The Northampton Mole Project – A case study of the application of freight pipelines in an urban environment

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Authors

Dr. Roger Miles
Managing Director, Mole Solutions Limited, UK

Professor Andrew Gough,
Northampton University, **UK**

Bob Silverthorne
System Director, Mole Solutions Limited, UK

ABSTRACT

The Northampton Mole Project - a Case Study in the application of freight pipelines in an urban environment.

Dr Roger Miles, Professor Andrew Gough and Bob Silverthorne

Introduction.

This ‘Case Study’ paper will describe: the background to the project; the planned technology and operation; the economic, social and environmental benefits; the project methodology with particular reference to ‘Barriers to change’; the deliverables and the ‘Next Steps’.

Background

In 2015 Mole Solutions were awarded a grant from Innovate UK to part fund a Proof of Concept project to evaluate the Mole Urban Freight Pipeline Concept for an exemplar UK town, Northampton, generally considered as the centre of the ‘Golden Triangle’ for UK logistics.

The project ran from April to December 2015. A multi-disciplinary team who, along with the Mole team, provided the balance of funds needed to complete the project, was assembled. This team included: DHL, Laing O’Rourke, Morgan-Sindall, WGH Engineering, Force Engineering and Northampton University.

Technology and operation

The Mole Technology designs developed with our long term partners for bulk products were re-designed to transport pallets and capital and operating costs estimated.

The concept has four components: an out of town Consolidation Centre; a freight pipeline designed to transport pallet carrying capsules to a number of delivery points and ‘Molehills’. Molehills are located at high demand centres and also operate as ‘Click and Collect’ centres and as a base for the ‘Last Mile Logistics Operation’ (LaMiLo) using low socio-environmental impact modes.

Benefits

Economic, both direct and indirect, social and environmental benefits are achievable and will be described.

Project Methodology

An objective of the project was to develop a methodology for determining the viability of the concept in any municipality, anywhere in the world. The project schematic and details of the major work streams will be described.

A practical route into Northampton was identified and a tunnelling specialist company analysed the route and prepared cost estimates for different tunnelling solutions. These costs, together with current and planned supply

chain costs for various demand scenarios, were then analysed using the Mole Financial Analysis Model to determine the Internal Rate of Return for selected scenarios. Estimates of the social and environmental impacts of the system were determined from the UK Department for Transport's 'Mode Shift Benefit Values' and compared against the County Council's Environmental Impact Assessment.

A critical work stream throughout the project was the need to understand the 'Barriers to change' and to attempt to reduce, or remove, them.

Project deliverables and Next Steps.

The project concluded that at relatively low capacity utilisations the investment in a Mole Freight Pipeline System for Northampton was viable and offered significant socio-environmental benefits.

The methodology and financial models required for similar Feasibility Projects were established and a video produced to assist in the adoption of the system.

The support of the key players for the proposed Northampton Freight Pipeline System has been gained and a comprehensive Business Plan is being prepared later this year.

Introduction.

Mole Solutions were awarded a grant early in 2015 to undertake a Feasibility Study on the application of their urban freight pipeline solution for a pilot UK town, Northampton, generally considered as the centre of the 'Golden Triangle' for UK logistics.

The project was completed at the end of 2015. This 'Case Study' paper describes: the background to the project; the project methodology; the economic, social and environmental benefits and the 'Next Steps'. The technology will be described in our second paper,

A multi-disciplinary team was assembled including: DHL, Laing O'Rourke, Morgan-Sindall, WGH Engineering, Force Engineering and Northampton University

The growth of urbanisation.

The UN estimate that by 2050 the global population will reach 9.6 billion and that the number living in urban areas will increase from 54% in 2014 to 66% in 2050. The number of cities with populations of more than 10million will increase from 36 in 2014 to more than 48 by 2030.

As the urban population grows so does the need for public transport and to deliver the materials for everyday living. All this puts ever more vehicles onto the roads of what are already congested cities. An indication of how congested established cities is given by the satnav company, Tomtom. They publish their 'Congestion Index' on an annual basis. This is simply the time taken for journeys at peak time compared to the 'free-flow' time. On this basis, the top three most congested cities in the world in 2015, were Istanbul 58, Mexico City 55 and Rio de Janeiro 51. On the same scale, London is 38, Shanghai 36 and Dallas 17.

In the UK, the government estimated in 2013 that road congestion cost the economy 52US$B, equivalent to 800US$ per person per annum and despite a lot of infrastructure investment, the index of delivery reliability was worsening by 1.1% per annum. A UK government report in 2006 concluded that 84% of road congestion occurs in metropolitan areas and that in the morning peak rush hour, heavy goods vehicles can account for 30% of the traffic volume.

Focus on metropolitan areas.

Given the need to deliver goods in urban areas and the negative impact that road freight has on 'life in the city', Mole have focussed the development of their concept in urban areas.

The concept combines the benefits of consolidation centres, low impact last mile logistics (LaMiLo) vehicles with a freight pipeline system connecting the edge of town consolidation centres to the inner city high demand locations.

The Mole urban freight pipeline concept is applicable to both new and existing cities but, as including the concept within a new city would be part of the planning process, we have focussed the development of the concept on existing cities. And, of course, the existing cities are all forecast to grow in population numbers and the space for surface transportation is not increasing in proportion to the population. The mass movement of people is being met with the increase in underground metro systems, the time to develop underground freight transportation system is long overdue.

Questions to be answered by the project.

The project had twin objectives: to address the specific question, 'Is there a role for freight pipelines in the supply chains of Northampton' and secondly, to use the project as a Pilot Project and develop the methodology that can be applied to any city, anywhere in the world. A 'Scoping Study' for Manchester was completed in 2015 and discussions with Transport for London are currently taking place.

In order to answer the primary question, 'Is there a role for freight pipelines?, it is necessary to answer a number of secondary questions and in turn, even more tertiary questions.

The questions are largely common, for any city but it is essential to understand the specific geography, commercial and social issues that must be accommodated within a specific Feasibility Study.

Proof of Concept Project Approach.

Northampton has a population of 210 000 and is growing at one of the fastest rates in the UK. It is an ancient town that has a history of being a defensive centre designed to keep people out and there are only five entry points.

The project was complex with nine partners to provide specific inputs to answer the primary question. It was divided into three discrete phases:

1. Phase 1 – 'Data Gathering', essentially to establish the current supply chain details of Northampton, identify the current 'environmental Impact, establish a route for the pipeline and determine the 'Barriers to change', or obstacles to be addressed within the project
2. Phase 2 'Data Analysis' which compared the current status with the status using the Mole Urban Freight Pipeline concept. The core analytical tool used was a Discounted Cash Flow model to establish the

'Internal Rate of Return' for different scenarios. In addition estimates were made of the indirect cost benefits from users being able to reduce non-productive, expensive town centre space and the beneficial socio-environmental impacts (less congestion, accidents, cleaner air and a reduction in road damage). The Mole engineering costs were established in conjunction with our engineering partners, Force Engineering, WGH Engineering and Logistex and the civil engineering costs with our civil engineering partners, Higton Associates, Laing O'Rourke and Morgan-Sindall. To determine the operational viability, a discrete event simulation model was established for different combinations of the Mole Urban concept

3. Phase 3 – 'Finalisation' examined a range of sensitivities, produced an outline Development Plan for implementation of the Mole system and also Design Specifications for the civil and Mole system aspects. To help in promoting the concept a video of the project was produced along with a final report.

VIDEO

A video of the proposed Mole Urban solution for Northampton will be shown at the conference and will subsequently be available via a link on our website, www.molesolutions.co.uk

Smart Corridor – utilities, freight and people

The disused railway line that is proposed as the route for the Mole system lies mainly in a flood plain and therefore the proposed design improves the flood protection and the opportunity to incorporate two other initiatives that are being promoted by Northampton:

1. The development of a Gasification Plant in the centre of the town that will convert domestic waste into heat and electricity. The delivery of the domestic waste from a site at Brackmills to the plant would be by using hermetically sealed capsules and the Mole system. The alternative of road transport would require 150 HGV trips per day into the centre of town. The heat and power pipelines and cables from the plant can be incorporated within the culvert and, as the Mole system is electrically powered, Mole would be a 'customer' of the biomass it delivers

The proposed new route provides a green corridor for cyclists and pedestrians, from the outskirts of the town into the centre. As the route runs directly past the new location for Northampton University, this offers a sustainable route for many of the 8500 students that will be attending the campus from September 2018.

Financial viability.

The key evaluation viability is financial and the accepted parameter is the Internal Rate of Return (IRR) of the investment required. The approach we've adopted is to establish the IRR for increasing the volumes to be transported in the system. Within the potential Northampton volume we have categorised the volume into three groups:

1. High volume users ('Founding Stakeholders') who have simple 'source' to 'sink' supply chains. These would have direct connections to the system
2. Full truck load (FTL) volumes that traditionally take a full 12m trailer load into their retail store. Some of these loads originate at Regional Distribution Centres at the edge of town, 'Swan Valley' logistics park and the freight pipeline could be linked directly to them
3. Part truck load (PTL). This volume would enter the system at one or two Consolidation Centres located at eastern and western ends of the system. The consolidated loads will be transferred to the capsule and transported to the inner town pipeline termini, co-located with a high volume user. The final delivery to the 'customer' would be by the use of low impact vehicles.

The development of the stacked bar chart together with the determination of the design capacity of the system enables commercial decisions to be made.

Socio-environmental benefits.

Much of the socio-environmental benefit that adoption of the system can provide can be estimated using 'Mode Shift Benefit Values' (MSBVs) that are used by the Department of Transport to encourage users of road freight to transfer goods from road to more sustainable modes. These values are categorised for type of road, for example 'Congestion' on a rural motorway is 99p/truck mile and only 24p/truck mile on rural motorways. The round trip distance from the Swan Valley Logistics Park to the centre of town is approximately 10 miles and therefore every delivery trip that uses the Mole system generates approximately 20£ in social and environmental benefits.

In addition to the mode shift benefits there is the considerable benefit of providing an environmentally friendly route into the centre of, out of and across Northampton.

Socio-environmental impact based on 2013 Sustainability Assessment

Every Local Authority in the UK has produced a 'Sustainability Assessment' which establishes a base line against which any investment in infrastructure can be evaluated. A preliminary Environmental Impact

Assessment was made which showed that the 29 ratings were positively affected by the introduction of the Mole system. Notably, with Mole the seven ratings that were scored a high negative impact became zero and from zero high positive in the baseline, ten were rated high positive.

JIT, JUT and growth factors

The obvious benefit of the Mole Concept is the low operating cost but in addition there are the socio-environmental benefits and the indirect cost benefits that can be achieved with the availability of a delivery system that can provide a number of deliveries during the day rather than a single delivery before trading begins.

The development of the pipeline infrastructure also provides a convenient route for other utilities and a 'Greenway' for pedestrians and cyclists.

An intrinsic benefit of the Mole system is that it should suffer lower inflationary pressures as the two major cost elements of trucking, the cost of drivers and hydrocarbon fuels are removed.

Benefits summary.

In summary the benefits can be categorised as:

1. Direct cost savings of approximately 15% of truck operating costs
2. Indirect cost savings from being able to design, operate and achieve the benefits of reliable Just in Time supply chains
3. Social from a reduction in the levels of congestion, more resilient from being unaffected by weather, accidents, road works, etc and safer from being a freight only system
4. Environmental with reductions in carbon, other air pollutants, noise levels and infrastructure damage. The energy to power the system can be supplied from gasification plants, which in turn, can receive their biomass feedstock using the Mole system

Two important considerations to take account of in the investment appraisal are: 1. that the operating costs will not increase as fast as road systems as there are no driver costs and the power can come from renewable sources; 2. the level of socio-environmental benefits are proportional to the population and therefore will increase as the level of urbanisation increases.

Capital costs.

The capital costs of a Mole system is dependent on a number of factors:

- The volume and nature of the goods to be transported
- The construction cost of the pipeline. With 'cut and cover' techniques being significantly cheaper than tunnel boring, it is imperative to select the route very carefully ('Cut and cover' 1.1US$M/mile; tunnel boring 9.0US$M/mile)
- The number and functionality of the intermodal facilities

As with all infrastructure networks, the first A to B system is the most expensive. Subsequent incremental extensions are easier to justify financially.

The cost effectiveness of the Mole system is shown by the latest estimate from the UK government for the construction of new trunk roads as 18.4US$M/ lane mile.

As the chart in Slide 8 indicates, the investment can be financially attractive at low levels of utilisation and also delivers significant other cost savings as well as major socio-environmental benefits.

Next steps.

We have outgrown our existing demonstrator and so are planning to relocate to a larger site with space for us to have a complete 400m loop and space for intermodal facilities. This will allow us to carry out long term testing and develop critical elements of the system. This development work is scheduled for us to achieve a Manufacturing Readiness Level for the complete system of '9' in the next two years.

In parallel with the technical and operational development work we will be developing the construction methodology and preparing the comprehensive Business Plan. Both Transport for London and Transport for Greater Manchester will be represented on the Stakeholder Panel of our development project.

Conclusions.

The conclusions of the study are that the Mole Urban freight pipeline system for Northampton is technically viable, financially viable at low levels of utilisation and offers major socio-environmental benefits to the population of Northampton. It is planned to commence the next stage of the development process later this year with the system operational in 2020. It is expected that the system will be a Pilot Project for Manchester, London and Any Town, Anywhere.

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