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David Bennett examined the history and progress of underground travel in his book *Metro, the story of the underground railway*. The following is based on his findings.

London was one of the first cities in the world to experience extreme traffic congestion. In 1843 Charles Pearson, a lawyer by profession thought an underground line running beneath the surface to be the solution. The line from Paddington through Euston, St Pancras and Kings Cross on to Farrington would provide easy access to central London via an underground railway, thus creating a transport system that would avoid the crowded city streets. The venture was easier said than done, and the Metropolitan Line only opened in 1863. Nevertheless, it gave birth to the London underground culture.

The Thames Tunnel in London was the first underground tunnel constructed through the use of modern excavating principles developed by engineer Marc Brunel. Though risky, the concept of underground tunnels weren't new as it was alleged that the Romans constructed a tunnel under the sea at Marseilles and that the ancient Assyrian Queen Semiramis had a tunnel through the Euphrates. The completion of the Thames Tunnel was a great achievement even though it took 9 years before it could be opened for public use in May 1843. The process was hindered by several flooding incidences, tunnel collapses, human tragedies and financial downfall.

The East London Railway gained control over the Thames Tunnel in 1869 and decided to transform the pedestrian tunnel into a railway tunnel. At the turn of the century the tunnel was transferred to the London Underground and today it forms part of the Metropolitan Line. In 1870 a second tunnel, the Tower Subway tunnel connecting Tower Hill to Vine Lane was opened by the East London Railway company. Due to financial issues the open-top carriage railway



FIG 001

The cramped interior of a City and South London carriage

service had to be closed and the tunnel became a pedestrian subway.

The City and South London Line, between London and Stockwell, was the first twin-tunnelled underground railway in the world and opened in 1890. The line was the first deep-level tube system in London.

In mainland Europe, Budapest opened its underground railway service in 1896, while Paris opened the first of its six planned lines just after the Great Exhibition in 1900. The first electrically powered rapid transit rail, the U-Bahn, started operation in Berlin, Germany, in 1902, although the Vienna U-Bahn started operation in 1898.

In the United States of America, New York opened its first elevated metro system on Ninth Avenue in 1863 and a New York subway followed in 1904 (http://en.wikipedia.org/wiki/rapid_transit). Boston was the first city to open a "subway" in America. In 1901 it converted its streetcar (electrically driven tram) tunnel into an underground system.



FIG 002

Art Nouveau entrances of the Paris metro, designed by Guimard c.1913

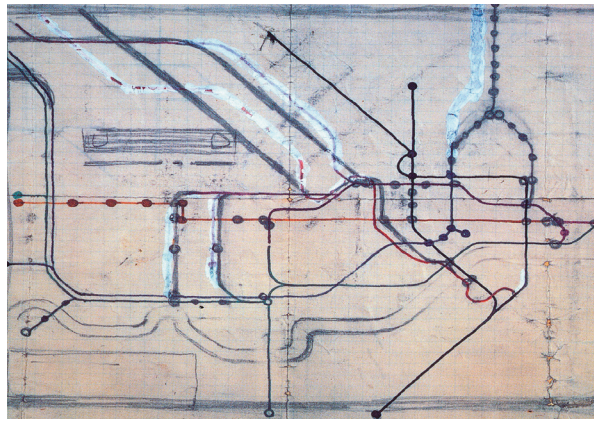


FIG 003
Harry Beck's original diagram for the stylized London Underground map

Moscow, the world's busiest system, was the first Soviet underground metro and started operation in 1935, while subterranean building issues caused the first planned system for St Petersburg only to open in 1955 (<http://www.urbanrail.net/as.htm>).

Asian underground rapid transit development only became prominent later in the 20th century. The Hong Kong Mass Rapid Transit (1976) and the Singapore Mass Rapid Transit (1987) offer technologically leading systems (<http://www.urbanrail.net/as.htm>). Lines are almost entirely automated since the introduction of the EZ-link and Octopus fair systems in 2002.

As the idea of underground transport became more popular, original lines were extended and transformed to increase carrying capacities and to accommodate the technological advances in train

and track development. New and improved lines with new stations and platforms were introduced. The Paris Métro initiated its conversion from steel to rubber-tyred trains in 1959 which allowed the system to increase its capacity without the need to modify station platforms. Vertical transportation in subway stations became more critical as stations became deeper and passenger numbers increased. The elevator was able to cope with the light passenger traffic of the early days, but it was the invention of the escalator in 1922 that allowed progression in deep underground station design.

Metro systems became a dense network with many interconnecting lines and a new mapping system had to be developed to aid commuters in finding their way. Scaled topographic maps were used until 1940 when the simplified metro map concept was introduced. Due to the lack of good colour printing, early maps were printed in black and white and not in the bright colours we see them in today.

Station designs have evolved from the traditional cylindrical corridors and platform spaces, to technologically advanced architectural structures that capture the user's attention. The introduction of smart cards (rechargeable tickets that look like credit cards) and electronic access control units provide a faster and more efficient circulation to cope with increasing station capacities. Today modern trains and stations can operate entirely automatic. Platform screen doors, an idea that was introduced in St Petersburg to regulate the underground station's temperature, are now becoming a safety feature where sliding powered doors on trains allow such intervention ([http:// railway-technical.com/stations](http://railway-technical.com/stations)). Davey, a journalist for the Architectural Review states (2002:70) that great attention is given to transparent spaces that import daylight into the underground platform levels and so prevents dark, isolated and confusing spaces that are uncomfortable to commuters.

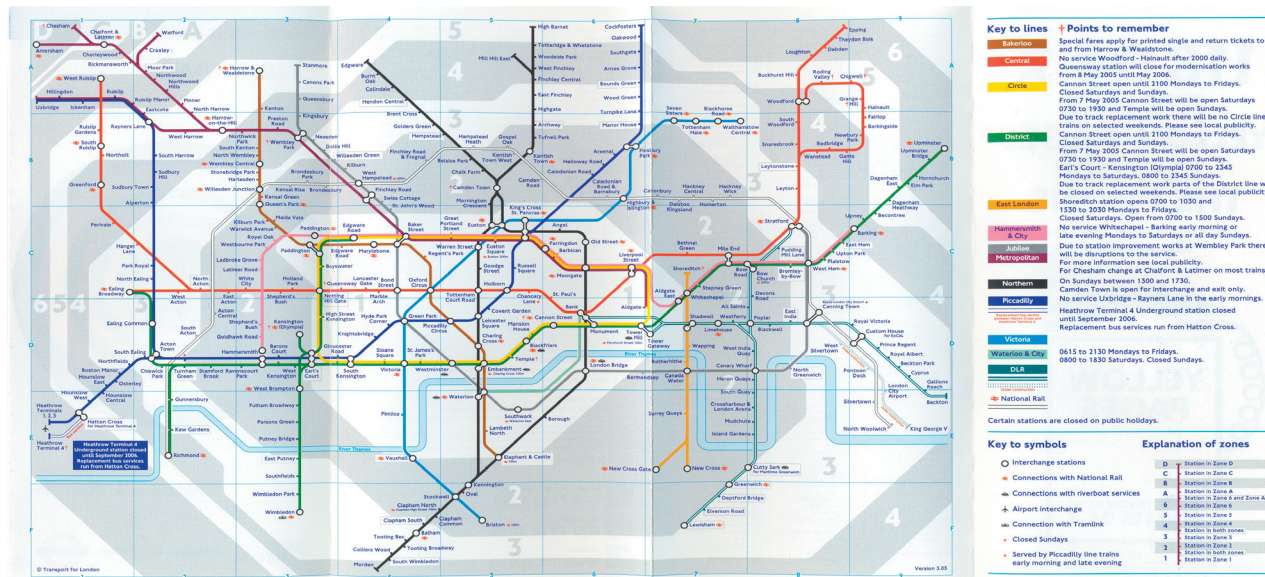


FIG 004
Current iconic London Underground map