antarctica... by boat. There is a seemingly timeless truth to Tanenbaum's adage that we should "never underestimate the bandwidth of a station wagon full of tapes hurtling down the highway."¹⁹

But what's the bandwidth of a fully laden Airbus A380 holding 500 or more passengers, each with a lifetime's worth of experience and knowledge? We can only work from heuristics, but a 2016 estimate²⁰ is that a human being can 'store' something like 1PB of 'data', in which case we're looking at a notional capacity of 500PB—and the understanding needed to interpret it—able to get anywhere on the planet in less than 24 hours. There isn't a fibre optic network in the world that can come close to matching that kind of capacity; and even if you thought just a fraction of that knowledge was relevant, treated as a communications platform the bandwidth of a fully-laden A380 is truly breathtaking!

As we'll see later, the benefits of the improved bandwidth of an everyday 'communications technology' like face-to-face interaction can outweigh the time and money spent on travel in many settings; especially once we factor in all of the unspoken cues of facial expressions and body language! According to some researchers these unspoken signals are actually *more* important than the oral content of the message, and yet they are lost by all other modes of communication except, possibly, video-conferencing calls. Realistically, these differences are unquantifiable, but the very real extra 'bandwidth' of personal contact suggests that we can perhaps see business travel as a contemporary version of Tanenbaum's station wagon: it is the rapid movement of a firm's expertise and experience over trans-oceanic distances. Tanenbaum forgot the passenger!

COST

The monetary cost of both communication and transport has been falling for a long time: in 1930, a 3-minute transatlantic phone call would have set you back \$250 in 1990 prices; by 1995 it was less than \$1.00.²¹ A one-way flight from Shannon to New York in 1946 cost the equivalent of \$3,000; in mid-2015 Aer Lingus were offering "Shannon to New York or Boston from €209."²² For many, the falling cost of communication has been even more dramatic: VOIP, whether over public or private networks, has effectively made international calling free. 'Skype Out' credit to call someone on a landline in another country will set you back just 1.8p per minute for America, 0.9p for India, and 1.3p for calls to China. Drop the need to ring a regulated legacy network and the cost falls to £0. \$0. ¥0. €0. ₹0...

However, it's quite easy to forget that *relative* cost matters too because it changes the relationships *between* these networks and, consequently, our preferences for one over the other. Trans-European rail travel has gotten cheaper and easier in the past two decades: trains no longer stop at national borders for travellers to switch rail systems, and the Schengen Treaty means that our passports are no longer checked at borders either. But at the same time, the rise of low-cost, point-to-point airlines operating out of underused regional airports—like Ryanair's 'Milan' airport, actually in Bergamo—mean that air travel has become, *relatively*, cheaper still. Similarly, in rural Britain the declining reliability and frequency of bus services—together with an absolute increase in their cost thanks to privatisation—has led to an increase in the use of private cars even though they are, often,

the more expensive option! You simply can't look at the monetary cost of one form travel in isolation from all of the *other* networks that we can use for getting from A to B.

CONNECTIVITY

As we briefly discussed above, the 'hub and spoke' topology of airline operations means that connectivity is found in 'hub' airports: as more flights stop in New York, it becomes more attractive for other flights to stop there because you can connect passengers to more destinations without having to add new routes. So even though flying through a hub can feel like going a long way out of your way, creating hub airports is the best way to offer more flights between A and B (even if you have to travel via C) because it reduces the number of connections required between every possible pair of *other* places. This is why the concentration of flights in the New York airport system is out of all proportion to the number of people whose origin or destination is in this metro region alone.

Hub and spoke topologies are fairly common in physical networks—you get the same kind of thing happening for shipping and railways—but things work a bit differently in telecoms and social networks where there's no real cost to adding another link between nodes; 'friending' someone or dialling a *new* number doesn't require network reconfiguration or hard graft. In this situation we see something often expressed as 'Metcalfe's Law'²³ which holds that the *value* of a network is proportional to the square of the number of compatibly communicating devices or users. Or, in plain English: one phone is useless because you can't call anyone else, two phones have one possible connection, eight phones have 28 possible links, twenty phones have 190... and 10,000 phones have 49,995,000 possible links. This exponential connectivity of ICT networks is what makes them seem so much more *exciting* than adding a new runway or terminal.

CONVENIENCE

And, of course, digital networks are convenient; this comes in many forms: frequency (how many times a day can I use the service?), accessibility (how far must I travel to use it?), as well as comfort (how pleasant is it to use?). One of the paradoxes of modern life is that the blurring of the boundaries between 'travel' time and 'activity' time is that people are travelling *more*, rather than less, because mobile ICT is reducing the inconvenience of travel. We can ask "to what extent are ICTs providing *substitutes* for use of travel time and to what extent are they providing *enhancements*?"²⁴ All of these concepts are, of course, generally subsumed under the catch-all concept of 'utility' by economists which is quite a handy way of tidying up the mathematics, but it's not quite so useful for policy-makers or busy professionals trying to think about real places and real choices; between here, and there.

NETWORKS CHANGE, NETWORKS INTERLINK

So far we've tended to talk about the networks in terms of how the user registers their existing costs and benefits in terms of convenience, speed, cost, etc., and in how this impacts their conceptualisation of their 'utility'. Physical networks and the connections within and between them obviously change very slowly in comparison to digital ones, but this does not mean that they are preserved in amber: over time, even the most expensive

high-speed rail and air networks respond to shifting user needs. We can frame this process of change in terms of flexibility and integration.

FLEXIBILITY

By flexibility we mean a network's ability to respond to changes in demand and use over time, but this can just as easily mean changes at the level of nodes as it can the level of the links between them. So we can further break down this concept into nodal and link flexibility: for example, although there is quite a lot of coordination involved for safety reasons, there is no real cost to adding a new link between two airports, but there are a lot of costs involved in building a new airport. So the air transport network has high link flexibility and low nodal flexibility. In contrast, the rail network has very low link flexibility (adding entirely new lines is *very* expensive) but it might not be *that* difficult for the train to make a new stop on an existing route.

Adding the fact that networks change over time introduces the overarching concept of temporal flexibility to look at how quickly a network can evolve. It is, for example, fairly straightforward to add highway junctions incrementally as new roads and developments are built, but an underground metro line is pretty much an all-or-nothing proposition. In other words, cities don't build a subway line with two stops and expect to 'add to it later', they try to anticipate—or stimulate—demand for decades to come! Compare this to our telecoms infrastructure: over time we've gone from plain-old copper, to fibre optic cable and on to wireless, with each radical improvement being slowly rolled out across time and space without anyone really noticing.

THE PARADOX OF FLEXIBILITY

The conjunction of multiple networks with different degrees of flexibility means that our thinking about place runs counter to the assumptions of most pundits. If you are buying a house, you don't typically consider the availability of mobile reception or phone lines in the neighbourhood because you assume that the flexibility of the network is such that the phone company will add a connection if it is needed. Unless we really are out back of beyond, we take ICT networks *for granted* but spend rather a lot of time looking at, say, the transport network trade-offs because those services are not at all flexible.

It's this concept of flexibility that, we think, explains why a world of rural telecommuters is always just around the corner: by enabling us to work from *anywhere* ICT has simply taken itself out of the picture. So counterintuitively, the *more* flexible a network is overall, the *less* likely it is to be factored into our decisions; or, as Amdahl's 'Law'²⁵ would have it: it is the *least* flexible element of the *least* flexible network which determines the system's overall flexibility. In global transportation networks it's the major ports and airports that constrain our flexibility to move more stuff between A and B. In local and regional transport it's the heavy rail and subway systems that are the least flexible, often leading to people thinking it's a good idea to drive instead.

Firms are much more complex than households, of course, but the point about flexibility remains: businesses will tend to gravitate towards those places where they can best meet their mix of needs. And they will tend to focus on those places that provide the best access to the *least* flexible networks upon which they depend because those are the

needs that cannot be met elsewhere. So if a firm can meet its ICT needs anywhere, then what's left are their *other* network needs. You won't normally find a global management consultancy far from a major airport. And you won't normally find a data centre far from a reliable power supply. A restaurant doesn't require any of these things and, as a result, has a great deal more flexibility when it comes to location.

INTEGRATION

The other part of what makes telecommunications seem so *different* from other types of infrastructure is the way that they have penetrated and altered other networks: automated toll roads are a good example of what becomes possible through the integration of road infrastructure with ICT. Cars and trucks now whiz through toll plazas—if they exist at all—that were once the principal source of congestion on some highways. And few industries have been so reshaped by this kind of integration as logistics: it is now possible to track in real-time nearly any package or container from origin to destination across the entire planet.

We mainly notice ICT integration when it fails: being unable to get into your hotel room because a power failure means that your key card no longer works; or being unable to download an e-ticket to your phone and having to get a paper one issued at the airport. Integration problems aren't always this obvious and can have very *un*-sexy regulatory or institutional causes: in Europe this became particularly obvious as the national rail operators set themselves up to compete with the low-cost airline operators for city-to-city travel only to find that a host of competing national standards—and associated signalling technologies—would require the outlay of billions of Euros to correct.

We can also think about integration in a more pragmatic sense: airports are places that integrate air, road, rail and telecoms infrastructures to support the flow of people and goods, while an intersection between secondary roads may not even integrate technology to control the flow of traffic! So major international airports sit at the intersection of multiple types and scales of networks—local roads, regional rail, international air, and ICT—while a rural crossroads is simply a place where two links meet on the road network. Rationally, the more networks you are trying to integrate, the harder and more expensive it's all going to get, and the *less* flexibility you're going to have because *everything* needs to mesh for this to work.

THERE'S NOT JUST ONE NETWORK: THE 'PREMIUM' SERVICES

There are many ways to get from downtown London to Heathrow: taxi, bus, subway, 'regular' train, and the Heathrow Express. It's been said that the Heathrow Express is, per kilometre, the most expensive train journey in the world because a 1-way ticket to Paddington will set you back a cool £27. However, the Heathrow Express trip will also take you just 15 minutes compared to a car journey of at least 45 minutes—if you're 'lucky' enough to be travelling first thing in the morning or late at night—and a Tube journey of up to an hour. What distinguishes the Heathrow Express from the Tube or the road is that it constitutes a kind of 'premium' service in which we pay for the privilege of *not* stopping and *not* connecting to lots of other places along the way.

In other words, we're trying to buy our way out of the negative effects of heavy network usage: congestion, breakdowns, and delays. Similarly, France's TGV service is premised on the fact that it doesn't have to stop at every town *en route* from Paris to Lyon, or Paris to London. It's like a hub-and-spoke system for trains. But this sort of service is only possible between large 'nodes' with high centrality and, even then, it doesn't always work quite as well as expected: the success of business-only airlines operating between London and New York has, to put it charitably, been fairly mixed.

In transport, these premium networks—what some researchers have called 'higher-order' or 'upper tier' networks²⁶—are fairly obvious: they're usually distinguished by price (they cost more), by speed (they are faster), and by number (they have far fewer nodes and links). Premium networks also rely rather heavily on technology to manage flows—air traffic control systems, iris scanners and biometrics, etc.—and that adds to their cost. Perhaps the most 'exclusive' transport networks around today, even though in some ways the network itself is decidedly low-tech, are the parallel transit systems operated by Google, Apple, and the other Silicon Valley firms: you cannot buy your way on to them at any price, and they offer mod-cons that other business travellers would kill for.

The 'premium' exists in communications networks as well, though they are far less obvious: companies like SohoNet, Akamai and Cloudflare use private IP networks and cutting-edge technology derived from deep space satellite communications to ensure that their clients' data get from London to Hong Kong or Los Angeles just that little bit faster than it would over the public network. Here, access is controlled by price: these connections aren't offered as a service that you or I could buy for our home, but they *are* something bought by firms which depend on responding fractionally faster to queries as an essential cost of doing business.

When we try to envision the future, we should note that premium networks often shadow their less privileged brethren: HSR often parallels regular rail routes, and when it doesn't the costs can mount astronomically. The rationale for this shadowing is often to be found on the demand side: the big users and the high densities of users are in already-established locations with high centrality, so why would you run new infrastructure to riskier locations without charging a hefty premium? In plain English: why is 5G being rolled out in places that are already saturated with 4G, Fibre-to-the-Cabinet, cable modems and all the other types of high-speed networks instead of in places where you can still barely get online at all? That's the 'for he that hath, to him shall be given' nature of infrastructure provision, and this is another powerful example of, literally, path-dependency in network growth.

THE CHANGES

At each stage in their growth and evolution, the networks that emerged to move all of this 'stuff' around reshaped cities and their hinterlands to fit the technology. Railway stations grew their 'quartiers de la gare'. Docks collecting and dispatching goods to far-flung colonies exploded across the Victorian cityscape. And whatever you think about the idea that urban growth in the future is mainly going to happen around airports—giving rise to the 'aerotropolis'—there is no question that airports *have* attracted their own edge cities and satellite business districts. Plans have been made for new super-ports and for

‘airport cities’, and then, inevitably, for *ex*-docklands, and *ex*-airports like Croydon and Tempelhof.

The physical changes we’ve seen in cities are *less* associated with the spread of modern telecommunications than they are with changes in transportation itself. Yes, there may be a lot fewer docks, but the ports we have today are much, much bigger. The docks at Tilbury cover the same area as the City of London with its million-plus jobs; the Europoort Rotterdam complex is the size of the whole of Amsterdam; and if you dropped it on New York you’d easily cover Manhattan Island. Of course, these docks are heavily dependent on automation and telecommunications, but—and this is crucial—ICT plays no obvious role in the choice of location for these mega-ports, which is determined by the shape of the coastline, and their proximity to population centres as well as road and rail networks.

PACKET INSPECTION

We can understand this impact further by examining the technology of the information revolution a bit more deeply: for modern networks distribution generally occurs using some version of TCP/IP (Transmission Control Protocol & Internet Protocol) in which *everything*—video, email, data, text messages...—is broken down into generic pieces or packets. These can be transmitted anywhere in the world using a common addressing scheme such that a mobile phone user in Central London can talk to a web server in Outer Mongolia without anyone really needing to care how that minor miracle happened. TCP/IP separates the data from the ‘channel’ over which it is transmitted: DSL modems on copper landline networks, wireless technologies, or fibre-optic and satellite links²⁷... it makes no difference to the data.

But dig a little deeper and the difference between the Internet and the modern supply chains is no longer quite so clear: the containerisation of freight amounts to something neither more, nor less, revolutionary than the emergence of a ‘packet network’ for goods. Thanks to shipping containers²⁸, we no longer need to care, as they did in the days when the ports of London and New York employed thousands of stevedores, what is inside. As long as it fits in a container we can stick it on a boat quickly, transfer it to a truck easily, and handle the whole process using standardised kit. It’s hardly coincidental that this transition lines up with a massive increase in the volume of global freight: the analogies abound while the differences erode.

WHAT IT ALL MEANS FOR CITIES

This history of successive waves of change, and the dynamic of aggregation of services, suggests that it will be much more difficult for today’s less-connected towns and cities to leap to the front of the pack, and that the advantages accruing to the most-connected nodes will be cemented by upgrade processes. There are almost no examples of break out from this logic. The best case, in the world of international travel, is Dubai which—with colossal and sustained state investment in airport infrastructure and a state-run airline, minimal tax and regulation, and intense marketing of itself as a hub location and tourist destination—has managed to break into the dominant and self-reinforcing web of global

air travel by virtue of adding a highly connected node linking Europe, the Gulf, and the 'Far East'.

More intriguingly, research by far-flung co-authors on academic collaboration suggests that the arrival of a low-cost airline in your city could increase collaborations by up to 50% with the strongest benefits flowing to younger (and grant poor) and more productive scientists.²⁹ Air access? Rail access? City access... strangely, one thing that businesses *don't* normally take into account when making plans for the future is whether there will be any roads or Internet when they get there. In other words, it's not about *freedom*, it's about *constraints*. We're arguing that—with limited exceptions—firms don't really pay much attention to ICT as part of their big decisions: you don't choose Chicago over Seattle, or London over New York, because of the quality of its Internet connections.

THE PUSH AND PULL OF NETWORK EFFECTS

We've argued that understanding the impact of 21st century communications technology means thinking about *all* of it—not just ICT but also transport; not just bits of data but also the flow of products and the movement of people; not just how connections have helped determine urban locations, but also how they, in turn, determine where the networks go and where they grow; and not just what networks people depend on, but how much freedom and flexibility they have in their use. We need to think in terms of a spectrum of flexibility: at one end are the networks such as telecoms or roads that are capable of offering nearly ubiquitous service across space, while at the other end are the restricted 'nodal networks' like High-Speed Rail and air that bind development to specific sites. The first type tends to flatten space by making all areas equally accessible, but the second accentuates the differences between connected and unconnected regions.

For cities, this means that two powerful network effects are pulling in opposite directions. The networks which 'equalise' space exert a centrifugal force on activity and growth, spinning it outward and deconcentrating the urban form. The nodal networks, in contrast, tend to reinforce concentration, pulling growth in a 'centripetal' way towards the best-connected, most central locations. Planners and geographers would talk here about difference 'scales', and that would be a useful way to think about it: looking at the Eastern Seaboard's *megalopolis*³⁰, you see multinational businesses drawn towards the global networks that touch down in New York, Boston, and D.C., but those tendencies are then overlain by regional-scale infrastructures (rail services such as Amtrak, LIRR, and NJT... but the interstates too), and then comes the more local stuff (the busses and subways as well as local highways).

THE CENTRIFUGAL PUSH

The centrifugal forces have been, and remain, very strong: over the course of the Twentieth Century the pendulum swung strongly away from water and rail towards roads, and this seems to have brought with it an apparently irreversible trend of ex-urbanisation, lower densities and more diffuse travel patterns with greater 'polycentricity'³¹. The ubiquity of ICT seems to have accentuated this trend towards looseness of form and freedom of spatial choice. The effects have been dramatic: the suburbanisation of industrial and logistics activity thanks to the Interstate and motorway systems, the move of business

activity to office parks and campuses or big-box retail parks with lots of parking and lower land costs, and the emergence of new nodes of development often called ‘edge cities.’³²

Often located near an out-of-town interchange between major interstates or highways, the edge city is a rational response to infrastructure dependencies such as road in North America, or even road and rail in Holland. In some cases, Atlanta GA for example, the phenomenon is so substantial that the edge-cities have become a kind of Central Business District on the (road-) accessible metro fringe³³. What seems to be happening is that these emerging sub-centres are highly specialised, but that they are specialised in *different* sectors from the original urban core. So in the examples from France, the sub-centres are systematically biased towards manufacturing, construction, and transport, and away from personal and collective services³⁴. But in Canada, around Montréal for instance, the sub-centres each specialise in at least one high-value service as well³⁵. In short, the permutations and combinations of network flexibility—particularly of roads and ICT—enable a redistribution of activity out of the core for some, but by no means all, businesses.

We’ve also mentioned another emerging urban form, the aerotropolis, as the crystallisation of large clusters of activity around major airports. Schiphol, Amsterdam’s airport, is the prime European example, with its Zuidas (South Axis) development supported by road and rail infrastructure³⁶. In Korea, Songdo, being developed around Seoul’s Incheon international airport, is a conscious development strategy as well. And in the USA, DFW has emerged, midway between Dallas and Fort Worth, as an important business area in its own right, even though it’s largely just arranged around the airport perimeter. The mix of activities there includes, somewhat bathetically, ‘the world’s largest Infiniti car dealership’, but “its periphery has attracted scores of major companies to locate their headquarters nearby and has spawned upscale suburbs that are home to corporate executives and entrepreneurs willing to pay for the convenience of being minutes away from a flight to just about anywhere in the United States or the world.”³⁷

Less well-known outside of England is the presence of a large tech sector running across an arc of towns about 30 minutes from Heathrow. The new arrivals in the King’s Cross ‘Knowledge Quarter’ and around Shoreditch’s ‘Silicon Roundabout’ garner the media and policy attention, but far more people are employed by tech firms in and around places like Reading, Slough, and Maidenhead than in Central London. This industry was traced back to Britain’s military-industrial complex by Peter Hall³⁸, but its subsequent growth is a clear product of businesses responding to the locational pull of the international airport at Heathrow, and to the road and rail links into outer metropolitan London, but especially to high-amenity villages in the Cotswolds.

These are perhaps the most striking examples of responses to infrastructure potential and the flexibility that it offers. Underlying their growth is the fact that this centrifugal push is immensely powerful, has affected every urban region, and it has *not* been reversed by the much-heralded urban renaissance and revival of inner cities.

THE CENTRIPETAL PULL

So what accounts for the ‘pull’? If dispersion and flattening are such powerful forces, why *have* urban rents gone up? There is clearly no single or automatic driver towards deconcentration, and the freedoms and flexibilities of the “20th century networks” are far

from removing the vital role of busy central places. In fact, the rising cost of infrastructure, and the level demand needed to support it, may well mean that, as Feitelson and Salomon put it: “we have no reason to expect that the emergence of upper-tier networks and our increasing reliance on them will herald the ‘liberation’ from space envisioned in the late 20th century.”³⁹

Over time, high-accessibility areas will tend to draw in high-added-value firms which, in turn, stimulates demand for yet more infrastructure and greater connectivity. And those firms ‘add value’ by doing what exactly? Usually it’s bringing people and ideas together! Consequently, many businesses will find that it is entirely logical to congregate around the nodes of the *least* flexible network upon which they depend: “Advanced producer services (APS) firms increasingly use major cities as hubs for global business networks.”⁴⁰ This does not mean that other centres have no role—they will continue to thrive and to use the most modern networks—but the path-dependency of highly-connected nodes is focussing the high-end activity in a more and more concentrated way.

It was demand from business that led first to the Heathrow Express and, more recently, to the £18 billion being spent on London’s Crossrail 1. Crossrail 2, which doesn’t even have a price tag yet, is already being planned. And we don’t need to invent a new term to describe these areas where many networks overlap: looking at the pattern of settlements, roads, and canals in southern Germany more than 80 years ago, the controversial—because of his connections to Nazi master-planning⁴¹—economic geographer Walter Christaller called them ‘Central Places’. We think that central places remains a key concept for 21st Century town and cities, so we’ll be returning to this idea again and again.

DIFFERENT STROKES...

...for different folks. We’ve set out a somewhat binary choice so far: some firms need high-centrality locations, and some firms don’t. But the push-pull tension is overlain by an enormous range of factors which will determine how specific places or sub-regions can offer ‘packages’ which are sufficiently distinctive to influence locational choice. Alongside the pattern of high-order activity tending to cluster around network nodes whilst routine activities are exported from the core, all sorts of other variables come into play: market town ambience, university spinouts, and the lifestyle choices of entrepreneurs. ‘Compromise’ locations will work for some firms: perhaps sites that offer access to both Central London and to major airports, but from a semi-rural environment that punches well above its weight in terms of cultural offerings... as in the case of the Oxford and Cambridge sub-regions. But for others there just doesn’t seem to be an alternative to ‘being there’: culture and media; high-end banking and finance... unless you offer something truly unique with a name like Glyndebourne or Buffet.

It is the differing needs of the ‘different folks’ which will determine whether centrifugal push or centripetal pull is the strongest for any given business or location. In principle, businesses will always find areas with greater connectivity more attractive than areas with less connectivity. But which connectivity? Not every business needs every network: a furniture-maker *probably* doesn’t factor in airport location, but a global consultancy or logistics firm does. So even before we start to think about the needs of

individuals and individual firms—which we’ll do in much greater detail in later chapters—we can still begin to see the outlines of different ‘spatial logics’ influenced by the mix of networks, the degree of centrality, and the mix of connections required to ‘do business’ at particular (geographic) scales.

To economists, these choices can all be expressed by the ‘cost’ of travel (not just the price of course, but all the other convenience and time elements that we factor into our travel choices). Instinctively, we know that knowledge-intensive firms experience these ‘costs’ differently from manufacturing ones; however, explaining why this is, how it works, and what the consequences are takes up much of the rest of the book! We’ve sketched a picture of networks, of all kinds, offering unprecedented speed and capacity; and of an emerging pattern where those networks can *simultaneously* permit more choice of location and concentrate development around a few highly-connected places. We’ve identified, as key to understanding locational choice, the degree of flexibility that firms and households have in terms of the infrastructures on which they rely. That means understanding the specific mix of types of mobility and access that firms need, for the specific markets they serve and, their business-specific reliance on moving some mix of products, people, and data around. It’s time to take a look at how these ‘central places’ take advantage of, and react to, the new levels of connectivity: Chapters 3 and 4 will now look at how the markets that firms are in, and the transactions that they engage in, relate to the framework of communication and space that the networks provide.

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⁴ Miller, William (1970) *A New History of the United States* London, Paladin (3rd.ed.)

⁵ Aspin, Christopher (1969) *Lancashire: the First Industrial Society*, Helmshore: Local History Society (p.14)

⁶ Cockburn, Henry Lord (1888) *Circuit Journeys* p.268, Spring 1845, quoted in P.J.G. Ransom (2013) *The Iron Road* Edinburgh: Birlinn Publishing (pp.56–7)

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¹² *Whitaker’s Almanac* (2000) London: The Stationery Office

¹³ Office of Technology Assessment (1995) *The Technological Reshaping of Modern America* Washington DC: US Government Printing Office (p.106)

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¹⁵ OFCOM (2018) *Annual Monitoring Update Postal Market*, Executive Summary para.1.10

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