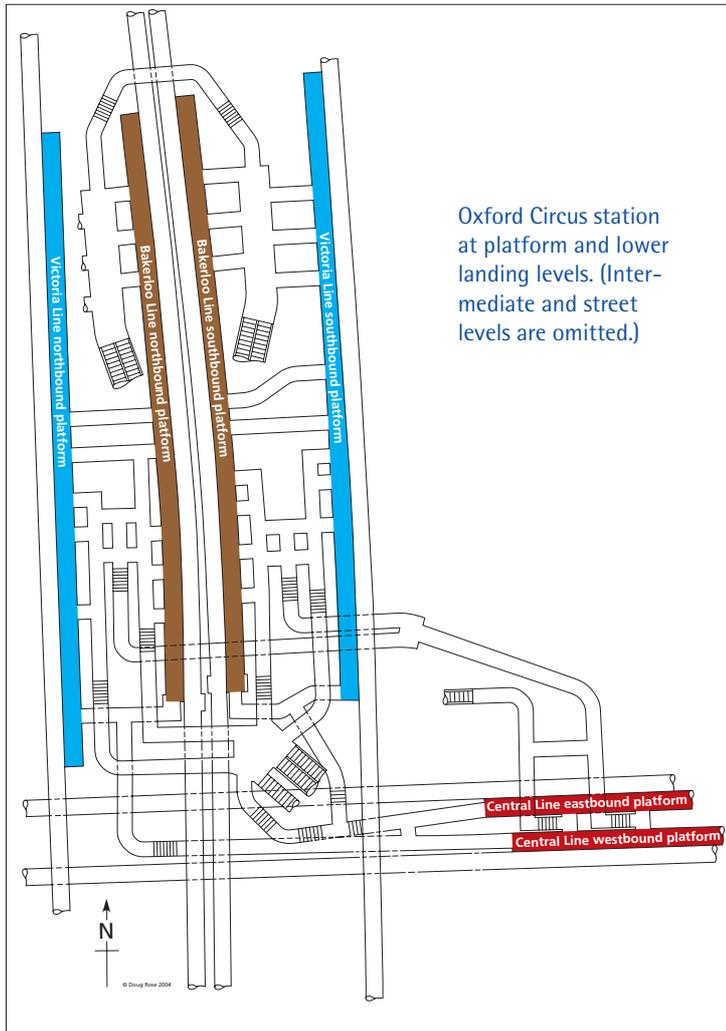


took responsibility for following through over a dozen identified shortcomings of the map and investigated them from first principles. The map is seen as a worldwide icon and pushing necessary changes through inevitably involves a large number of interested parties.

# London Underground Map



Knowing which stations offer the easiest interchanges can be a major influence on journey planning and of benefit to the operator in speeding up passenger flows. The desire to show these has engaged operators and designers alike for several decades and FWT was asked to look at it as part of a major review and re-design of the whole map. Various other aspects of the map had also come in for justifiable adverse criticism, in terms of less than optimal geometry and ambiguous features. The story that unfolded was lengthy and this case study focuses on just a few aspects.

## THE STARTING POINT

As always, our priority was to identify the problem. It was accepted that distilling all possible interchange types to 'easy' or 'hard' cannot be done, as every station has its own physical features. The real task was to see how few meaningful categories could be identified, that could be symbolized unambiguously and helpfully to the uninitiated, and this of course required detailed knowledge of all station layouts. FWT prides itself that it has this level of subject knowledge, without having to create a lot of work for the client – which we are proud to say is why we were chosen to carry out the investigation in the first place.

## IDENTIFYING THE INTERCHANGE TYPES

The ease of interchanging between one line and another on the Underground varies considerably across the system. For example at Ealing Common it is possible to leave a Piccadilly Line train and catch one on the District Line from the same platform. The reverse is also the case.

On the other hand a change between the Northern and Bakerloo Lines at Charing Cross involves two sets of stairs and an extraordinarily long subway, while the Northern to Metropolitan at King's Cross (at the time) involved two sets of

escalators, a walk, stairs and two lots of ticket gates. Some interchanges with National Rail or DLR are far more complicated.

This wide variation in local geography is in no way reflected by the interchange conventions on the diagram, which are historically underpinned by a single ring where up to three lines cross at an angle and a dumb-bell at other locations, where Lines are shown parallel. Inconsistencies have crept in over the years though the starting point was to show as few black rings as was geometrically possible for each station, as the intention was to portray the network as simple and easy to use.

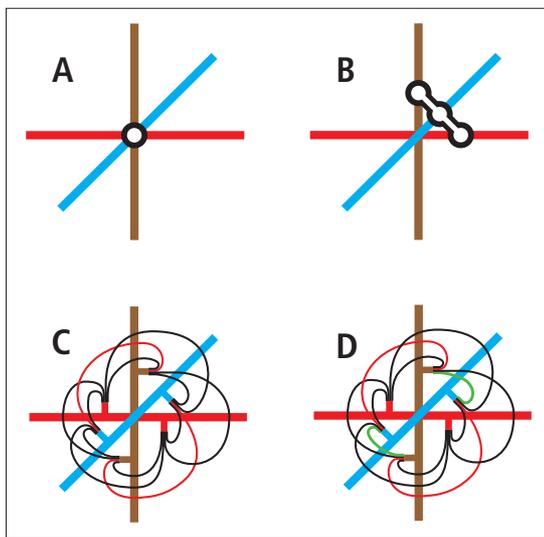
Another significant factor is that some sections of the map are designed to deliberately convey a particular feature, whereas others are simply an unavoidable constraint of geometry and the laws of physics. Of course, passengers are very unlikely to spot or realize the differences.

The suggested objective was to indicate complexity of interchanges on the Underground diagram so that passengers can take these into account when planning which possible route to take on a journey. For example, it is much easier to travel from Baker Street to Victoria using the Bakerloo and Victoria Line route (same level interchange at Oxford Circus) than Jubilee and Victoria Lines (escalators and stairs at Green Park).

Possible types of interchange would seem to include:

1. same platform;
2. different platform but same level;
3. escalator;
4. one or more stairway;
5. one or more stairway, with one or more escalator;
6. very lengthy subway;
7. interchange involving ticket barriers;
8. interchanges involving walking between separate station buildings at street level;
9. any combination of (3)-(8).

There is obviously much overlap among these in terms of perceived 'difficulty' and what is difficult for one person may not be for another. Nevertheless there is obviously some gradation between one end of the list and the other and the question arises as to whether or not it is possible to portray this on the Underground diagram, and if so, how.



**A:** the simplistic portrayal of Oxford Circus on the Underground map. All editions since the Victoria Line arrived in 1968 have shown this station with a single ring interchange, for sound reasons.

**B:** Expanding the geometry, one ring for each Line, does not help as each ring actually represents two starting points.

**C:** an insight into the real interchange possibilities; all twelve are possible and of course all twelve can be made in either direction. The red links are unlikely to be used much in one direction.

**D:** Links here are graded to show the easy ones in green. This was not intended as a recommended means of providing the information to the public, but merely to illustrate the possibilities for discussion.

One way forward might be to consider whether different types of symbol might be shown for easy/medium/difficult, but one would probably not want to have more than two or three gradations without generating considerable informational difficulty. In attempting to be helpful, the outcome would more likely be information overload; this would be utterly counter-productive. One would then need to consider which interchanges would fall into which grade. This in itself is far from straightforward.

For example at Oxford Circus there are twelve rational interchange possibilities of which two (Bakerloo northbound to Victoria southbound and Bakerloo southbound to Victoria northbound) may be excluded on the practical ground that few people ought to need these – though they are both viable in the other direction, raising another level of explanation to consider. This leaves ten practical options. Two possibilities are of Type 2 (easy), four are of Type 4 (medium), and four are of Type 4 plus a long walk. Which symbol would one use? Would multiple symbols be practical?

At Paddington, interchange between Bakerloo and Circle outer rail (clockwise) involves an escalator and a moderate walk. However, Bakerloo to Circle inner rail (anti-clockwise), two long staircases must be added in, making it 'difficult'. Which symbol would one use? There are many interchanges easier in one direction than the other.

Another good example would be Piccadilly westbound to Metropolitan westbound at Rayners Lane (a heavily used interchange) which is same platform, while Piccadilly westbound to Metropolitan southbound (still a busy interchange) involves two very long stairways. Stations such as Edgware Road (Circle/District Line) present a similar problem, this time complicated by not knowing in advance into which platform a District Line train will reverse and, hence, whether an interchange will be cross-platform or via stairs.

#### MAP SYMBOLOGY

The corollary of grading and portraying interchanges based on the geography is that the existing means of showing interchanges on the diagram is entirely constrained by the existing symbols deployed. There is a trade-off between achieving the clean geometry of vertical, horizontal or 45 degree lines (with minimum visual changes of direction) on the one hand, and the consistent use of single ring interchange symbols where lines cross and dumbbells where interchanging lines are parallel (or where a single circle is otherwise impossible). It is down to the ingenuity of the draftsman to get the best possible balance.

#### FURTHER INTRICACIES TO CONSIDER

In an attempt to show service pattern, a triple circle interchange was introduced at Earl's Court just before our study was commissioned. This visually implied a level of complication that is not reflected by the practicalities on site. However, nowhere else was this level of detail included. (The desire to show service pattern on the Metropolitan was another aspect of our brief; more on this below.)

Over the decades an on/off feature has been the use of unconnected rings (Paddington and Hammersmith) to indicate 'out of station interchange'. These have never been explained and may not be obvious. It is however a simple indicator of 'poor quality' interchange, or would be if it were used consistently (it isn't used at Tower Hill/Tower Gateway, Bow Road/Bow Church or Canary Wharf, to name a few examples of poor interchanges involving a walk at street level).

Showing two 'ticks' on parallel routes, at places such as Barons Court, might by the same logic imply 'out of station' interchange while in fact at a practical level it will invariably be cross-platform. This device has tended to be introduced in an effort to dissuade passengers from changing there – another subtle visual travel hint. Gloucester Road has swung back and forth from being shown with linking rings or a pair of ticks; it is not an easy interchange.

There was a deliberate decision made a few years earlier to make the two Shepherd's Bush stations look uninviting to make a change. Curiously though, Bow Road to Bow Church and Shadwell/Shadwell are encouraged, though neither can be regarded as 'good'. Canary Wharf (DLR/Jubilee) is a particularly poor interchange though has been shown (because the geometry is easy) as a single ring – actually Heron Quays (DLR) to Canary Wharf (Jubilee) is an easier interchange than Canary Wharf (DLR) to Canary Wharf (Jubilee). Perhaps the real problem is the choice of names for the stations.

Subsequently the solution at Shepherd's Bush has been to rename one of the stations, introducing a further inconsistency with Bank and Monument stations. These have distinguishing names though there are in-station interchanges among all four components. In reality it is one station with two names, albeit some tortuous interchanges and, paradoxically, an easy one between Bank, Northern Line and Monument, District.

In summary, we concluded there would seem to be insuperable difficulties in harmonizing a gradation of interchange quality on the ground with the existing symbols. There may be limited scope for indicating really difficult interchanges this way, or to do more by changing the symbols (which would have an effect on map geometry). It would be easier on maps where only limited routes were possible (in-car diagrams) or station-specific maps, because assumptions could then be made about the possible routes passengers would take and that would reduce the route possibilities at each interchange and reduce the problem to something more containable. This however would not help users of the network map, which was what the brief requested.

The use of single and multiple rings at some stations has implied an interchange facility since the diagram's first appearance in 1933 (and on many earlier geographical system maps too). It is part of a very well established visual language. On the newly designed London Underground diagram proof we submitted as part of this project, we elected not to diminish this communicative strength, but attempted a more rational approach to showing interchanges, and graded them into three categories:

- a) single or multiple joined rings to imply interchange without leaving London Underground property;
- b) detached rings where railway property has to be left and returned to elsewhere. (Even this is not clear cut and sometimes hinges on station names. At Hammersmith a walk is required at street level, though one station name suffices. Canary Wharf is similar but an even poorer interchange. Contrariwise, Bank and Monument have different names but are closely linked (easy interchange) for Northern/District Line. However, as noted above, the Northern/ Central interchange is very poor though the Bank station name is shared. The solution would be to rename Bank (Northern Line) to Monument, but this would introduce a new range of problems – some far reaching);
- c) closely related ticks where interchange is poor or between two nearby stations.

Having addressed the issue, all points were accepted by London Underground and it was agreed not to attempt this level of detail on a pocket network map.

#### MAP SPECIFIC FAILINGS

Our brief listed several areas of the map which were regarded as unsatisfactory, mostly caused by poor geometry. Designing a successful diagrammatic map is much harder than it looks

and simply joining lines on fixed angular trajectories, according to a shallow understanding of the supposed 'rules', can achieve a map that is much harder to use than may be expected. This is a huge topic and will not be dealt with here. However, suffice to say, there is a lot more to a virtuoso musical performance than playing the notes in the right order. To put it another way, the rules in themselves are important, but it is the execution of them, with understanding, that is crucially important.

The brief highlighted several aspects of the existing design that were unsatisfactory, in that they did not convey the network as clearly as they should. Some of this had been caused by a build-up of relatively low-contribution features whose disruptive costs were outweighing their value. Some of this had caused poor geometry, making following the Lines and stations (the primary function of the map and not to be compromised) to become hard.

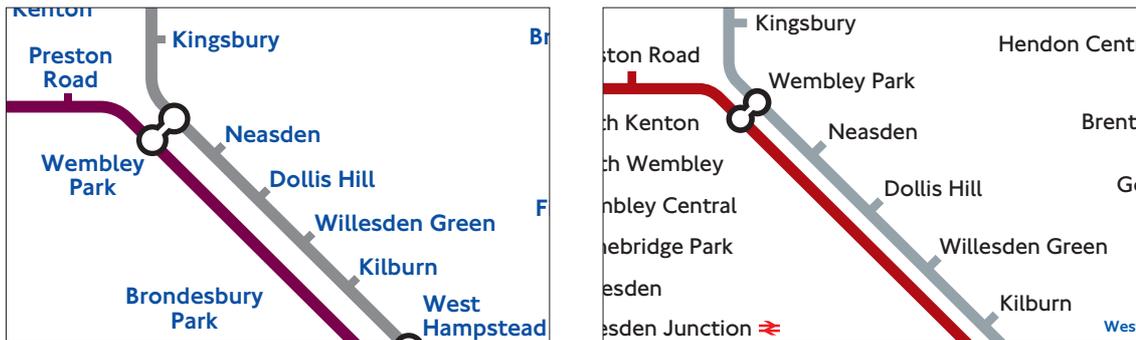
In particular, we explained that the fare zones were unnecessarily dictating the geometry in many areas, to the point where it was easy to misread the sequence of the stations on a given Line. The map was suffering as a result of poor priorities as well as the execution of them.



**Paddington interchange:** the existing design is shown above and the proposed re-working below.

Physically, the Hammersmith & City station (pink line) is at the far end of the main line platforms, relative to the Circle/District Lines (yellow/green lines). The connection between the Circle/District and Bakerloo (brown) is quite close and easy. The existing design offered a clue to the remoteness of the H&C (several flights of stairs, a lengthy walk and two ticket barriers) but suggested that Bakerloo to Circle/ District was not much better. The revised design cannot tell the whole story but at least offers a better synopsis and implication. How much can be asked of a simplistic line diagram? That is the real issue.



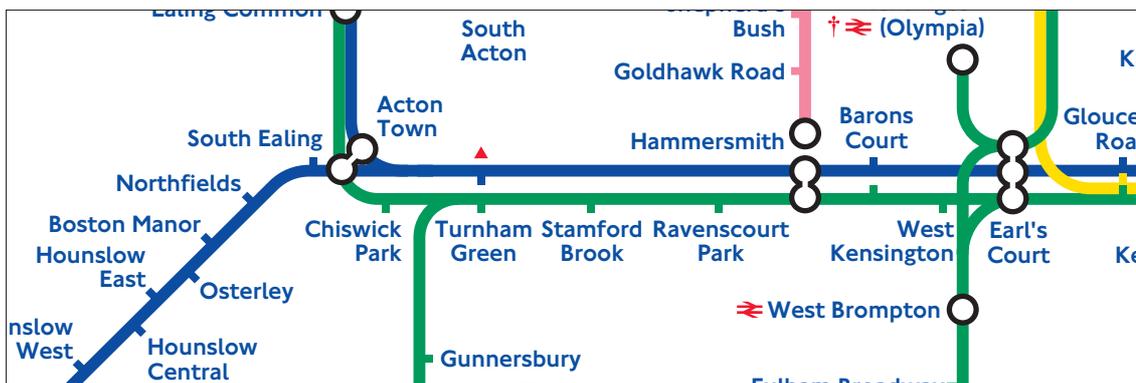


**Station sequence flows:**

The existing design is shown to the left and the proposed re-working to the right.

Reading the sequence of stations effortlessly along each line is a fundamental design requirement for ease of use. The existing map failed on this in several places, inviting reading errors. The majority of mistakes are made when in a hurry and designers must anticipate the kind of errors people are likely to make. Now, stop and read **quickly** the Jubilee station sequence (grey line) from Kingsbury down to Kilburn. Did you miss Wembley Park?

(Note also the flow of the Bakerloo and Hammersmith & City station names in the Paddington example on the previous page.)

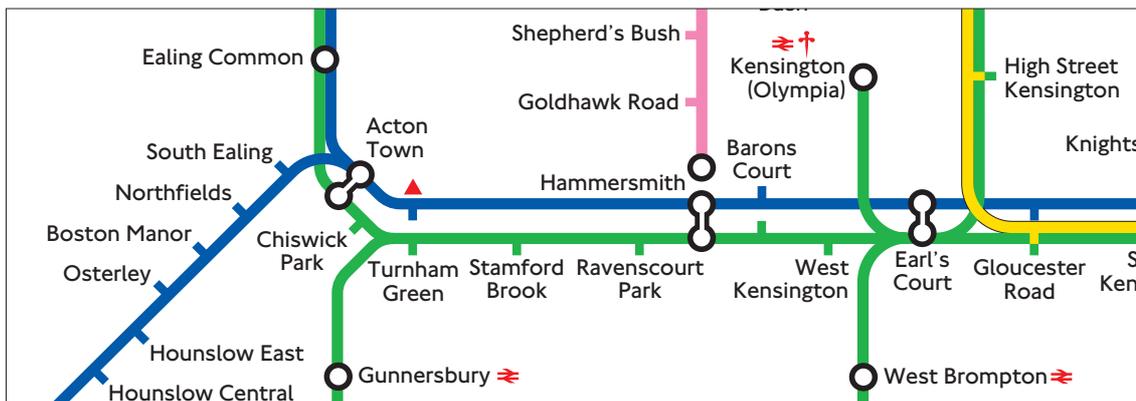


**Acton Town to Earls Court:**

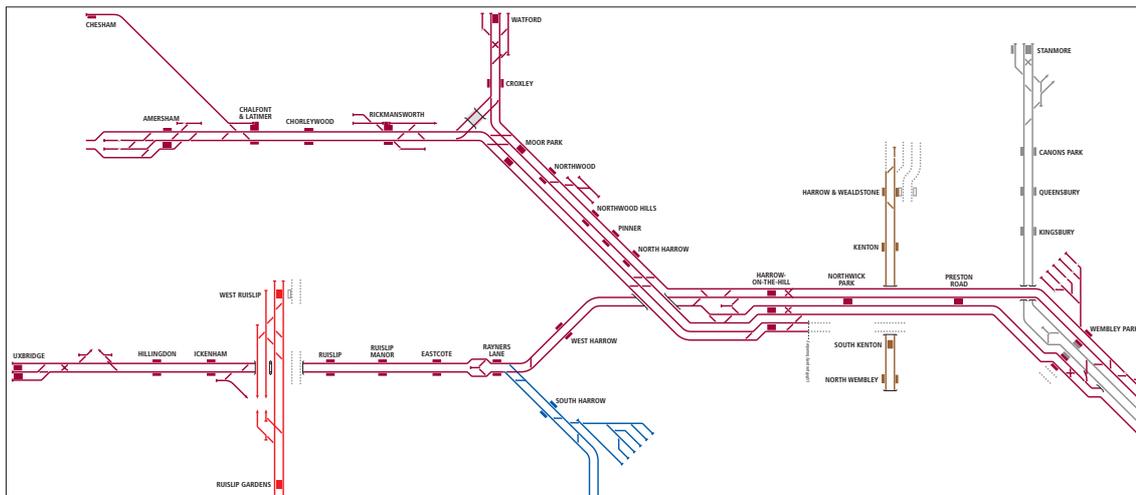
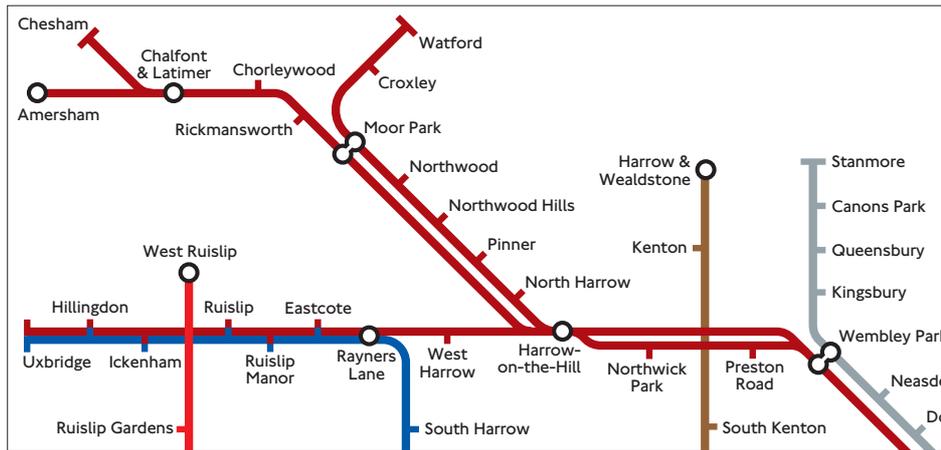
This has always been a difficult area of the map to get right, largely caused by Turnham Green, Stamford Brook and Ravenscourt Park all being served by the District Line (green) but not by the Piccadilly Line (blue). The very wide names have to be side-by-side and eat up space, putting pressure on Acton Town and Hammersmith. The constraints of the wide New Johnston typeface and restricted map width overall, compound the problems.

On the existing map (above) South Ealing is crashing into Acton Town and the Piccadilly Line turns less than clearly through 90 degrees through the station, thus putting extra cognitive load on the reader. There is more jumping about of station names on the Piccadilly Line. In a hurry, how clear is it which branch West Kensington is on?

It is also worth noting how complicated a station Earls Court looks and why the much simpler geometry of the new design (below) relieves it. (See also the section below on service pattern.)



In trying to reduce not only the track layout, but also the routes taken by the trains over it, to simplistic service pattern line trajectories, the inferences taken by the uninitiated invite assumptions and errors.



### THE SERVICE PATTERN ISSUE

We noted earlier that showing service pattern at Earls Court attempted to help travel planning but caused a bigger problem than it supposedly solved. Another aspect of our brief was to mimic the service pattern of the Metropolitan Line north of Baker Street, as per the then current car line diagrams and local area timetable booklets. We offered the following comments:

Off-peak all Watford trains run to Baker Street and serve all Metropolitan stations along the way – the diagram could be read that some miss Northwick Park and Preston Road and that they could run to Aldgate.

All Uxbridge trains run to Aldgate and serve all Metropolitan stations on the way – the diagram could be read that some miss Northwick Park and Preston Road.

All Amersham trains run to Baker Street and serve only Chalfont, Chorleywood, Rickmansworth, Moor Park, Harrow-on-the-Hill, Wembley Park and Finchley Road – the diagram could be read that some trains serve Northwick Park and Preston Road and could run to Aldgate.

Furthermore, during the peaks, the service pattern is not the same.

The success of the diagram over the years has been in its simplicity. We believed that attempting to show the Metropolitan Line service pattern did not fit in with this and could mislead those not in-the-know, when these are just the people it is seeking to help. Metropolitan stations are generally well signed and explain the service pattern at the point of entry. Other Lines (particularly District, Northern and Central) have variable calling patterns but these are not shown.

Our recommendation was noted and it was agreed that the service pattern suggestion would not be pursued.

### TYPESIZES

This was a potentially explosive request and a very difficult one to explain meaningfully here. Unfortunately the evolution of about 400 years of highly specialist typographic skills have been severely damaged (along with many other similar ones) by the widespread use of computers. These make it all too easy to get a reasonable result with insufficient understanding of the effects of those results.

We were asked to use type no smaller than 12pt; allegedly on legibility grounds. There are many contributory factors to 'legibility' and the typesize is only one of them. Ease of reading depends more on the space surrounding letters than the letters themselves. (This in itself is a highly simplistic statement.) The choice of typeface (we are resisting the use of the word 'font' as it too is misleading, but that is another large topic) has a major bearing, not least of which is the context in which it is used. This applies to all typefaces.

The Underground diagram, and many earlier pseudo-geographical maps, have used the typeface designed by Edward Johnston and introduced from 1916, though it was never intended for this purpose. Johnston's exquisite work was commissioned for signs and posters and not available for use smaller than 36pt. In those days typesetting was done largely using metal and wood-letter type. It was only with the advent of photosetting, in the 1970s, that smaller sizes could be created. Digital methods of course came much later. Prior to all

of this however, there was little to stop talented designers and artists hand-lettering it; indeed this is how the Underground map had received its station names from the outset in 1933, and the geographical ones before that.

By the 1970s a lot of material was being produced by London Transport using the worn metal and wooden type and the sad outcome was the design and introduction of New Johnston (another long story). The designers unfortunately made matters worse by increasing the x-height of the lower case letters and made all variants (light, medium, bold etc) heavier. At the smaller sizes New Johnston was now commonly being used, it suffered from reduced legibility in some ways more than the ill-defined printings from worn type of the original face. In recent years, the Underground map had been further hampered in legibility by setting all names in corporate Piccadilly blue. So we now had a typeface that was a bit too heavy and in a less than optimal colour contrast with the white paper and coloured lines, at a size smaller than it was designed to work. All these affect legibility.

We therefore recommended that the blue be dropped in favour of a return to black. We also recommended that New Johnston Medium be replaced by Light (closer to a normal medium). The New Johnston range, similar to Helvetica in this respect, has all its weights too heavy for clear reading, and

especially so at small sizes, where it is out of its territory as well. New Johnston Light in black has a similar visual impact to New Johnston Medium in dark blue, but is easier to read at small sizes. The heavier darkness of the black is compensated by the lighter weight of relieving the bolder blue and, the latter being thinner has more open space within its letterforms, and thereby easier to read.

The inevitable consequence of this diatribe is that the printed pocket map would have to get bigger – a lot bigger. This was soon discounted. The compromise was that we could go bigger and make the type as big as we could, but not on a sheet size larger than A3 overall. This was also necessary for another important reason, though not part of the original brief. The first diagram of 1933 had around half the number of stations as now, but the map size had not increased at all.

Taking into account all the other demands of the brief not retold here, finished designs were provided for both the pocket map and the station (quad royal) posters. Along with our analysis and report, all our solutions were accepted, though the project appears to have buckled under its own weight and was not implemented. Aspects of it continue to surface on an occasional basis.

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As with any other point size, 12pt in New Johnston will not look the same as 12pt in an other typeface. The four examples below are all set in 12pt with leading set to 16pt. The expression 'point size' refers to the overall height of the letterforms and not the height of the capitals ('cap height') nor the distance from the tops of the capitals to the bottom of the descenders. (This is a massive subject and many books have been written on it.)

**12pt is not a visual size constant (set in New Johnston Medium)**

12pt is not a visual size constant (set in Garamond No.3)

12pt is not a visual size constant (in Frutiger Light Condensed, as in the main text of this case study)

12pt is not a visual size constant (in Rotis Semi Sans, as in the captions of this case study)

For those who may be interested, below is a comparison of just two typefaces – Univers and Garamond No.3. The two have been superimposed and both are the same point size.



The image shows a comparison of two typefaces, Univers and Garamond No.3, at the same point size. The text 'Upper & Lower Case Words' is displayed in both colors. Below, the words 'Upper & Lower Case' are shown in pink (Univers) and blue (Garamond No.3). The Univers version has a significantly larger x-height for the lowercase letters compared to the Garamond No.3 version. Labels indicate 'Cap height', 'x-height', 'Baseline', 'ascender', and 'descender' for both. A diagram on the right shows two vertical lines representing the x-heights, with the text 'same point size but two different x-heights' above it.