Holding together logistical worlds: friction, seams and circulation in the emerging 'global warehouse'

Journal:	*Environment and Planning D: Society and Space*
Manuscript ID	EPD-2015-0195.R2
Manuscript Type:	Article
Keywords:	logistics, distribution, storage, seam space, cargo mobilities, supply chain capitalism

Holding together logistical worlds – revision 2 – September 2016

Abstract:

This paper examines logistics in the space of action between production and consumption to provide 1) a rethinking of logistical power, not as seamless flow but through seam space and friction; and 2) a re-conceptualisation of cargo mobilities, as the dynamic articulation between things being freight cargo, and being products and goods. The paper uses empirical research on cargo movement in Northern Europe to reveal the frictions resulting from freight cargo's spatial ordering and from systemic imbalances in trade flows. It shows the multiple lines of friction produced by and productive of cargo mobilities across maritime and terrestrial space. It argues logistics is an art of accommodating this and creating competitive advantage through making interruptions, discontinuities, or seams in the spaces of flow. This is done through different temporal logics of ordering physical cargo sequenced across maritime and terrestrial space. The paper further shows the frictions between the physical spaces and flows of freight and the corresponding code-space and data flows. Bespoke corporate systems translate freight cargo to data and provide visibility to actors such that logistical and regulatory work can be anticipated and planned. Yet they do so through specific lines of sight. Bespoke systems also create seam spaces between networks as they simultaneously make frictions between rival corporate systems. The effect is to generate a contested, fractured space in which at stake is whether logistics works to further the interests of lead actors in the distribution chain linking up the global factory or as a tool of supply chain capitalism that spans continents and connects material supply to consumer, in which logistical actors increasingly perform the role of contractors in a global warehouse.

Key words: cargo mobilities; logistics; distribution; supply chain capitalism; seam space; storage

1: Introduction

In the last fifteen years, in response to the mobilities turn, there has been much research in the social sciences dedicated to flows of people. Research goes beyond classic approaches to migration that focused on outcomes or tourism that emphasised destinations, to examine the practices and processes of mobility itself. Studies have addressed how motion creates communities in daily routines (Edensor 2011, Wilson 2011) and binds nations (Verstraete 2002) as well as 'passengering' across multiple modes of transport (Crang and Zhang 2012; Laurier et al. 2008; Watts, 2008; Bissell, 2010; Jain, 2011). Since 9/11 there has been an understandable focus on border security and governing people's movement through biometric passenger data (Amoore, 2006; Amoore & de Goede, 2008; Adey, 2009). By contrast, the equivalent flows of freight cargo around the world, or cargo mobilities, have only recently attracted sustained critical attention (Nordstrom, 2007; Cowen, 2010, 2014; Martin, 2013, 2014; Birtchnell et al. 2015), with most accounts focusing on the shipping container, or box. For sure freight cargo has long figured in the field of transport research, but there freight itself is largely subordinate to interests in shipping lines, their global networks and the importance of ports to urban and regional economic development (e.g. Ducruet & Lee, 2006; Olivier & Slack, 2006; Wang et al. 2007; Ducruet & Notteboom, 2012; Notteboom et al. 2013).

Critical cultural accounts have focused on the shipping container as an 'image of an economy' (Klose, 2015). The image of 'frictionless, well-ordered organization through standardized containers makes the container attractive as a metaphor. It evokes a neutral medium, a pure movement of units of information, production, and consumption on the circuits of systems' (Klose 2015, p76).More tellingly, Allan Sekula charted how these 'mundane and omni-mobile boxes (…) make the global factory possible' (Sekula 2002, p 7); 'transform(ing) the space and time of port cities, and mak(ing) the globalization of manufacturing possible' (Sekula & Sinclair, 2000, p 411). Building on this, we argue that if there is a metaphorical 'global factory' then it is enabled by a corresponding 'global warehouse' that not only holds goods in motion through devices such as the container but coordinates the flows of goods as cargo through space and time. Having rendered the globalised economy visible and apprehensible, the recitation of the container as icon risks reinforcing an image of an apparently labour-free, abstract and homogenised space of seamless flows rather than its critical opening. Arguably, Sekula's focus on boxes and ports echoes how capitalism itself pacifies and homogenises the spaces of the ocean and the movement of cargo (Steinberg 2015). His image of ships as 'floating warehouses' is a useful step but it only takes us so far in understanding the workings of, and work inside, the 'global warehouse'.

Focusing on the container occludes what we term logistics-in-action, operating in what Cowen refers to as the 'space of action' between production line and consumption (Cowen, 2010 p 614). Recent work in the field of critical logistics by scholars such as Cowen (2014) and Neilson (2012) has begun to move away from a focus on the military and political origins of logistics to unpack the calculative devices and spatial orderings in what Anna Tsing (2009b) called supply chain capitalism. This has set the agenda for empirical research (Hepworth, 2014; identifying reference removed) that has exposed the differences between logistics as idealised and as practised and shows that it is too easy to be too enamoured of the story of the shipping container. Examining logistics-in-action reveals the importance of queuing trucks, vehicle booking systems (VBS) and port congestion, and the work of moving empty containers. It points to inefficiencies, rupture points, glitches and displacement effects. As such, it is the starting point for rethinking logistical power (Neilson, 2013, 2015), and indicates that frictions and interruptions are not aberrations, or external shocks, but part of how value is made and captured. Analysing logistical power through frictions and interruptions therefore is essential to the further development of the field.

As Hepworth (2014, p 1128-9) remarks, it is not enough in this regard to focus on the existence of frictions and showing the importance of 'seams in flows imagined to be seamless' (idem. p 1129; Neilson 2015). Rather, to generate an alternative account of logistical power requires consideration of 'the tension between the optimisation of specific parts of the supply chain for the benefit of particular actors versus the optimisation of the entire supply chain' (idem 1129; Neilson 2013, 112; 2015). The production of obstacles, sudden turbulence, and stillings in freight flow may be deliberate strategies or tactics of specific actors to gain advantage/capture value. As Tsing (2009a, p 347) argues, supply chains only exist due to diversity and, for all their claims to create a 'universal legibility created by standardisation', multiple and competing actors seek to capture value and/or displace costs by 'inserting new forms of incommensurability' into the system. As she has it, the 'productive friction of global connections' is about 'the awkward, unequal, unstable, and creative qualities of interconnection across difference' (2011, p4). A focus on supply chains, then, reminds us that these are not just linear value chains, from sub-contractor to supplier to retailer, where value is created in the product, but that there are also competing and clashing logistical actors for whom value lies in how those products are translated into freight. Critical here are two transitions – first, products' consolidation as cargo (how in the argot of logistics companies it is 'unitised' into freight) to enable its physical mobility, through the apparatus of freight movement (boxes, ships, trucks, trains etc., transport infrastructure and software), and second, cargo's deconsolidation to become goods for the client, be that a retailer, wholesaler or manufacturer. As we show, these processes of consolidation and deconsolidation are central to logistics and critical to rethinking logistical power, not least because they establish the existence of a seam space that both works to distribute value and enable accumulation by actors along the supply chain.

Examining this seam space requires a close, and empirical, engagement with logistics-in-action, specifically with how logistics moves freight cargo, and how freight cargo moves through logistics. Work on logistics-in-action necessarily has to choose specific points and sites of intervention and flows to investigate. If the box has been seen as the vehicle of flows, then the port has been privileged as the site of logistical operations (Olivier & Slack, 2006; Martin, 2013; Hatzopoulos, 2014; Hepworth ibid; Stenmanns & Ouma, 2015). This focus occludes two important aspects of contemporary logistics. Firstly, much of the work of bundling and unbundling cargo has been displaced from ports to warehouses and distribution centres (DCs), where containers are consolidated (or 'stuffed') and deconsolidated (or unloaded). Second, therefore, attempts to control and exploit logistical labour have moved beyond the archetypal struggles of port stevedores that have provided much of the political impetus for research on critical logistics (Cowen, 2007; Neilson 2013, p 106). Rather, these struggles are being enacted additionally beyond the port, in less visible and less celebrated spaces such as DCs and truck parks (Bonacich & de Lara 2009; Yu & Egbelu, 2008; Cidell, 2015; Gutelius, 2015). This transformation underpins the empirical research that informs the paper. Conducted in 2013-14, the research focused on industries and businesses defined by, or heavily dependent on, freight cargo movement. It comprised 9 months of qualitative fieldwork in and around the owner-driver sector of container road haulage in South East England, interviews with UK, Belgian and French port managers, and with shipping owners, freight forwarders, logistics providers, product warehouse managers, border inspection teams, and trade facilitation and customs experts based across the UK and Hamburg-Le Havre range. The accounts of these actors and observations of actual practices show that logistics involves volumes that surge and overflow as well as flow, and are comprised of more heterogeneous units than accounts of containerisation suggest. Interruptions in these flows areas often intentional as they are unintended but inevitable, and the smooth space of seamlessly integrated and coordinated flows promised by algorithmic software turns out to be punctuated by seams. Logistical power creates a patchwork built from multiple legacy systems and institutions across modes of transportation. It is marked by inter-institutional tensions between the priorities and outlooks of different actors, each wrestling to exercise control and capture value. Seams result from the continual need to stitch the competing actors and their systems together. In recognition of this, we argue that freight cargo flows are held together by logistics, not as seamless flows of unitised spatial order in a homogenised abstract space but by creating temporal gaps for the coordination of networks of freight cargo flow, across and between maritime and terrestrial space.

The paper is structured in three main sections. Section 2 establishes the importance of not just the aggregate volume of freight cargo flows but the multiplicity of standardised freight units. Multiplicity demonstrates that, far from being a seamless system of flow enabled by the standardised unit of the container, freight cargo flows are heterogeneous, characterised by a need to integrate multiple spatial units, and they thus have inherent frictions. Section 3 builds on this to establish the importance of planned interruptions to and for the coordination of freight cargo movement. Planned, intentional pausing in the physical flow of goods is distinct from unplanned interruptions that disrupt cargo flow and that are chiefly an effect of weather, infrastructure breakdown, strikes and labour unrest, and piracy. The last two categories in particular have attracted attention from scholars in critical logistics – with the effect that planned interruptions have been overlooked. The latter are essential to freight cargo flow, providing the space-time in which products are assembled to become freight cargo, and in which units of freight cargo from one actor are assembled into suitable and moveable volumes by another. These planned interruptions are not frictions to be overcome by better tailored algorithms and tighter control but a means to exploit the inherent frictions in the system of flow; they are not the obstacle but rather the means to the space-time coordination of freight cargo and thus to the integration of the global factory and the global warehouse. As such, supply chain management analyses that equate efficiency with speed and slowness with value loss and inefficiency need qualification (Paché, 2007). In Section 4 we show how these planned interruptions relate to logistical space as code-space, by focusing on an example of the data information systems that coordinate freight cargo flows. These information-based systems produce a seam space that holds freight cargo flows together across multiple maritime and terrestrial spaces; they do so by making space for the planning and execution of discrete forms of logistical work, at the land-sea interface of port terminals and beyond. Yet there are clear rupture points in the seams produced by these systems. They are indicative of the distinctive interests of particular parts of the supply chain and of the existence of multiple logistical systems. The result is a fissured logistical space with tension between different 'lines of sight' (Amoore, 2009). We conclude by considering the implications of these findings for further research.

2: Unpacking freight cargo – surges, gaps and the frictions of packaged inefficiencies

Whilst the critical logistics literature highlights the rise of an abstract space created through unitisation and standardisation of cargo flows (Martin, 2014), a focus on logistics-in-action establishes that economic actors are continually constituting different volumes of unitised cargo; logistics therefore is always an achievement. Shining a light on logistics-in-action shows, first , that unitised freight cargo is more diverse than the literature suggests, with multiple spatial metrics apparent in and producing freight movement, and second, that these different unitised volumes must be knitted together in order for freight cargo to flow.

For most economic actors (e.g. manufacturers, service providers, retailers), cargo flows relate to exchange, that is, to the buying (ordering) and consumption (sale or use) of particular goods by these actors. Critical work has highlighted that logistics, combined with ICTs, has enabled the reduction of large stock-holding inventories, and the rise of just-in-time (JIT) production. Instead of static inventories, JIT holds inventories in (slow) motion. Here the container functions as a form of storage, but one that is not rooted so much as routed (Hirsch, 2013 p 18) - be that on ships and being taken to or from ships via road or rail transportation that, together with warehouses and DCs, comprise a global warehouse of goods in storage yet on the move. For organisations whose products are either globally or internationally sourced and/or comprised of such parts, anticipated demand leads to advance purchasing of unitised cargo space. Over the course of a year, a major retailer, for example, will need a very large number of guaranteed container units on multiple ships just to bring goods to market. [1] Typically, that space will involve liner routes that offer services between Asia (often China) and Northern Europe and North America-Asia, but it will often also involve space on feeder routes plying regional and intra-regional services, as the global supply chain extends to lower cost labour markets beyond China, such as Indonesia, the Philippines and Bangladesh. Procuring ship space and arranging onward land-based transportation is the task of logistics be it in-house or outsourced (Aoyama & Ratick, 2007; Coe, 2014).

The distribution industries broadly correspond to the major modes of transportation; in them unitised volume drives revenue and is closely related to economies of scale. Nowhere is this clearer than the tendency within ocean-going shipping to ever larger container vessels

[1] Given volatility in spot freight rates, our informants suggested logistics providers seek to procure some 70% of a major retailer's annual shipping requirements from a shipping line at an agreed rate. The remainder would be purchased at spot rates, but the whole is underpinned by a substantial derivatives market in which hedging is widespread.

whose capacity is denominated in standardised Twenty foot Equivalent Units (TEU). Whereas in 2006 a large container ship was capable of carrying 9000 TEU, by 2012 this had reached 13000TEU, then in 2013 Maersk's Triple E class exceeded 18000TEU and in 2015 the Mediterranean Shipping Company's *Oscar* set a new record of more than 19200 TEU. The effects of these scale economies include the concentration of such vessels into the small number of ports that can handle them and a growing tendency to focus port infrastructure on servicing such vessels, rather than accommodating smaller ones. The result, particularly in the world's large container ports, is freight cargo flows that have large surges. Indeed, West coast US ports have been subject to repeated disruption as the volumes from single ships now overwhelm distribution capacities. The efficiency gains of 'mega-ships' for maritime shipping companies, then, create overflows and frictions for other actors in the distribution chain.

The annual trade cycle across the key global trading routes itself has surges and rhythms. It reflects key consumer festivals as well as seasonal consumer markets, and works in anticipation of peaks in demand. On the major liner shipping routes peak volume occurs in the period July-September, as retailers' orders arrive in ports ahead of Christmas trading for delivery to stores or indeed repackaging into couriered parcels. It is not just Western festivals that drive schedules, Chinese manufacturers and western retailers alike seek to push goods through the Chinese ports in the weeks ahead of the Chinese New Year and attendant shutdown. Seasonal trading patterns are illustrated by a major UK DIY retailer. Whilst there is a steady flow of imports across the year associated with the basic range of goods, surges occur in February and April as well as July/August, and are characterised by large volumes of containers full of seasonal products. Particularly instructive is the 11000 TEU of artificial Christmas trees shifted through one port for this retailer in July/August 2013. They were transported to regional DCs in September/October and then to stores for mid-November. It shows how, at key times, major retailers push increased volumes through their supply chains. In this case, 1900 in-bound boxes were being handled per week through that one port for this retailer, compared to a norm of around 1000. In practical terms, that is double the intensity of boxes to be moved off vessels, into port stacks, shifted to road transportation and thence to DCs. Multiply that across multiple major retailers, each pushing goods through a small number of ports, and the even fewer that can handle the largest container vessels, and it is possible to see how, at key times, port infrastructure can be overwhelmed with containers, how backlogs develop, and how – as infrastructure has to work flat out for longer periods – equipment breakdowns happen and delays come to be a common feature of freight cargo flows. Equally, surges in containerised cargo have major effects on the road haulage industry, producing further friction as port and road congestion, as a container vessel offloading say 3000 TEU translates to 3000 individual truck movements. Intermodal train solutions also have knock-on effects, as in California, where pooling containers onto double-decker trains produces surges of different scale, and, whilst they reduce truck congestion, they produce other congestion at multiple level crossings (Cidell 2012, p 242). Surges, then, whilst enabling the strategies of particular actors, produce frictions in the distribution system. As we shall see in Sections 3 and 4, the nature of these frictions reflects the power differentials between economic actors.

Freight cargo flows are not just about the movement of physical goods. They involve the packaging of cargo space to allow movement across, and between, maritime and terrestrial space, and across different terrestrial spaces. The significance of the container in this regard is impossible to overstate. It is the means by which intermodal movement between ocean-going and land-based modes of transportation has become so much quicker and less laborious. Nonetheless, the container is not quite the means to unitised standardised packaged efficiency detailed by Martin (2014). Indeed, the very term Twenty foot *Equivalent*

Unit reflects that this is a metric for a range of actual sizes, some relatively uncommon, others – such as the 45 foot hi-cube that is in widespread use on European short-sea routes – more commonly used. Add to that temperature-controlled 'reefer' boxes, which must be continually plugged-in to a power supply to keep products within designated temperature thresholds, and the diversity of packaged efficiency, along with its implications for the units of cargo conveyance, is clear. The shipping lines must have the capacity to move units of multiple standards. Accommodating these multiply-sized units simultaneously is not straightforward since vessel space for non-standard boxes is restricted.[2] The plurality of unitised standards starts to disrupt any sense of a singular flow ordered by homogeneity, revealing instead an interweaving of flows of heterogeneous units.

The multiplicity of unitised standards in containers is compounded when attention shifts from the container itself to the sub-units that are used to package products inside containers. These units perform two roles. First, they are the means to the safe, stable internal packing of containers on ships. Second, they enable the efficient movement of goods within DCs, warehouses and yards, and in turn allow for less-than container loads to be consolidated by logistics providers. Chief amongst these units is the wooden pallet.

The humble pallet is largely invisible in the literature that celebrates the container as the enabler of globalisation (Broeze, 2002; Cudahy, 2006; Levinson, 2006). Yet it is this form of packaging, and not the container, that allows products to be moved from a manufacturer's premises to the inside of a container, and thence from a container into, within and around warehouses and DCs. The pallet therefore provides a logic of spatial order across the distribution chain, and does so in a way that goes beyond the reach of the container, which

[2] For example: the number of reefer boxes on any one vessel is conditioned by the power points available, whilst height dimensions mean that a 45 foot hi-cube container can only be placed on the top tier of containers on a deep sea vessel.

– although it allows goods to travel across and between maritime and terrestrial space - stops literally at the door of factories, warehouses and DCs. Pallets too come in an array of shapes and sizes; even more so than containers. There are UK standards and EU standards, as well as US and ISO standards. The absence of inter-regional standardisation leads to problems in packing pallets in containers. For example, the 'euro pallet' (the industry standard in continental Europe) is too big to fit in a safe, stable parallel-stacking arrangement inside a standard TEU. However, this arrangement does fit inside a 45' hi-cube container. In this way, we can see how the container alone is insufficient to enable goods to flow across and between maritime and terrestrial space and how freight cargo flows instead involve multiple unitised standards that cut across and link an integrated, hierarchical and scalar system of ship-[truck-train-barge]-container-pallet, but in several potential ways. The global warehouse is stitched together from multiple logics of spatial ordering.

In systems of flows involving many ways of integrating multiple unitised volumes, friction as packaged inefficiencies is never far away. Signs of packaged inefficiency include half-empty containers, those containers whose flow is disrupted by a need to wait for vessel space, and others that are problematic to unload due to being jammed with pallets of the wrong size. But the largest structural inefficiency by far is the abundance of empty boxes (Neilson, 2013, 2015; identifying reference removed). Empty boxes are everywhere in freight cargo flows. Correspondingly, shipping lines and haulage companies dedicate much work to their 'repositioning', whilst ports typically have at least one terminal dedicated to their storage (Rodrigue, 2013). At the macro level, 'empties' are an inevitable effect of imbalances in global trade: they are trade imbalances rendered material. Thus, there is a surfeit of empties in economies where imports greatly exceed exports, such as the UK and the US. Here mountainous piles of empty containers are a constant presence in the port landscape (Cidell, 2012). Empties also result from imports and exports in a country coming from different regions and ports.[3] Countering such imbalances as efficiently as possible is a major task for logistics providers; entire analytical teams attempt to match orders and anticipated orders to the location of empties, and arrange their repositioning accordingly.

3: Unpacking cargo mobilities – coordination, friction and the interruption of flow

When Brett Neilson remarked that cargo-mobilities are most effectively understood 'when we subtract the cargo – the container's contents – from the box' (2015, p 61), he was right to shift attention from the products to how they are moved. But it is the dynamic relation of the box and its contents, that is enacted upstream and downstream of port terminals, that is crucial. In order for cargo to become mobile it must first be assembled. That – as much as physical movement – is the work of logistics providers. The integration and coordination of boxes with content is the means by which containerised cargo moves between, within and across logistical spaces, as well as between other economic actors.

For cargo to move through logistical spaces involves constituting unitised volumes of freight, a process known as consolidation. For cargo (the concern of logistics) to translate back to products (the concern of manufacturers, wholesalers and retailers), however, requires that consolidated freight be 'deconsolidated', or to shed the things that make them cargo (ships, trucks, trains, barges, containers and pallets) and become products again. The processes of consolidating and deconsolidating cargo are complex, and essential to the flows and frictions of cargo mobilities. The following example, taken from research conducted in and around the owner-driver sector of the container road haulage industry in the UK in 2013, illuminates

[3] In the UK the shipping lines endeavour to get empties to Scotland for whisky exports, whilst in continental Europe, Germany is the desired repositioning location. In global terms, the shipping lines will routinely ship empties W-E, whilst at least one major line uses their vessels as a mobile store, effectively repositioning boxes through the network.

some of these processes and the frictions that result. This 'box' is an instance of the global factory that in this case connects plastic bag manufacturing lines in China to a small wholesale business supplying the catering industry in the UK.

> Box TEMU 365XXXX 22XX is an import load, described on the manifest as containing 17 tonnes of LDPE plastic bags from China. It was collected from London Thamesport late afternoon on 7 November and delivered to a warehouse on an industrial unit in rural Essex at 9am on 8 November, one hour ahead of the booked delivery slot. There four people are waiting for it: a forklift truck/driver, 'the boss', and two young lads described as 'the labour'. At the back of the yard are piles of pallets. The seal on the container is broken with a pair of B&Q bolt-cutters, and the doors opened to reveal a container stuffed to capacity with tiny cardboard boxes. There are no pallets, no dunnage, just boxes; thousands of them, given the capacity of the container. 'This is going to take some time' says the driver, with ironic understatement. Four hours and 15 minutes later, the box has finally been emptied of boxes of plastic bags by the two lads. They are in a muck sweat, and the cardboard boxes are now in multiple piles, roughly sorted by size, awaiting placement on pallets, and loading into the warehouse by the forklift truck driver. Contractually, deconsolidation from a container is allocated a maximum waiting time of three hours by the UK road haulage industry. This driver's arriving early has given them an hour's grace period on their 10am booking, meaning that they get away without paying the demurrage charge that would normally be owed. The container itself, now empty, is returned to London Thamesport, where further conversations disclose some of the back story to its latest journey. The freight manifest for TEMU 365XXXX 22XX was created on 9 September 2013. In early

> October the box left Ningbo bound for Rotterdam on an Evergreen vessel, where it was trans-shipped onto the Rotterdam-Thamesport feeder, eventually arriving at Thamesport on 3 November, before being released for road transportation late on 7 November.

Four points emerge regarding the friction of cargo mobilities. First, the labour intensity of deconsolidation is clear. In the UK that work has to be completed inside three hours, otherwise fines (demurrage) are incurred. So 3 hours of waiting time for truck and driver are normal. Second, containers may be standardised units, but varying practices of packing have effects on the labour intensity of their consolidation and deconsolidation. A characteristic of containers imported from China is that they are packed 'high and tight' to maximise volume usage for the shipper. In-bound boxes from China, then, are stuffed full of un-palletised contents. A container of shoe products is stuffed full with small cardboard boxes. So, multiply this up, and the labour intensity of deconsolidation for a major UK footwear retailer, importing say 1000 containers a week, where each container will contain different sizes, and potentially different models, of shoes becomes clear. The shipper has made the most efficient use of box space, with the effect of more friction in deconsolidation. That friction is felt most keenly by the logistical labour involved in deconsolidation – often temporary and subcontracted staff. For DC workers, as well as truck drivers and road haulage companies in the UK deconsolidation is frequently too much work to complete in too little time. These frictions are also systemic frictions, borne of fundamental differences in labour regimes between China and the UK, and also the ability of lead retailers (e.g. Walmart/ Asda) to mobilise casual labour and displace costs back down the supply chain. Financial penalties for delays (demurrage) in themselves are both indicative of attempts at the system level to keep things moving and an admission by UK logistics providers of the friction in (de)consolidation and its effects in costs on their businesses. However, more powerful consignees (particularly large retailers) often refuse to pay the demurrage that ought to be incurred when trucks are delayed at DCs, as they frequently are. So, in the UK, the costs of the friction of deconsolidation are displaced onto the road haulage industry. Queues of trucks parked up in lay-byes, on hard shoulders and in overnight lorry parks are all manifestations of drivers who have run out of driving time (identifying reference removed), often as a direct effect of delays in (de)consolidation. Not only does this disclose the lines of power in logistics provision, it makes roads into a form of state-subsidised warehouse (Keiller 2013).

Third, cargo mobilities involve the coordination of multiple temporalities across multiple networks. Friction is an inevitable effect of the resulting 'arrhythmia' (Neilson 2013). At one temporal extreme is current 'slow steaming' across maritime space. The current global downturn has reduced demand for vessel space causing plummeting shipping rates, to which shipping companies have responded by reducing speeds, to reduce fuel costs and keep more ships laden and at sea, rather than idle and incurring port charges – so Ningbo-Rotterdam at the time of writing takes 52 days (c.f. 21-23 days in late 2013 above). At the other temporal extreme is the one hour allocated for a truck driver collecting a container from a busy UK port and the scheduled delivery window to the consignee, and the three hour window for (de)consolidation.

In between these two temporal extremes is the work that goes on inside port terminals, which is governed by the logistical software of terminal operating systems (TOS). This work entails grouping containers that arrive by land at the port in stacks, in such a way that these can be grouped for loading onto vessels due to berth, and taking data from arriving ships about their cargo and planning the sequence of offloading those containers, onto the quayside, back onto the vessel, into stacks and reordering containers in the stacks for onward land-based transportation. Various ports trumpet the success of their software in orchestrating this ballet of box moves. The world's most efficient port in 2013 was Yokohama managing 163 container movements per hour – though the world record remains with Singapore that in 2001 managed a ship at 280.4 moves per hour (Gordon et al. 2005). In contrast to this picture of ever accelerating automation, it is worth noting that major UK ports like Southampton, averaged 71 container moves per hour and Felixstowe, the UKs largest container port, 49 (Journal of Commerce2013, page 16). Suboptimal performance can be due to physical factors like exposure to wind (Felixstowe); more generally it reflects how port terminals operate a patchwork of software systems relating to discrete areas of work, so integration between software systems is often hard to achieve (Bierwirth & Meisel, 2010- see section 4 below). Further, as Hatzopoulos (2014) notes, whilst TOS appear to possess an all-encompassing power boxes get out of place in port stacks, misplaced, and even lost. Friction, then, is visible even inside the supposed heart of algorithmic logistical power, the port terminal.

Then there is the challenge of network coordination across maritime space. Ships do not just sail anywhere. Rather maritime space is constructed around largely fixed patterns of connectivity, or the 'motorways of the sea'. There are specific lanes, and specific routes with specific timetables, on which space may be chartered but where not every place is connected evenly. Shipping lines, then, carve the oceans into network spaces – with hubs and connecting feeder lines (Ducruet & Notteboom 2012). Shipping lines compare port terminal performance based on a measure of hours-at-berth divided by containers moved (on and off). They have little interest in what happens to the containers. Rather they want to ensure that a 4-6000 TEU-vessel is only in port for a day, whilst bigger vessels, normally carrying some 10000 - 13000TEU, such as service the Ningbo-Rotterdam route, would be looking to be in-berth for no more than 36 hours. Connecting to these mainline services is a network of much smaller ‘feeder’ services (1000-1500 TEU) plying short sea routes, such as Rotterdam to Thamesport. The schedules for feeder vessels must anticipate likely demand, coordinate with mainline carrier schedules into the major container ports, and also allow sufficient time for the loading and unloading of vessels. Whilst client analysis enables anticipation of likely patterns of demand for feeder vessel space, coordination is tricky to enact in real time, and is compounded by schedule integrity, or rather its lack. On the mainline routes it is rarely above 70%, and as low as 60% for some carriers. Vessels may be off-schedule for both planned and unplanned reasons. Slow steaming, bad weather, and maintenance issues all have major ‘ripple effects’ on network coordination but their effects are felt particularly acutely by actors operating in the more restricted time windows that comprise short sea or feeder routes. Moreover, schedule integrity is falling in a depressed market, as carriers prioritise costs over reliability, and ‘blank sailings’ are appearing in port timetables where a vessel is so out of place that it skips a scheduled port call. Indeed, February 2016 saw the worst reliability figures for a year with more ships missing their slots by longer margins.

Friction, then, is everywhere in the movement of cargo. A fourth, and final, point therefore is that logistics works through this known friction. There is purposeful pausing, or interruption, of flow that is most visible in the spatialities of storage that are critical to the achievement of coordination. There are multiple forms of logistical storage space. They include space to assemble stuff such that it can become containerised goods (e.g. warehouses); port stacks that enable containers to be consolidated as vessel loads, and then offloaded from vessels to await road transportation; and yards, warehouses and DCs, where container deconsolidation occurs and where products are reconsolidated as saleable goods.

In sum: cargo mobilities are marked by multiple frictions and discontinuities that are both planned and unplanned. Logistics knows this, and controls and coordinates frictions through the intentional pausing, or interruption, of physical flow, that is, by making discontinuities. Planned interruptions also work to buffer a system in which unplanned interruptions are relatively commonplace, by displacing problems and costs onto less powerful actors. Pausing flow is essential for ordering cargo mobilities; without it there would be cargo disorder. Storage space, both upstream and downstream of port terminals, as well as within them, is central to this. It provides the space-time in which products are held-over, assembled and transformed to become standardised unitised freight, and where standardised units (cargo) can be re-ordered back into goods. Equally important, however, are the frictions in flow. Systemic frictions result from patterns of global trade and of manufacturing in the global economy, and labour regimes. Who bears the cost of those frictions is a site of logistical struggle. In the following section, we turn from an examination of cargo flows in physical space to examine how they are coordinated by the data information systems of logistics.

4: Freight cargo as data flows

Contemporary logistics is often portrayed, and portrays itself, as an exemplar of code-space, where physical movement depends on software (Kitchin and Dodge 2011). Yet the actualities of software in freight logistics are often oversimplified. Even perceptive commentaries, make only generic reference to ‘packets of data interacting with each other under the direction of a heterogeneous array of software routines and hardware devices’, where total visions of software like enterprise resource planning (ERP) are ‘as much ideology’ as they are ‘actual software’ (Neilson, 2012 p 328, 332). The ideology is illustrated by contrasts with rather more low-tech ‘can do’ container parks competing successfully with those using the latest Navis software (Neilson 2013, p 107).

Focusing on the shipping container has meant that it is TOS in ports that thus far have attracted attention as the primary site of logistical software control (Gordon, Lee & Lucas 2005; Hatzopoulos, 2014; Hepworth, 2014). Three open-market TOS are most commonly found in the main container port terminals: SPARCS (Navis), SPACE (Cosmos), and CATOS (TSB). Theoretically these integrate but in practice integration can be hard to achieve. Further, Navis estimated that, in 2013, 69% of terminals were using in-house products. But TOS are only a small part of the interactions of data, software and hardware that govern freight cargo. This patchwork of software systems, and resultant frictions, is further compounded by the widespread practice of putting together different software products to coordinate distinct areas of terminal activity. Areas include vessel load planning and vessel unloading, crane-stack routines within a port, haulier planning and operations, and border inspection, customs declaration and clearance. Far from being a seamless code-space, port terminals are perhaps best characterised as a 'kludge' – a programming term for repurposing protocols that are not optimal but work 'well-enough'. It is data information systems that increasingly are used to hold all this logistical work together.

Data information systems are proprietary software, and there are also multiple such systems operating across the world's ports. The major port conglomerates (Hutchinson Port Holdings (HPH), DP World (DP), and also COSCO) operate their own systems across their global networks. These systems do the same tasks but they do not integrate easily. The (deliberate) effect of that is to seek to push the shipping lines to call at port terminals in the same organisational network, since to move across systems is likely to lead to unwanted delays. Data information systems, plus terminal software, are part of how port conglomerates exercise power. However, not all ports are either owned or operated by the major conglomerates and many have their own bespoke systems. Further, several major ports (e.g. Rotterdam) have different terminals, each operated by different conglomerates with different software. This situation has created a patchwork of data information systems whose effect is predictable difficulties of information flow. Frictions in information flow show there is no master line of sight in logistical power. Rather, rival corporate interests draw on logistical power to connect and coordinate the world in ways that suit their interests, whilst simultaneously, and intentionally, making friction between their and rivals' networks. The patchwork of data information systems performs a logistical space fractured by commercial and proprietary interest – an oligopticon rather than the promised total logistical panopticon.

To illustrate how these data information network spaces work, let us examine one widespread system - Destin8™. It comprises five main sections: vessel, manifest, consignment, release details, and wharfinger information. These sections are sequenced and correspond to discrete operations within the distribution chain. Each stage of the chain can see all the others, but write access is passed between them only once a container has been released from the previous stage. To enter the chain, a box manifest (corresponding to an actual numbered box that is physically under consolidation) is first assembled by a shipping line (or freight forwarder) and incorporated into a baply file, and then allocated to a vessel. Whilst at sea, it remains in the control of the shipping line but, since its location in time and space, and also speed of steaming, is visible to its scheduled ports of call, port terminal operators can anticipate and position the vessel in their berthing schedules. Terminals know this vessel not just as a vessel due to berth, with particular requirements consequent upon size and shape, but also as an ensemble of numbered containers which are positioned in different sections and holds of the vessel. Approximately one week ahead of a vessel's estimated arrival date, terminal operations start work in a different software system optimising the vessel plan that will choreograph the work plan for the berthing vessel. This details those boxes that are to come off at the port, and those that need to come off to access those required boxes and then be put back on again. With even a relatively small vessel, this is likely to involve 1500 – 3000 individual box/ship crane moves; larger vessels would involve 6-7000 moves or more, and the very biggest container ships, capable of carrying over 13000 TEU, would be likely to tie-up all a terminal's port-side crane infrastructure for 24-36 hours. So, these plans are complex things to optimise and to effect physically. At the point of berthing, the vessel shifts to the consignment part of Destin8 and the active agent in the software becomes the port. Boxes that have come off of a vessel for land-based transportation then need to be shifted from 'ship side' to 'road/ rail side' of a port. These movements are all choreographed by congeries of other software packages (sometimes with the only means of connecting them being via emailing comma-separated variable spreadsheets of data). In all, this transition typically takes terminal operations some 2-3 days to effect, during which customs declaration and clearance also occurs, via another variable and separate 'integrated' software system (in the UK, Chief, or Integrated Customs for Europe (ICE) or MIC-CUST Global Customs Management). Once both operations are complete, so too is the work in the consignment section of Destin8, and write access to a numbered box passes to the release and wharfinger parts of the system. Here, in the case of road transportation, the designated haulier for contracted loads, or a single box, allocates each container to an individual truck driver, whilst the wharfinger part locates the box in the port stacks. To collect a box, a truck driver takes the paperwork to the terminal booking reception. The seal number of their allocated box works as a PIN, connecting via Destin8 to a gantry crane driver's cab screen, to bring up the box number and grid reference for the box in the port stack.

More analytically, Destin8 achieves flow in three ways. First, the system attaches data files pertaining to boxes to unique box numbers (that is it creates object codes). It is this number (e.g. TEMU 365XXXX 22XX) that allows a box to flow through maritime and terrestrial space. Secondly, the system constitutes temporal order. It does this through sequencing activities across and between maritime and terrestrial space and through the ordering of authority and responsibility, from shipping line, to port operations and thence to port storage operations, and finally the land-based carrier (that is it creates transactional codes of who is doing what). Thirdly, and most importantly, the system produces long-distance control through the visibility afforded of the box's number (if not its actual contents). This is the calculable object for all agents in the distribution chain (c.f. Kanngieser, 2013). Visibility allows for the anticipation of freight cargo in physical space-time. In turn, anticipation allows for the creation of temporal gaps, which in this case enable port-centred logistical and regulatory work to be planned and then accomplished, through the pausing of flow for 2-3 days. These temporal gaps indicate the workings of a seam that allows logistics to achieve integration through creating a space-time of coordination in which the different velocities, rhythms and capacities of sea and land-based freight transportation can be articulated and their frictions accommodated.

Destin8 itself also produces friction. An effect of the combination of visibility, sequencing and power in Destin8 is to concentrate friction at particular points. Chief amongst these is the transition from maritime to land-based transportation. Thus, whereas port terminal operations at major container ports have around a week to produce the optimal plan for the offloading and reloading of a vessel, feeder ports receiving short-sea shipments have much less, sometimes only receiving the data 'as the vessel rounds the pier'. In general, the passage of boxes from the consignment part of Destin8 to release for land-based transportation allows for even less anticipation. Terminal operations release boxes from the consignment part of the system in batches, typically at the end of each working day. Planning for haulier firms is responsive, and on a day-in-advance basis. So, haulier agents see their designated boxes in consignment; they then use a different set of software tools, even simple Excel sheets, to allocate a driver to a box, depending on driver availability. This allocation occurs less than 24 hours in advance of a driver turning up at a port. However, it is by no means unusual for drivers to arrive at port terminals only to find the box they have been allocated digitally is 'not yet released' physically by handlers or customs. In this way, the apparently seamless, integrated flow of freight cargo that occurs on the Destin8 screen can come undone; it materialises as truck queuing and congestion in and around major ports. Stitching this seam back together again has become an important task. Vehicle booking slots (VBS) are the means by which major ports attempt to tackle port congestion, linking the flow of trucks into port terminals with anticipated physical box availability (see also Nielson 2013). But, although these devices work to alleviate port congestion, they have the effect of displacing congestion and the problem of coordinating out-port flows of containers onto the road network and road haulage industry respectively as trucks arrive and then wait for their slots. Added to the effects of large surges from ever larger ships, this meant surges at US ports created traffic jams '13 lanes wide and 10 trucks deep' queuing for eight hours outside their gates (Wall Street Journal 2015). The temporalities designed into VBS therefore are designed to accord with port conglomerates' interests, and displace costs rather than attempting to resolve frictions.

Port conglomerate power, and the costs of frictions produced by data information systems such as Destin8 that have the major global port conglomerates' networks as their line of sight, is now being contested by major supermarkets and manufacturers. The latter have sought alliances often involving smaller ports and/or terminals out-with the global networks of the major port conglomerates. These terminals offer such clients preferential logistical solutions to those they would receive in the ports of the major conglomerates – often to the cost of their less powerful clients, for whom the consequence can be a slower service. A case in point is a major UK supermarket's relationship with a port in North East England. Key to this arrangement is not just the reduced costs that come from less congestion but also a bespoke data information system that allows for flagging boxes consigned by the supermarket and, given its dominance in the port's business, the preferential sequencing and ordering of its boxes in the port's work, and, within that, of particular boxes containing particular products. In this way, retailer POS data is utilised to inform the planning of vessel unloading routines. Boxes containing certain products can be pushed through port operations to DCs first, whilst others containing goods that are not selling so well can be held back and even placed in deep storage for a year or more, turning the stacks in this particular port into cheap warehousing for a supermarket. Far from always speedy flow being the desired outcome of logistical operations, there is then, and conversely, the intentional, long-term pausing of certain boxes containing particular, currently hard-to-sell, things.

We see here, then, how logistical data information systems enact not a code-space of seamless space but rather an increasingly fractured patchwork of competing spaces and sites of logistical control, each of whose parameters coordinate cargo flows in ways that suit the business models of different actors. The result is not a simply 'machine-readable world' (Dodge and Kitchin 2005), but rather a world that necessitates multiple often manual translations between different code systems that in themselves represent stakes in a game of logistical power.

5: Conclusion

This paper has built on studies that have rebalanced an academic focus on production to include the logics of circulation in economic analysis. However, we have suggested that while the achievement of logistics in coordinating global supply chains is evident, that achievement is not constituted by seamless flows, speed and packaged efficiency grounded in unitised, homogenous standards. Instead, logistics produces frictions and creates seam spaces that patch together, and provide the space-times in which to coordinate, physical and informational flows. These seams and frictions are not just exogenous impediments or the result of structural and geographic imbalances in global trade. They also reflect the competitive garnering of value between different actors in and across supply chains. Thus, we have shown how shipping lines minimising the cost per box with larger ships create costs for other actors in the distribution chain; how the maximal stuffing of containers optimises shipping costs but creates difficulties in deconsolidation for distributors and knock-on consequences for road haulage; and how software routines in port terminals optimise port operations whilst displacing the resultant frictions onto the road haulage industry. But frictions are also generated by the competing internal lines of sight of logistical data information systems. Bringing this together we see the logistical space of action. Instead of the fantasy of the optimisation of the entire supply chain, a focus on logistics-in-action discloses that optimisation is always actor and network specific. In logistical worlds each line of sight is limited. As one informant in the heart of a global port put it: 'logistics is always local.' Logistics, then, is an instrument for a long-distance control but one that is commercial, proprietary and multiple, and currently it is at the heart of a struggle between the port conglomerates and major shipping lines on the one hand and, on the other, retailer and manufacturer-controlled supply chains, over the primary line of sight of logistical power. This struggle produces frictions and heterogeneities in the codespace of global trade that is often held up as an exemplar of space homogenised and unified through digital information. Rather than seeing frictions as anomalies we echo Tsing's (2011, page 272) sense that global connections are 'made, and muddled, in friction' out of fragments from various schemes. Attending to this fragmentation is not then about listing idiosyncrasies or empirical variations, but seeing that logistics is about creating multiple, though commensurate, spaces not a homogeneous single order.

The implications of these findings are that research must move beyond accounts that recite global logistical power to further interrogate logistics-in-action. There is a need, then, to map the archipelago of economic spaces and the seam spaces that join them. Such a circulation-centred mapping would need to bind together the topologies of shipping networks with those of land-based freight, from suppliers and consolidation, through DCs to deconsolidation into delivery networks that encompass manufacturers, retailers and consumers. It would enable the identification of lines of friction between rival corporate networks and the struggle being wrought between them through the medium and devices of logistical power. At the same time, it would highlight the importance of the spatialities of storage for contemporary capitalism. Warehouses and DCs, port stacks, as well as the technologies of freight movement (ships, trucks, trains, barges and planes, containers and pallets), together with their lines of physical connectivity (roads, rail tracks, canals, air corridors and sea lanes) are not unimportant economically. In supply chain capitalism, these spaces have become the global warehouse – the necessary adjunct to the global factory. This is why contemporary struggles between capital and labour being enacted worldwide at DCs, on roads, as well as in ports and port stacks (Bonacich & Wilson 2008; Bonacich & De Lara 2009) are significant. They are not simply yet more sites of labour of specific kinds and struggle but part of the global warehouse that forms the integrating space-time of supply chain capitalism. The global warehouse comprises the connected space-times of displaced inventories, in which products are held and moved, awaiting a fast-tracked or slow-lane transition to saleable goods and the realisation of value. But who gets to control the speed (and cost) of that transition is paramount. For here, through the medium of logistics, lies the key to the control of the global warehouse.

References

Adey P, 2009, "Facing airport security: affect, biopolitics and the pre-emptive securitization of the mobile body" *Environment and Planning D: Society and Space* **27** (2) 274-95.

Amoore L, 2006, "Biometric borders: governing mobilities in the war on terror, *Political Geography*" **25** (3) 336-51.

Amoore L, de Goede M, 2008, "Transactions after 9/11: the banal face of the preemptive strike" *Transactions Institute of British Geographers* **33**(2) 173-85.

Amoore L, 2009, "Lines of sight: on the visualization of unknown futures" *Citizenship Studies* **13** (1) 17-30.

Aoyama Y, Ratick S, 2007, "Trust, transactions and information technologies in the US logistics industry" *Economic Geography* **83**(2) 159 – 80.

Bierwirth C, Meisel F, 2010, "A survey of berth allocation and quay crane scheduling problems in container terminals" *European Journal of Operational Research* **202** (3) 615-27.

Birtchnell T, Savitzky S, Urry J, Eds. 2015, *Cargo Mobilities* (Routledge: London).

Bissell D, 2010, "Passenger mobilities: affective atmospheres and the sociality of public transport" *Environment and Planning D: Society and Space* **28**(2) 270-89.

Bonacich E, Wilson J, 2008, *Getting the goods: Ports, labor, and the logistics revolution*, (Ithaca: Cornell University Press).

Bonacich, E, De Lara J, 2009, "Economic crisis and the logistics industry: financial insecurity for warehouse workers in the Inland Empire" *Institute for Research on Labor and Employment* Working Paper 2009-13, available at http://escholarship.org

Broeze F, 2002, *The Globalisation of the Oceans: containerisation from the 1950s to the present* (St John's, Newfoundland: International Maritime Economic History Association)

Cidell J, 2012, "Flows and pauses in the urban logistics landscape: the municipal regulation of shipping container mobilities" *Mobilities* **7**(2) 233-45.

Cidell J, 2015, "Distribution centres as distributed places: mobility, infrastructure and truck traffic", in *Cargo Mobilities* Eds T Birtchnell T et al. (Routledge: London) pp 17 – 34.

Coe N, 2014, "Missing links: logistics, governance and upgrading in a shifting global economy" *Review of International Political Economy* **23**(1) 224-56.

Cowen D, 2007, ""Struggling with security": national security and labour in the ports" *Just Labour: A Canadian Journal of Work and Security* **10**(1): 30-44.

Cowen D, 2010, "A geography of logistics: market authority and the security of supply chains" *Annals Association of American Geographers* **100**(3) 600-620.

Cowen D, 2014, *The Deadly Life of Logistics: mapping violence in global trade* (University of Minnesota Press: Minneapolis).

Crang M, Zhang J, 2012, "Transient Dwelling: trains as places of identification for the floating population of China" *Social & Cultural Geography* **13:** 895-914.

Cudahy B, 2006, *Box Boats: how container ships changed the world* (Fordham University Press: New York).

Dodge, M, Kitchin, R, 2005, "Codes of life: identification codes and the machine-readable world" *Environment and Planning D: Society and Space* **23**:851-881.

Ducruet C, Lee S, 2006, "Frontline soldiers of globalisation: port-city evolution and regional competition" *GeoJournal* **67**(2) 107-22.

Ducruet C, Notteboom T, 2012, "The worldwide maritime network of container shipping: spatial structure and regional dynamics" *Global Networks* **12**(3) 395 – 423.

Edensor T, 2011, "Commuter: Mobility, Rhythm and Commuting", in *Geographies of mobilities: practices, spaces, subjects* Eds. T. Cresswell , P. Merriman (Ashgate: Andover), 189-203

Gordon J, Lee P-M, Lucas, J 2005, "A resource-based view of competitive advantage at the Port of Singapore" *The Journal of Strategic Information Systems* **14** (1) 69-86.

Gutelius B, 2015, “Disarticulating distribution: labor segmentation and subcontracting in global logistics” *Geoforum* **60**: 53 – 61.

Hatzopoulos P, 2014, ”Software, machines, people and things as tangled species”, in *Logistical Worlds: infrastructure, software, labour* (No. 1) – November 2014 pp 23-8.

Hepworth K, 2014, “Enacting logistical geographies” *Environment and Planning D: Society and Space* **32** (6) 1120 – 34.

Hirsch S, 2013, “Inhabiting the Icon: Shipping Containers and the New Imagination of Western Space” *Western American Literature* **48** (1)17-40.

Jain J, 2011, “The classy coach commute” *Journal of Transport Geography* **19**(5) 1017-22.

Journal of Commerce 2013 Terminal Velocity: Port Productivity Rankings, 22 July 2013

Kanngieser A, 2013, “Tracking and tracing: geographies of logistical governance and labouring bodies” *Environment and Planning D: Society and Space* **31** (4): 594 – 610.

Keiller, P, 2013, *The View from the Train: Cities and Other Landscapes* (London: Verso Books.)

Kitchin R, Dodge M, 2011, *Code/space: Software and everyday life* (MIT Press, Boston).

Klose A, 2015, *The Container Principle: How a Box Changes the Way We Think*. (MIT Press: Boston, trans. C Marcrum).

Laurier E, Lorimer H, Brown B, Jones O, Juhlin O, Noble A, Perry M, Pica D, Sormani P, Strebel I, Swan L, Taylor S, Watts L, Weilenmann A, 2008, "Driving and 'passengering': notes on the ordinary organisation of car travel" *Mobilities* **3**(1) 1 – 23.

Levinson P, 2006, *The Box: how the shipping container made the world smaller and the world economy bigger* (Princeton University Press: Princeton).

Martin C, 2013, "Shipping container mobilities, seamless compatibility and the global surface of integration" *Environment and Planning A* **45** (5) 1021 – 36.

Martin C, 2014, "The packaging of efficiency in the development of the intermodal shipping container" *Mobilities* **9**(3) 432-51.

Navis 2013, *Building the Optimal ToS*, February 2013 available at http://navis.com/news/in-news/building-optimal-tos last accessed 2 Sep 2016

Neilson B, 2012, "Five theses on understanding logistics as power" *Distinktion: Scandinavian Journal of Social Theory* **13**(3) 322-39.

Neilson, B, 2013, "Life and Code: Logistics, Culture and Economy" in *Challenging (the) Humanities*, ed. T. Bennett (Melbourne: Australian Scholarly Publishing) pp 99-116.

Neilson B, 2015, “A city that exports air: containers, traffic and logistics in Sydney’s intermodal network and beyond”, in *Cargo Mobilities* Eds. T Birtchnell et al. (Routledge: London) pp 48 – 64.

Nordstrom C, 2007, *Global Outlaws: crime, money and power in the contemporary world* (University of California Press: Berkeley).

Notteboom T, de Langen P, Jacobs W, 2013, “Institutional plasticity and path dependence in sea ports: interactions between institutions, port governance reforms and port authority routines” *Journal of Transport Geography* 27 (1) 26-35.

Olivier D, Slack B, 2006, “Rethinking the port” *Environment and Planning A* **38**(7) 1409-1427

Paché G, 2007, “Slowness logistics” *Time & Society* **16** (2-3) 311-332.

Rodrigue J-P, 2013, “The repositioning of empty containers.” In *The Geography of Transport Systems* Eds J-P Rodrigue, C Comtois, B Slack B (3rd edition, Routledge: New York) – available at http://www.people.hosftra.edu – last accessed 21 July 2015.

Sekula A, Sinclair D, 2000, “Freeway to China (Version 2, for Liverpool)” *Public Culture* **12** (2) 411-422.

Sekula A, 2002, “Between the Net and the Deep Blue Sea (Rethinking the Traffic in Photographs)”. *October* **102**:3-34.

Steinberg P , 2015, "Maritime cargomobilities." In *Cargo Mobilities* Eds T Birtchnell et al. (Routledge: London) pp 35-47.

Stennmanns J, Ouma S (2015) "The new zones of circulation: on the production and securitization of maritime frontiers in West Africa". In *Cargo Mobilities* Eds Birtchnell T et al. (Routledge: London) pp 87 – 105.

Tsing A, 2009a, "Beyond economic and ecological standardisation" *The Australian Journal of Anthropology* **20** (3)347-368.

Tsing A, 2009b, "Supply chains and the human condition" *Rethinking Marxism* **21** (2):148-176.

Tsing, A, 2011, *Friction: An ethnography of global connection* (Princeton: Princeton University Press)

Verstraete G, 2002, "Railroading America" *Theory, Culture & Society* **19** (5-6):145-159.

Wall Street Journal 2015 U*.S. Ports See Costly Delays as Cargo Ships, Volumes Grow* – 29 April 2015 – available at http://www.wsj.com/articles/u-s-ports-see-costly-delays-as-cargo-ships-volumes-grow-1430340113, last accessed 2 September 2016

Wang J-J, Olivier D, Notteboom T, Slack B , Eds. 2007, *Ports, Cities and Global Supply Chains* (Ashgate: Aldershot).

Watts L, 2008, "The art and craft of train travel" *Social and Cultural Geography* **9**(6): 711-26.

Wilson H, 2011, "Passing propinquities in the multicultural city: the everyday encounters of bus passengering" *Environment and Planning A* **43**(3): 634-49.

Yu W, Egbelu P, 2008, "Scheduling of inbound and outbound trucks in cross docking systems with temporary storage" *European Journal of Operational Research* **184** (1) 377 – 96.