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Aspects of Transit Map Design

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ABSTRACT A printed transit system map is a specific representation of a transportation network, typically covering an entire urban area. In comparison to interactive guides offered by services such as Google, such a transit system map is subject to limitations of scale and range of information for users. Transit maps from London, New York, and Paris show evidence of consensus by designers and map publishers on what information is required and how to graphically convey it. Indications of streets and surface geography show some divergence and reveal conceptions of local identity and wayfinding. In addition to their functional role subway or metro system maps have attracted attention as design artifacts.

The design approach taken by Henry Beck and later adapted by Massimo Vignelli restricted the complex reality of transit lines to a limited number of angles. Advocates for network maps based on this technique claim greater understanding by users. Writers of books on transit have been gathering rules of thumb and formulating design guidelines. Separately, design guidelines for bus system maps have been produced. Both these guidelines and individual maps produced by transit map publishers are good candidates for further investigation concerning the user-centered design process. Given the growing use of interactive itineraries and other tools, the role of printed maps should be evaluated from the perspective of a diverse group of users. These users benefit from public information systems and should not be forced to adopt unnecessary technology.

PRINTED AND INTERACTIVE TRANSIT MAPS

This paper is focused on the design of printed maps for public transit, with some consideration of present online mapping applications. Printed subway and metro system maps, even where extensive, necessarily include only a portion of the transportation networks within an urban area. Typically these maps exclude other modes of travel such as automobiles, buses, ferries, and rail services and indicate only terminals or parking for continuing journeys. Although regional or national railways carry daily commuters into large cities, these systems may be only partially represented on urban transit maps. The integration of bus rapid transit and surface light rail with a subway is reflected in transit maps of Los Angeles County. This is an example of an urban area that unites modes of travel as a replacement for the automobile. Lastly, while subway and metro systems are commonly thought of as running below streets, many combine underground routes with elevated or surface tracks that extend into outlying districts.

Compared to other transit travel modes, bus services can be very complex to map. In the United States, the majority of transit riders utilize buses. These vehicles may run on dense downtown streets and on limited-access roads; they include both local and express commuter services that reach outlying suburbs. Given this range, bus maps may show an entire road network, or details where separate maps may be needed to represent scales from city street grids to regional and national motorways. Bus frequency also varies widely, with some routes only running during peak hours in specific directions. Similar types of scheduling information may be far less critical to subway or metro riders, since service is often frequent within operating hours. The potential range of transit map scales and the necessity or value of schedules to transit users point to decisions that must be made by publishers and designers of printed maps.

A transit system can be understood as a network that: patrons enter, travel across, and exit. Riders must find their way to a transit stop to begin their journey, decide how to travel on the network, and then navigate from the transit system stop or station to their final destination. This process involves multiple decisions and specific information requirements at each stage. One guiding question for anyone planning transit information, such as a system map, is how much information does a rider need? Transit riders may weigh the perceived convenience of alternative start and end points and may have to select among various routes. Typical judgments include estimating the time needed for travel, distance to the final destination, and planning which transfers to make.

Key differences between interactive transit media and print media require consideration. One valuable online resource is offered by *Google Transit*, which encompasses a set of specifications for transit and map data used by Google. A distinctive feature of this and other applications is that scheduling information can be as detailed as desirable, without the constraints of space or need for updates presented by print editions. Another key difference is the emphasis on entering start and end points for

directions or guidance. Interactive tools make a series of wayfinding decisions for users, which is both a significant aid, yet at the same time, a potential for loss of understanding of the overall network. It is beyond the scope of this discussion to examine the flexibility or adaptability of interactive transit map services and whether their design affords further learning by users.

The printed transit map, necessarily limited to what it can represent, must be carefully designed as a complete package to provide information for transit users to navigate the network or system. Even frequent riders may not know the entire set of stations. These factors come together in users' experience of transit and transit maps. With daily exposure this experience may take on an emotional dimension as well; the emergence of transit maps as local graphic artifacts in the cities where they appear is not unexpected nor unreasonable. This has happened in London and New York, where artists and designers have appropriated the visual style of the Underground and MTA subway maps. Transit enterprises themselves have publicized their services through reproductions and authorized interpretations of their maps.

If we inspect subway or metro system maps from three large cities: London, New York, and Paris, we find a number of similarities. There is agreement on what constitutes the basic components of each network: station indicators, station names, lines, line identifiers or names, and interchanges. Color coding is used to help differentiate each line (or groups of lines) from each other line. Major railway terminals are denoted, as are nearby airports and connecting services. Links to these are indicated. All three cities developed on navigable waterways, so there are representations of rivers or bodies of water on all the maps as well. But the most significant trait is geographic distortion. It is geographic distortion that makes these maps practical. Position of stations are adjusted. Route paths are simplified. Station indicators and lines have been separated in the more concentrated central areas and compressed around the periphery. Without these interventions, it would have been impossible to create a useful map that spanned the breadth of each network. Each map must be simultaneously able to portray the nearly street-level scale of the dense central portions on the same sheet as those in the dispersed outlying areas (FIGURE 1).

The variances between the three transit maps indicate areas of differing priorities and conditions. For example, some schedule information is given on the London and New York maps, but none on the Paris map. Uniquely, the Paris map includes tram (light rail) lines, as well as a

FIGURE 1: *Detail of London Tube map*

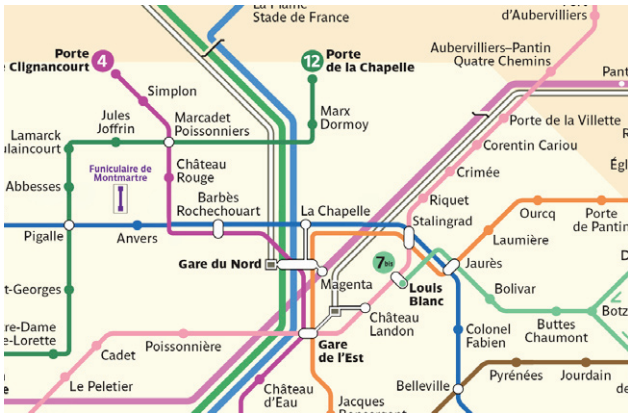

FIGURE 2: *Detail of Paris transit map*

FIGURE 3: *Detail of New York subway map*

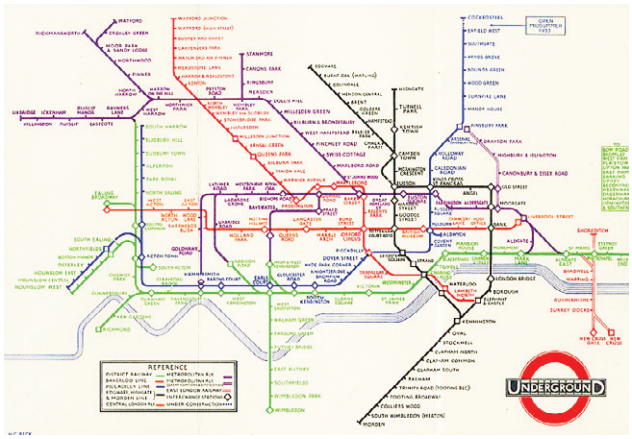

FIGURE 4: *London Underground map,* 1933.

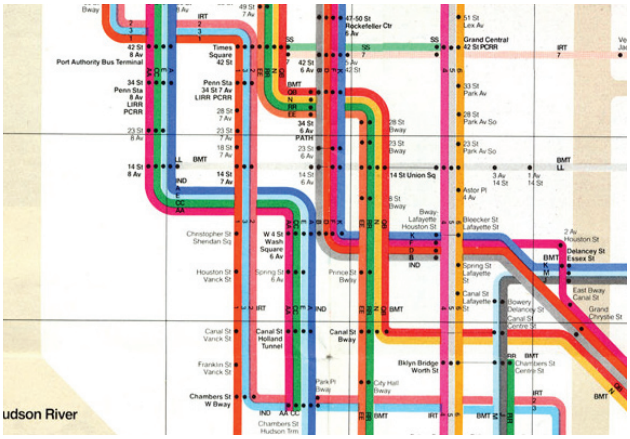

FIGURE 5: *Detail of New York subway map,* 1972.

regional commuter rail system (FIGURE 2). Both London and Paris indicate different fare zones (the New York network is single fare). The New York map noticeably lacks the portion of New Jersey close to the Hudson River, respecting the administrative boundaries of the Metropolitan Transportation Authority (which is responsible for New York's subway). Thus, this map omits an international airport in Newark, New Jersey; minimizes rail links between the two states; and presents a truncated view of the central urban region.

Since 1979 the New York subway map has been distinctive from other leading cities worldwide in its depiction of key streets. This was when Michael Hertz developed his design under map commission chair John Tauranac. This feature is less surprising given that the map also encompasses major parks, tunnels, bridges, neighborhood names, and even tourist destinations (FIGURE 3 on the previous page). One result of these choices is a richer visual texture compared to the others. In contrast, the London and Paris map designers and publishers do not attempt to orient riders, or anyone else, to these aspects of their cities. A solution offered by many transit systems, including New York's, is to post separate, detailed local maps at stations that show, with far less distortion, neighborhood streets and nearby points of interest for transit riders leaving stations.

Psychologist Barbara Tversky explains that our spatial mental models are subject to errors of importance. Graphic designer and design critic Michael Bierut cites the powerful organizing effect of the Manhattan street grid on perceptions of New Yorkers. The 1972 New York transit map designed by Massimo Vignelli omitted the street grid. Bierut identifies this as a major failing and a key reason why it was replaced. On his part, Vignelli has defended transit maps with minimal surface detail and significant geographic distortion, pointing to their success in London and elsewhere. Vignelli explains the role of additional information, such as verbal directions and neighborhood maps, which should supplement the transit map and provide more detailed guidance than any single map can.

Further analysis of strategies used in the design of transit maps is helpful. As early as 1926 one Boston rail map omitted all surface topography by abstracting routes into a series of line segments showing the interlocking nature of that system.[1] In 1931, Henry Beck's London Underground map, often referred to as a diagram, established a design standard for transit maps. He brought certain lines into strict vertical or horizontal alignment, as described in Ken Garland's account. Further, he combined a series of regularized curves with diagonals constrained at 45° to the verticals and horizontals. These refinements contributed to a more understandable, cohesive appearance. Beck continued the earlier use of color to identify individual lines. Other details he incorporated were the simple, evenly spaced tick marks to indicate stations, and uncrowded station names, since legible typography is critical. These techniques had appeared before, but Beck integrated them in one design (FIGURE 4).

The problem of indicating transfers or interchanges between lines was also explored in successive versions of the London map. By 1946 Beck revived an earlier notation for these stations by linking their open centers, forming a "white-line connector" for transfers. Created on his own initiative without any promise of compensation, Beck's map was released in 1933 and generated unexpected public demand. A key reason for this success was the

simplification of the complicated tangle of London's streets. Beck had merely attempted to render the Underground understandable. Despite some station positions on his map that were misleading to knowledgeable pedestrians, "Tube" riders expressed their preference for this depiction and it became a recognized design artifact. The London transit agency distributed graphic standards for the map by the design firm Henrion, Ludlow, & Schmidt in 1993.[2]

Others produced diagrammatic maps at about the same time as Beck. A diagrammatic version was produced for the Berlin network in 1931. By 1939 a design for Paris was created independently of the Parisian transit company (and unrelated to the current version).[3] As the diagrammatic approach has been adopted worldwide, it has led to a range of interpretations with the principles largely intact. Instead of names, some systems number the stations, pairing these identifiers with letters for lines. Station stops and interchanges are denoted by a range of graphic indicators. Beck's work was highly influential in two official diagrammatic New York subway maps, the first by George Salomon in 1958, and the second, already mentioned, by Massimo Vignelli.

Unlike the London map, Vignelli's map marked each stop by one dot on each route (FIGURE 5). A benchmark wayfinding study by Arline Bronzaft, Stephen Dobrow, and Timothy O'Hanlon found these markings problematic in representing interchanges or transfers. One visual explanation is that the principle of dot-to-stop correspondence led to presenting multiple dots where lines converged and did not imply transfers as strongly as other markings might. The marking of transfers is not universal; Tokyo and some European systems resort to large boxes placed over interchanges between transit lines.

The Bronzaft study also noted that maps are just one part of public information that a subway or metro rider needs to successfully navigate a network. Station signage is necessary for tasks such as navigating within a station and locating specific trains. Station signs may also be necessary to indicate at which station passengers have arrived. The trains themselves may need to be identified; all of these elements must work together in a coordinated manner. The interaction between signage and map in New York has been explored by Paul Shaw. Given the emphasis on text information in a transit environment, custom typefaces have been designed for transit agencies, appearing on signs and maps such as those used in London and Paris.

Writing for an audience interested in transit systems, authors such as Mark Ovenden and Maxwell Roberts have advocated diagrammatic maps. Ovenden gathered rules of thumb and formulated design guidelines, leading to a list of "good practice in diagram design."[4] His recommendations are not unlike those found in graphic design and typography manuals. The most valuable are those that distill the components and construction of diagrammatic transit maps. Elsewhere he acknowledges the value of accurate surface information for people trying to gauge the best routes to their desired destinations. Maxwell Roberts, as part of his analysis of London Underground maps since Beck's, explains his guidelines for diagrammatic maps and describes a study of transit route maps for complex journeys.[5]

A hybrid variation was developed by Paul Mijksenaar, designer and wayfinding consultant on international airport projects. During 1980–1981 his students, using the graphic vocabulary of London Underground maps, developed a hybrid map for London featuring a geographically representative central zone with landmarks to aid tourists combined with a diagrammatic periphery.[6] In some respects the Hertz map for New York was a hybrid, with its sweeping curves instead of fixed route orientations, and with its geographic landmarks complemented by helpful labels for visitors.

Design recommendations for bus transit maps have also been published. An example is a guide to effective printed transit materials from the Center for Urban Transit Research at the University of South Florida explaining the merits of Geographic Information System (GIS) overlay maps for bus systems. It includes various diagrammatic options. These design recommendations are generally not as prescriptive as those offered for rail maps, being derived from reported practices and previous research, yet they offer useful suggestions. A standards example concerns the number of colors used within the full palette. The argument is put forth that no more than nine saturated colors should be deployed. In the case of individual route maps and schedules, which are meant to appear together, a GIS overlay or street map is preferred. In this manner variations showing street distortion or diagrammatic compression may presented. The difficulty some riders have with interpreting time points and timetables is addressed honestly, leading to alternatives and the suggested inclusion of an instruction guide.

Alastair Morrison's study of European transit system maps concluded with bus map format proposals based on the number of routes and the geometry of the particular network. Those recommendations were derived by comparing graphic components and strategies, supported by the experience of transit agencies with maps and the changes made to them over time. Geographic (less

diagrammatic) maps are again favored as a result of the focus on bus and tram networks. This study also discusses schemes for indicating multiple travel modes on a single map, a useful addition as U.S. transit systems increasingly offer more than one mode of travel with the revival of light rail and growth of bus rapid transit.

What emerges from all of these guidelines is an overview of practice in transit map design. What is less clear is whether transit agencies routinely evaluate their printed maps and explore improvement. The approach of user-centered design has developed a variety of techniques yielding insight into how people understand and interact with artifacts such as maps. Related efforts by information designers have led to benchmarking information materials and testing new implementations for effectiveness. Public interest in transit systems and maps, outside of the agencies themselves, supports the argument that transit map development needs to explicitly bring transit users into the process. It should not be left to designers and publishers alone. There are ample opportunities to determine how well the various guidelines perform in practice.

The whole future of printed transit maps has been put into question by the accessibility of online tools. The flexibility and power of such tools for transit users and systems alike is driving their adoption, making them a compelling replacement — but raising questions of equal access to information. Transit riders without the latest handheld devices or data plans may not have access to applications that can supplant the traditional map. The numerous locations served by any transit network, and the transit vehicles themselves, still provide the primary sites for public transit information. The aspects of transit map design elaborated here provide a basis for future consideration. If printed transit maps are carefully planned and evaluated for effectiveness it is reasonable to assume they will continue to be an important and visually engaging part of any transit information system.

BIOGRAPHY

Peter Bain, a graphic designer and typographer, is Assistant Professor of Art at Mississippi State University. His MFA thesis at Virginia Commonwealth University was Design for Conspicuous Transit. He worked in New York from 1985 to 2007 and co-curated the exhibition *Blackletter: Type and National Identity* at The Cooper Union with Paul Shaw.

NOTES

1 Mark Ovenden, *Transit Maps of the World* (New York: Penguin, 2007), 48.

2 Maxwell J. Roberts, *Underground Maps after Beck,* Rev. ed. (Harrow, UK: Capital Transport Publishing, 2008), 54.

3 Mark Ovenden, *Paris Underground* (New York: Penguin, 2009), 150.

4 Ovenden, *Paris Underground*, 151.

5 Roberts, *Underground Maps*, 39.

6 Paul Mijksenaar, "Maps as Public Graphics: About Science and Craft, Curiosity and Passion," In *Visual Information for Everyday Use: Design and Research Perspectives*, edited by Harm J. G. Zwaga, Theo Boersema, and Henriëtte C. M. Hoonhout (Philadelphia: Taylor and Francis, 1999): 217.

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