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Delivering the goods

How technology can assist in last mile logistics operations.

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Delivering the goods - how technology can assist in last mile logistics operations **is published by the Institution of Engineering and Technology.**

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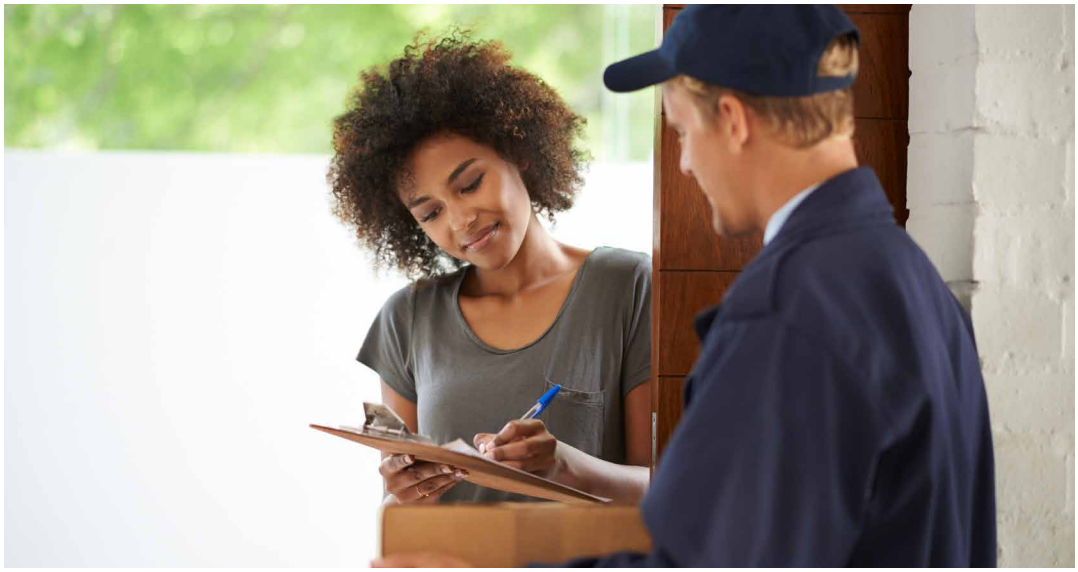
Introduction



The UK parcel sector generated almost £9 billion in revenue in 2015, a 6% increase on the previous year, with growth expected to increase by 15.6% to 2019. With over 1.7 billion parcels being delivered domestically per annum, LGVs (light goods vehicles – up to and including 3.5 metric tonnes gross weight) have seen the greatest growth, with 3.6 million licenced in the UK (2015), a 23% increase relative to heavy goods vehicles since 1995[1].

Many retailers offering 'free' or under-priced deliveries in order to generate sales turnover have exacerbated this recent growth in parcel vehicle activity levels over the last mile, which is heightened during 'shopping frenzy' periods such as Black Friday and Cyber Monday. Coupled with this, the demand for ever-faster, immediate same-day services has led to more 'less-than-vehicle' loads and greater numbers of vans serving both residential and business districts. These issues are intensifying freight transport operations over the last mile; this is not helped by the general reduction in on-site storage space in retail stores and offices as a result of rising land values, which has led to smaller, more frequent deliveries.

Some of the environmental challenges posed by growing parcels-related traffic levels over the last mile will be countered by the adoption of more stringent vehicle emissions standards, Low Emission Zones, and measures to encourage the uptake of alternatively-fuelled vehicles. However, these interventions will do nothing to address the growing demand for road and kerbside space that these parcel delivery services are generating.

From changes to land use and infrastructure that have forced depots out of urban centres and rising consumer demand for ever-faster services, this insight paper explores how tech solutions such as drones and droids, computerised vehicle routing and systems to help with freight consolidation could be used to address emerging challenges.

What is last mile logistics?

Last mile logistics is a term for the final stage of the delivery process when goods are sent from a transportation hub, such as a distribution centre or warehouse, to an end user, customer, shop or business, with the aim of achieving this as quickly and efficiently as possible. It can also refer to same-day point-to-point deliveries.

Land use and freight interactions over the last mile

The implications for infrastructure provision and policy

There are several factors that have intensified freight transport operations over the last mile in our urban centres. The reduction of on-site storage space in retail stores and offices resulting from rising land values has led to smaller, more frequent deliveries and therefore more intensive freight transport systems. The under-pricing of delivery services by ecommerce retailers to gain market share has resulted in the imposition of external costs on the road network, society and environment where consumers' desire for ever-faster response times does not reflect the true cost of their last mile transactions.

The lack of availability and affordability of logistics land in our major cities is making logistics operations more inefficient. 'Logistics sprawl' has seen depots moving ever further from central urban areas, towards the urban periphery, making large-scale business-to-consumer last mile delivery more challenging as longer journey distances increase journey time and journey time unreliability. This is expected to worsen over time as the demand for same-day deliveries increases, along with general diminishing road and kerbside space allocation for goods vehicles due to space reallocation to bus and cycle lanes. There is an important role for policymakers to play in their management of land-use in urban areas to ensure more sustainable logistics practices over the last mile.

This can encompass: i) strategic decision making and safeguarding of logistics land in cities to reduce vehicle stem mileage (the number of miles it takes to drive to a delivery route area); ii) the provision of appropriate road freight infrastructure on the road and at the kerbside that helps meet demand as efficiently and sustainably as possible (e.g. locker banks and collection points); iii) improving freight trip generation assessment capabilities.

How policymakers can address these issues

- **Mandate the collection of new data to capture last mile freight vehicle behaviour (e.g. reinstating the collection of van fleet data as part of the Continuous Survey of Freight Goods Movement)**
- **Interact with the logistics industry to better understand how companies' vehicle operating data could enable a greater understanding of delivery and servicing activity over the last mile by land use type**
- **Understand the impacts different waiting and parking regulations between neighbouring authorities and boroughs have on the efficiency of last mile delivery and service operations**
- **Look to proactively safeguard logistics land in urban centres to promote the development of micro-hubs, logistics hotels (as established in Paris), virtual loading bays and goods consolidation points**

Characteristics of last mile logistics: current and future trends

'Drivers' or 'walkers'?

Research undertaken as part of the FTC2050 project (www.ftc2050.com) in London has suggested that walking is a significant component of parcel delivery rounds over the last mile in dense urban areas, with vehicles spending approximately 60% of the total journey time parked at the kerbside while the driver unloads, sorts and delivers parcels on foot. The average horizontal distance walked by a driver undertaking last mile delivery was 8km and did not account for the vertical distances travelled climbing and descending staircases in buildings, which affected 23% of consignees on the average round. Walking can account for 30% of the total journey distance travelled from the depot by drivers, with 95% of vehicle stops taking place on-street at the kerbside. These delivery personnel could therefore as easily be termed 'walkers' as 'drivers', and gives rise to considerations about alternative methods by which this work could take place that would reduce road traffic and kerbside parking.

Human-computer interaction

Considering the growth in lifestyle 'gig economy' workers in the last mile logistics sector, new methods of computerised vehicle routing and scheduling which take into account driving, walking and cycling route optimisation according to the preferences of the worker could play an important role in improving the efficiency and sustainability of delivery operations. Looking at the considerable turnover of drivers in the sector, and research suggesting experienced lifestyle couriers are as much as 50% more efficient in terms of distance travelled per parcel delivered compared to novice drivers (www.ftc2050.com), there is an important role for human-computer interaction (HCI) to aid novice operatives becoming more efficient.

Keeping things moving

Sustainable delivery systems such as portering and cargo cycling offer great potential to reduce vehicle kilometres and kerbside dwell time by delivery vehicles in cities, as do the use of micro-consolidation centres and mobile depots. Such solutions would require city authorities to assist in the provision of adequate and affordable freight infrastructure such as: i) stopping areas, which might entail a review of current waiting restrictions; ii) vehicle loading bays; iii) storage and charging areas for electric cargo cycle fleets; iv) small reception facilities ('drop-off points') that would provide secure short-term storage for incoming and outgoing goods.

Decarbonisation

The use of bicycles, electric cargo bikes, and electric cars and vans rather than fossil fuel-powered vehicles are helping to reduce fossil fuel consumption, carbon emissions and local air pollutants over the last mile. There are however important considerations about how to effectively use cargo cycles due to their reduced carrying capacity and whether increases in vehicle trips would be necessary. Other issues are associated with vehicle and load security during the working day, the suitability of the vehicle's carrying capacity for the goods carried (in terms of weight and volume), and costs associated with the overnight storage space and recharging infrastructure required by the carrier for an electric cargo cycle fleet.

It is possible that autonomous vehicles will be introduced into freight transport operations but it is likely to be many years before drones (autonomous delivery vehicles in the air) and droids (delivery robots that convey goods within buildings and using pavements) are technologically, operationally and financially feasible for use in last mile delivery operations in our cities. Given that autonomous vehicles will only be able to stop at the kerbside or off-street loading areas, human assistance will be required for the last leg of the delivery from the vehicle to the consignee.

Drones and droids

These technologies face several operational difficulties when tasked with tackling last mile urban freight, including:

- **How to get safely into buildings and navigate inside them**
- **How to negotiate complex crossing points and other types of road and pavement infrastructure**
- **How to ensure that the goods being transported are secured**

Droids are more likely to be used for freight operations inside buildings rather than on-street, and have already been deployed within factories and hospitals for moving goods over relatively short distances. For example, Aethon TUG autonomous mobile robots have been deployed in American hospitals to transport medicines, equipment, meals, linen, and waste, and are able to open doors and call lifts[2]. Despite some of these issues, Starship Technologies have successfully trialled pavement droids in Greenwich for food delivery[3], but the wider deployment of such technologies in the future might require the extensive redesign of delivery reception facilities at commercial and residential buildings. Trials of food home delivery in the US have shown such systems to be deployable, where consumers are prepared to come to the kerbside to meet the droid and receive the goods[4].

Despite the legal and regulatory hurdles, drones do offer potentially large savings in journey times and emissions over conventional last mile transport. A study by the University of Southampton looked into patient sample movements from seven central London clinics to a main hospital, suggesting time and emissions savings of up to 61% and 93% respectively over the conventional courier operation. It is already possible for small machinery parts and medical samples to be successfully moved by drone between fixed locations, such as with the DHL Parcelcopter[5] and the Matternet Station[6].

Consolidation opportunities to aid last mile operations

Freight consolidation involves the use of urban, micro and mobile consolidation facilities, kerbside consolidation using portering systems and internal logistics/ concierge systems. This helps reduce the amount of freight vehicle activity (distance travelled, journey time, fuel consumption, kerbside dwell time) in urban centres while delivering the same level of service.

The major retailers already carry out considerable consolidation in their operations, where full vehicle loads are assembled from multiple suppliers at regional distribution centres for onward movement into cities to supply retail outlets. In the parcels sector, where there is much replication of activity over the last mile between the various carriers, consolidation opportunities do exist, but there is less in the same-day delivery sector (e.g. express parcels, same-day medical deliveries, hot meals).

There is potential scope to group jobs together and make better use of lifestyle couriers' spare time between jobs to undertake work across other delivery sectors. Consolidation in last mile deliveries could take several forms:

1. Parcel collection and delivery involves grouping parcel collections together and then using a single vehicle to make all the deliveries, thereby handling several customers' orders at the same time.

2. Merging together the work activity in different same-day delivery sub-sectors, which are currently operated entirely separately from each other by a single carrier (e.g. the same-day delivery of parcels and medical items - some same-day carriers such as CitySprint provide services in both of these sub-sectors but run these as separate operations).

3. Merging together the work activity in different same-day and next-day delivery sub-sectors, which are operated separately by different carriers (e.g. the delivery of next-day parcels by same-day couriers or meal delivery couriers when they have time to spare between same-day parcel/meal jobs).

Of critical importance to the success of consolidation is to what extent different loads can be consolidated given the delivery requirements imposed by the consignee. The true urgency behind many non-food business-to-business and business-to-consumer next-day and same-day parcel deliveries is questionable – even when customers claim that instant delivery is essential – and adding a couple of hours into the delivery process is likely to be acceptable to many users of these services as long as the item is still delivered within a given time frame. The option of a slower next-day or same-day delivery could be promoted to customers as a 'green delivery option', which may prove attractive to consignees with strong corporate social and environmental responsibility agendas. 'Green delivery pricing' strategies could also help promote less transport-intensive last mile services that reduce environmental impacts while still providing customers with timely deliveries. Despite the considerable negative press associated with the gig economy and the ethics of self-employed couriering, the scope for consolidating last mile parcel and food activity across this delivery mode is considerable if appropriate interfaces for human-computer interaction can be developed. Research as part of the FTC2050 project has shown that such portering concepts in London could reduce vehicle kerbside stopping durations as well as the total vehicle distance travelled.

Collaboration

There is much scope for collaboration between carriers and retailers to make better use of existing vehicle and logistics infrastructure capacity over the last mile. Through operational collaboration, freight transport operators can facilitate goods consolidation upstream in their supply chains and reduce vehicle trip generation prior to its last leg despatch to/within the urban area, with companies sharing their work for given geographical locations.

At present however, most of these companies are unwilling to work with each other in terms of delivery services, even if it can to lead to lower operational costs. Such collaboration could take the form of work sharing between carriers using a neutral, third-party 'carrier's carrier'. This neutral carrier consolidates loads from other carriers and undertakes the last mile delivery, a good example being Gnewt in central London. Based four miles from the City of London at Bromley-by-Bow, Gnewt use an all-electric vehicle fleet to service the capital. A case study carried out as part of the FTC2050 project of next-day parcel operations indicated that merging parcel flows from three London parcel depots into a single delivery operation could lead to a 14% reduction in total distance travelled on deliveries in the urban area.

A unique example of the carrier's carrier concept serving the Highlands and Islands in Scotland is run by Menzies Distribution, which consolidates the loads of 13 national parcel carriers (APC, Aspray24, DHL, DPD, DX, Fedex/TNT, ParcelForce, Tuffnells, UK Mail, UPS, XDP and Yodel), significantly reducing the amount of vehicle traffic serving the 89 inhabited islands. A key to the success of this system has been: i) developing a unified data management system based around common data (e.g. barcodes, parcel status, proof of delivery) so that processes remain the same for the driver irrespective of the carrier; ii) building and maintaining trusted relationships with clients, carriers, and couriers; iii) maintaining agility and flexibility in core operations to address variations in loads, demands and delivery times.

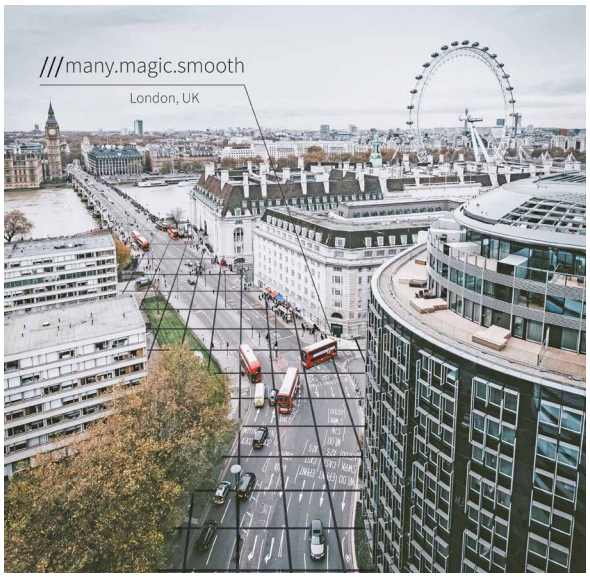
With more than 40 UK towns and cities having exceeded air pollution limits set by the World Health Organisation, city authorities are under increasing pressure to take action to improve air quality. As a result, more cities will introduce charges for the most polluting vehicles, and freight operators will be affected either through incurring these charges or through updating their vehicle fleets to meet specified emissions standards. These added costs and difficulties in meeting service requirements may act as facilitators towards more consolidation over the last mile in the industry.

Where technology could assist with planning and execution

In the case of delivery drivers working on multi-drop parcel delivery rounds over the last mile, several unique tasks are involved, and particularly impact on the novice driver in terms of round efficiency. Work undertaken by the FTC2050 project has identified how human-computer interaction could assist lifestyle couriers under these circumstances.

Locating the consignee and wayfinding

Computer-based vehicle routing and scheduling solutions do not currently address rounds which involve substantial amounts of walking. Nor do they allow for the optimisation of the walking task or the selection of the most appropriate vehicle stopping locations to serve walking patches. Technology such as what3words (www.what3words.com) can aid in identifying the exact delivery point in buildings to improve driver efficiency.



The what3words algorithm takes complex GPS coordinates and converts them into unique three-word addresses. Image courtesy of what3words.

Clustering consignees for more efficient walking strategies

Understanding the combination of consignees that can be served on foot using the van as a mobile depot, given the weight and size of the parcels to be carried relative to the distances involved is important. Human-computer interaction can aid the driver in this decision making where the addition of dynamic collection requests on the round, as well as failed delivery attempts, can add inefficiencies into an already complex decision making process. The FTC2050 project is addressing this through new cluster modelling approaches.

With a likely increase in lifestyle couriers in the freight sector servicing the retail and home delivery food markets, there will be a need to develop app-based management platforms to allow networks of freelance couriers to engage with carriers to provide the last mile transport link between consignor and consignee. This will naturally lead to more complex interfaces, which allow individual couriers to:

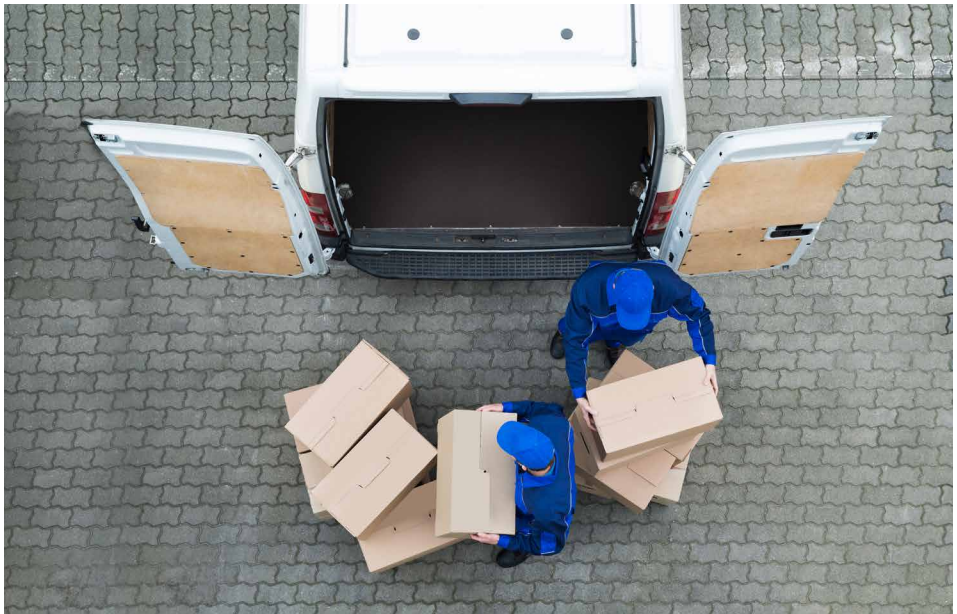
- **Visualise delivery and collection opportunities in their area that suit their preferred working time and style**
- **Plan their work and use built-in optimisation tools to organise their daily activity**
- **Work for different consignors across multiple carrier platforms moving different products**
- **Track their work progression, transactions and payments in real-time**
- **Collaborate with others to share transport resources and reduce costs**

Conclusion

As increasing amounts of goods are delivered to homes and workplaces the pressure on logistics providers to offer reliable and timely delivery services to our exacting needs becomes more acute. 'Next-day' delivery is often the default option offered by many retailers with the prospect of 'same-day' fulfilment resulting in even more inefficiencies and urban van miles driven.

The failure to make the consumer aware of the true cost of the delivery is fuelling the notion that it is somehow 'free' – a slogan often touted by retailers in an attempt to maintain market share. In the absence of any legislation to encourage behavioural change in this regard, logistics providers are adopting a number of approaches and technologies to become more efficient. The use of micro-hubs and sustainable last mile delivery options using cycle and foot couriers can negate the need for vans having to continually circulate in dense urban areas, reducing fuel usage and pollutants. This concept can be further enhanced when rival logistics providers adopt the 'carrier's carrier' model, choosing to engage with a third party who undertakes the last mile, consolidating their loads together.

Technology will also play a key part in maximising delivery efficiency in this area, from new optimisation tools to help develop better walking, cycling and driving delivery rounds; using micro-consolidation points; to navigation and wayfinding applications which pinpoint the exact entry points to buildings and the associated optimal parking locations. Such technologies will be relied on even more with droid and drone services now being actively trialled in this sector. For the foreseeable future however, humans will still play a significant role in the delivery process, utilising technology to aid the movement of goods from the consignor to consignee across modes, in as seamless a fashion as possible.



References and acknowledgements

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[1] Allen, J., Piecyk, M., Piotrowska, M. An analysis of the next-day and economy parcels market and parcel carriers' operations in the UK. University of Westminster, December 2016. Carried out as part of the FTC2050 project.

[2] www.aethon.com/tug/how-it-works

[3] www.starship.xyz/starship-launches-in-uk

[4] www.nuro.ai

[5] www.dpdhl.com/en/media_relations/specials/parcelcopter.html

[6] https://mttr.net

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