CHAPTER 10

THE CHICAGO FREIGHT TUNNEL SYSTEM

Graph-theoretic infrastructure used in this case:
Chapter 3: *subgraph*
Chapter 4: *component; connected*
Chapter 6: *planar*

The Great Chicago Flood: Background

Monday, April 13, 1992, a hole was accidentally opened in a tunnel under the Chicago River (Chicago Sun-Times 1992); the river swirled through the opening as valiant efforts progressed to stop a huge mass of water from filling the abandoned freight tunnel system forty feet below the streets of the central business district, spanning a length of over fifty miles (Figure 10.1). In the days when coal had been used for the central heating of the downtown buildings, barges delivered coal to designated docks along the Chicago River (Moffat 1982). The load was put into trains of small cars which then dove below the streets, delivering one car load to the subbasement (furnace area) of one building and another load to its neighbor. The cars were seldom empty; when coal was delivered, ash from the previous load was picked up (often by gravity, dropping ash from above into a train car below), and train loads of ash returned to the river dock to be dumped into the empty barge and shipped off downstream. In the early twentieth century, when this system was working well, plans were laid for the eventual introduction of a passenger subway; forty feet was thought to be sufficiently deep to leave space for an underground mass transit system that would run between the freight tunnels and the surface, and not interfere with the existing freight tunnel system (Moffat 1982).

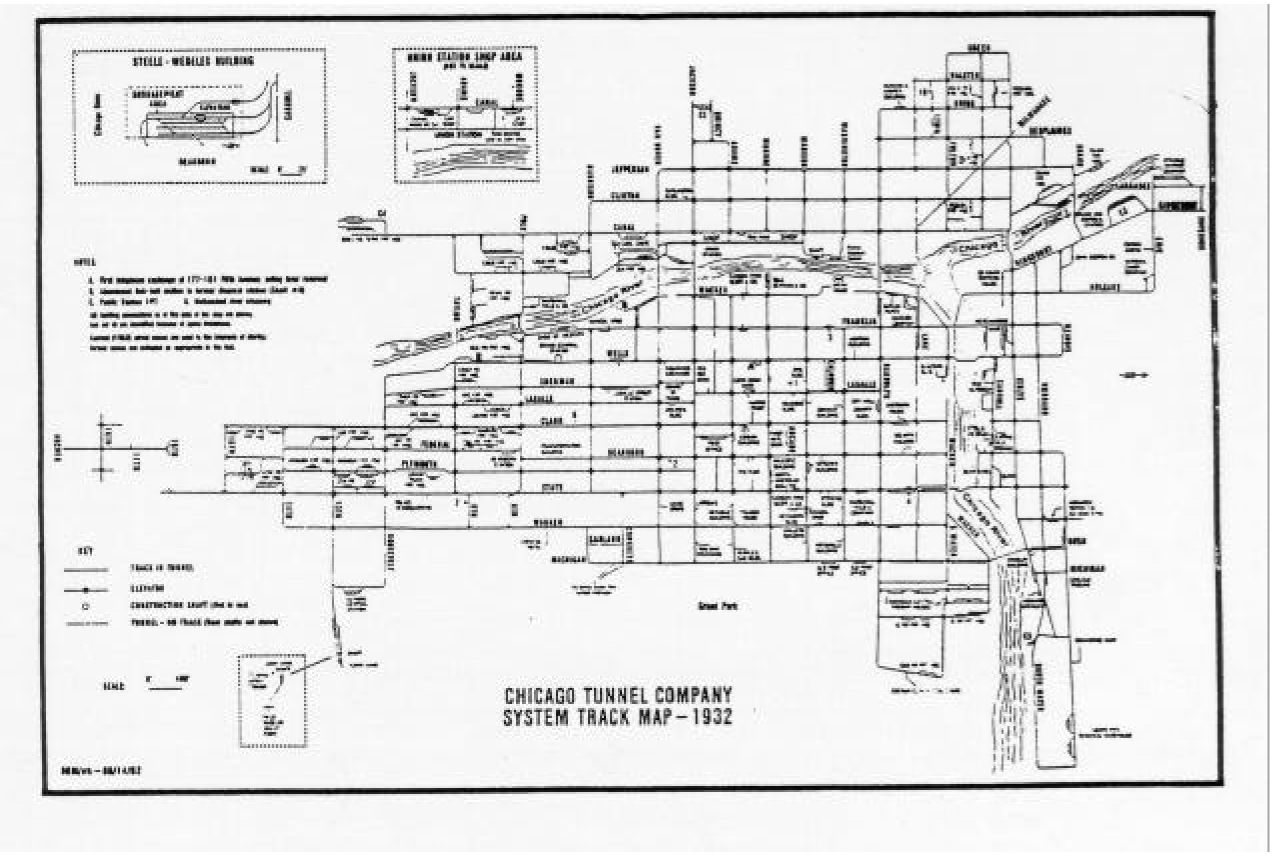

Figure 10.1. The Chicago Freight Tunnel System, 1932. After Moffat, 1982.

As coal-powered heating systems were replaced with gas-powered ones in which gas was delivered by pipeline directly into furnaces, there was no longer a need to transport coal and ash. The trains were called into service in conjunction with the postal network, often hauling bags of mail as a supplement to surface or pneumatic transport. Over the years, the trains and tunnels were used in a variety of imaginative ways. Before central air-conditioning was common in cinemas, the great, ornate theaters along State Street were able to boast central cooling during hot, muggy weather as they turned on their furnaces to permit the constantly cool freight tunnel air to circulate throughout the theater. Perhaps the most outrageous use proposed for these tunnels, but not implemented, was to use the systems as a detention area for the thousands of protesters arrested by the Chicago Police Department during the 1968 Democratic National Convention (Moffat 1982).

Subway of 1942 Causes Freight Tunnel Fragmentation

What was critical in causing this apparently forward-looking urban system to fall into disuse, however, was an alteration in its structure. The structural model of the system in 1932 had two *component*s (outlined in Figure 10.1); in 1942 when the mass transit subway tunnels were built, the little freight tunnel trains helped to haul out the dirt to excavate the larger tunnels that were to lead to their eventual demise. The space left above the freight tunnel systems, thought to be adequate by engineering standards of the early twentieth century, proved, by 1942, to be inadequate. The Lake/Dearborn/Harrison route forced tunnel reconstruction at selected crossings with north/south streets; it and the State Street route forced major disruptions in the freight tunnels along east/west streets between State and Dearborn Streets (outlined in Figure 10.2). The effect was to sever the transmission capability of the freight tunnel system, converting it as a structural model from one with two *component*s to one with eleven *component*s (Figure 10.2).

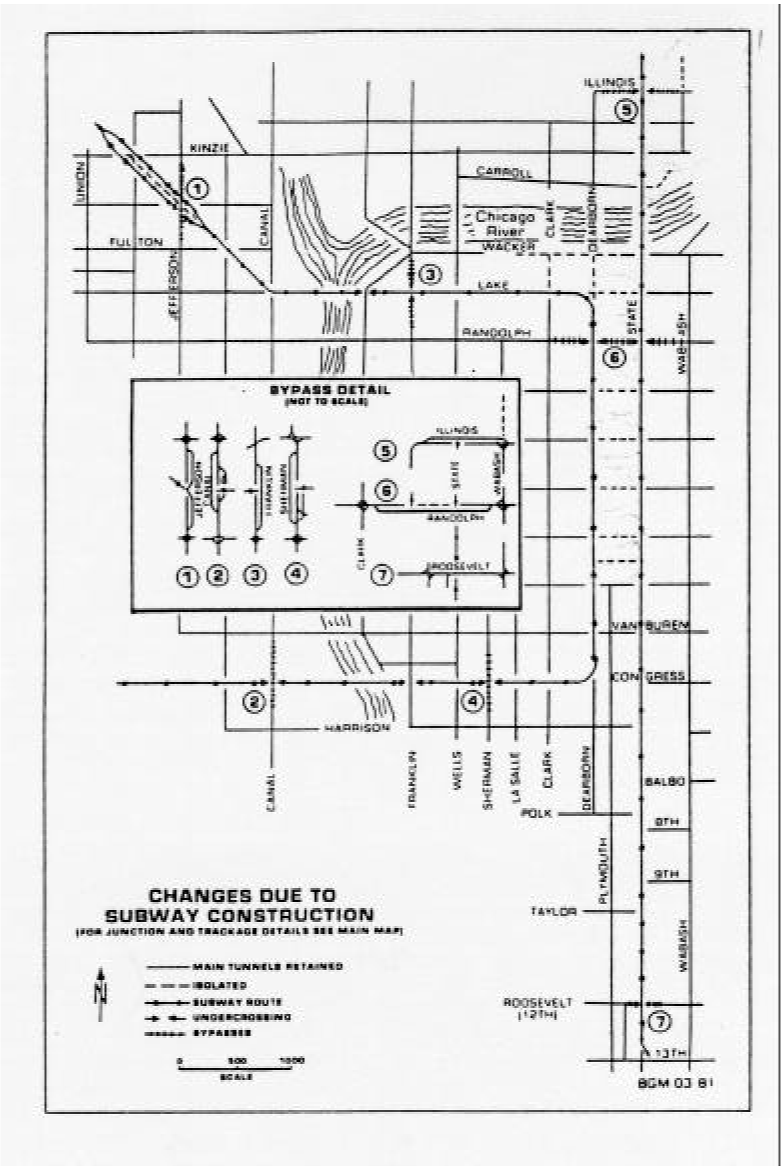

Figure 10.2. Changes in the freight tunnels caused by subway construction, source, Moffat, 1982.

The implications of this change in *connected*ness became apparent in the 1992 Chicago Flood. Chicago Fire Department and Commonwealth Edison records show that one site (item 3 in Table 10.1; site at State and Randolph Streets) reported a water-related emergency at 6:22 a.m. and that the site across Randolph Street did not report one until 9:58 a.m. (item 17 in Table 10.1). What might account for this sort of time lag, given that both sets of people in the buildings had ample opportunity to notice internal floods?

1.	5:57 a.m.	Merchandise Mart
2.	6:02 a.m.	222 N. La Salle
3.	6:22 a.m.	111 N. State
4.	6:47 a.m.	547 W. Jackson
5.	6:49 a.m.	121 N. La Salle (City Hall)
6.	7:04 a.m.	11 S. La Salle
7.	7:41 a.m.	55 E. Washington (Pittsfield Building)
8.	7:43 a.m.	10 S. La Salle
9.	7:43 a.m.	1 N. State
10.	8:00 a.m.	25 N. Wabash
11.	8:07 a.m.	547 W. Jackson
12.	8:29 a.m.	208 S. La Salle (Federal Reserve)
13.	8:33 a.m.	211 W. Wacker
14.	9:08 a.m.	231 S. La Salle
15.	9:25 a.m.	1 N. La Salle
16.	9:35 a.m.	135 S. La Salle (La Salle Bank)
17.	9:58 a.m.	30 E. Randolph
18.	10:00 a.m.	State and Madison
19.	10:32 a.m.	323 S. Michigan (Grant Park Underground Garage)
20.	10:58 a.m.	9 N. Wabash
21.	11:30 a.m.	30 N. State
22.	11:44 a.m.	16 N. Wabash
23.	12:08 p.m.	720 S. Michigan (Chicago and Hilton Towers)

Table 10.1 Buildings with water-related emergencies Monday, April 13, 1992. Source: Chicago Sun-Times, Tuesday, April 14, 1992. Source cited by newspaper is Chicago Fire Department, Commonwealth Edison.

The newspaper map that accompanied the published table offered no explanation as to why this variation in timing was not also accompanied by some sort of meaningful variation in spacing. However, when one takes a closer look at the *subgraph* showing the structure of the bypass introduced by the subway at State and Randolph, the seemingly confusing situation can be easily explained (Figure 10.3).

Planarity Explains Timing of East-bound Surge

The segment of freight tunnel between Dearborn and State Streets was isolated in the 1942 subway construction; it is denoted as a dashed line segment (Figure 10.3). In order to reconnect the tunnels, a newer bypass tunnel, that did not interfere with the subway, was built to join Randolph between Clark and Dearborn Streets to Randolph between State and Wabash Streets. This newer tunnel did not attach to the ends of the severed tunnels; cul-de-sacs were produced in constructing the bypass. Because this *subgraph* composed of the newer tunnel and cul-de-sacs is *planar*, the full surge of the east-bound waters in the Great Chicago Flood could flow downstream through the bypass, toward Wabash Street, and enter basements in stores on the south side of Randolph Street (Figure 10.3). Only later would water back up into the cul-de-sac, and into basements, on the north side of Randolph Street between Wabash and State Streets. A closer look at a suitably chosen *subgraph* suggests why there was the early response on the south side of Randolph followed by the later response on the north side of Randolph Street. The *subgraph* of Figure 10.3 accounts for the time lag.

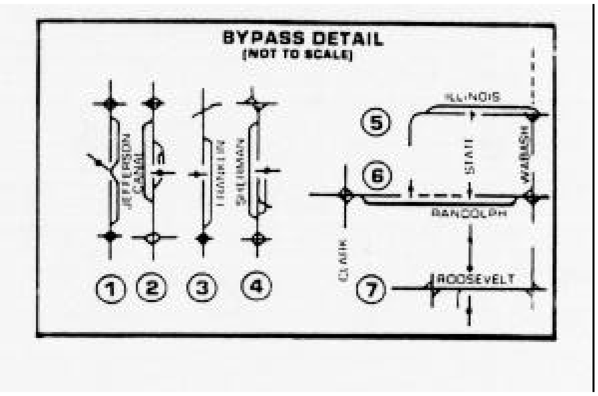

Figure 10.3. Detail of the Randolph Street bypass, showing cul-de-sacs (source, Moffat, 1982).

A disaster at the surface layer wreaked havoc in a subterranean layer in Chicago; use of a carefully constructed structural model coupled with historical evidence involving the construction of the subway system led to discovering a structural reason, rooted abstractly in the *planar*ity of a *subgraph*, that might have caused a delay in reporting the emergency. An understanding of structure in one layer can explain activities in another; armed with such knowledge, planners and municipal authorities can be better prepared to understand the likely structure of future interaction between surface and subterranean layers.

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