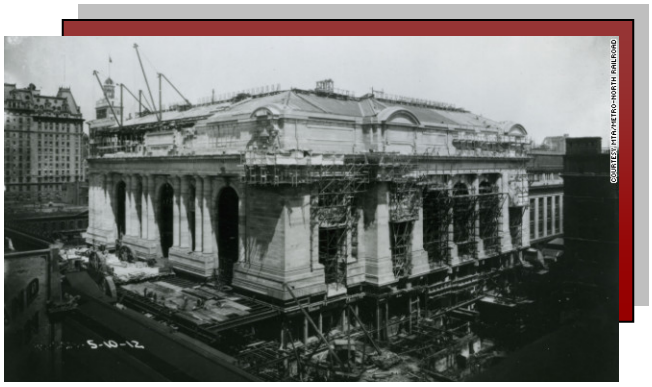
## Reminiscing: 15 Years of Mechanical/Electrical Infrastructure Design at Grand Central Terminal

*Charles Copeland, President Goldman Copeland*

### COMPETING FOR THE PROJECT

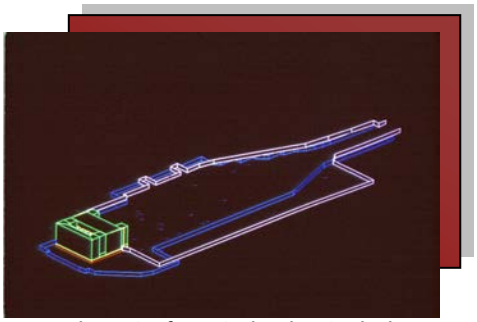
Engineering the infrastructure upgrades to one of the most famous landmarks in the United States was a challenging and rewarding professional journey for me. In late 1988, Peter Stangl, the first visionary president of Metro North, along with other officials, initiated the restoration of Grand Central Terminal (GCT). For many years, I have commuted through GCT, as did my mother for several decades before me. It was a structure both intriguing and mysterious and I was excited by the prospect of understanding its systems, many dating back to its original construction. Our firm, Goldman Copeland, joined an engineering team to compete for the project to upgrade the almost eight-decade-old mechanical/electrical (MEP) infrastructure. My former partner assured me that going after this high-profile project was futile because of all the anticipated competition. Little did he (or I, for that matter) imagine that our group would not only be successful in securing the prime contract later that year, but also that we would work on GCT for the next 15 years.



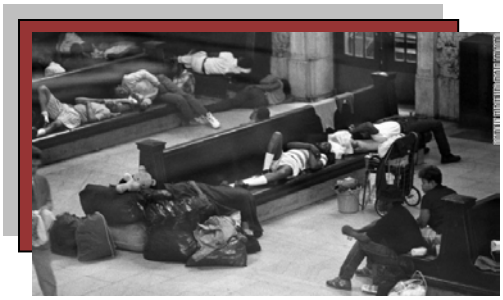

*Grand Central Terminal near completion in 1912*

### SURVEY OF THE SUBTERRANEAN TUNNELS

One of our first tasks was to survey the enormous underground expanse known as the Train Shed, an area rarely seen by daily commuters. Frankly, it gave us some concern walking the many underground piping tunnels and former baggage passageways in those years before the Metropolitan Transportation Authority (MTA) adopted a relocation program for the numerous homeless "mole people" inhabiting those subterranean spaces. (Some of the destitute also lived in the main waiting room.) Many would emerge from their "bungalows" as railroad workers sometimes called them, any time of the day or night, in some cases disoriented and seemingly unwashed for months, with clothing that often consisted of just old blankets. There were no sanitary facilities so the tunnels also served as their toilets. One of my recollections is how neatly some of the homeless drug addicts lined their crack/cocaine vials on shelves. We learned that an entire family was discovered living under one of the



*Schematic of Terminal and Train Shed*



*Living in the waiting room*

4-foot high lower level track platform walkways, after Metro North personnel traced an extension cord from a platform electrical outlet to a small refrigerator that the family reassembled below. We never surveyed the tunnels alone but always accompanied by one or two comrades, and fortunately, our surveys proceeded without incident.

**UTILITY WITHDRAWAL**

An early engineering assignment was to orchestrate the removal of the archaic pipe and electrical systems serving the neighboring buildings from the tunnels. This project was dubbed "utility withdrawal," a term not without its parallel to "drug withdrawal," a popular treatment program at the time. When it came to steam, however, the owners of these properties were left with an expensive dilemma since the price of steam redistributed from GCT through the old, leaky GCT distribution system was much more costly than buying it directly from Con Edison. However, reconnecting independently to the Con Edison steam grid in lieu of the terminal steam system was pricey, sometimes costing upwards of $300,000. The steam rate issue was often contentious, sometimes leading to litigation between the properties and the MTA. In the end, all the former GCT utility users were eventually disconnected from the various systems.

*Inspecting the utility tunnels*

**GRAND CENTRAL TERMINAL'S ORIGINAL CLIMATE CONTROL SYSTEMS**

Grand Central's climate control systems originally consisted of heating and ventilating (H & V) units, outside air supply fans, miscellaneous exhausts and operable windows. Some of the operable windows opened to the elegant east and west walkways, affording a superb view of the main concourse that I must say I enjoyed strolling through at every opportunity. The 1913 design drawings proposed H & V and evaporative air systems to condition the main concourse, but they were never installed; or as we euphemistically say these days, they were "value engineered" out. Most of us never realized that the main concourse lacked formal heating or air circulation. Even the ornate cast steel "roundels" as they are called located in the east and west ends of the historic ceiling, were to be exhaust grilles in the original design, but also were never connected. The lower level H & V units were installed and distributed warm air through the vertical masonry columns. Steam-to-hot-water heat exchangers and pumps provided hot water for heating the Terminal and eventually 24 buildings on Park Avenue and the neighboring streets in a clever tri-zone arrangement capable of serving buildings of various heights. Direct current (DC) motors energized all of the original fans and an early small refrigeration plant installed in later years cooled fountain water.

Not part of our scope was ventilation of the Train Shed, most of which occurs by natural convection or the push-pull of the trains through sidewalk gratings or vertical shafts inside various buildings. As the

commuter trains incorporated air conditioning over recent decades, however, natural ventilation became inadequate for the many underground tracks and walkways that become quite warm in the summer as many commuters can attest. Exhaust systems installed by MN a few years before this project to ventilate some of these underground areas met with modest success. Some future project may address both removing potential tunnel smoke as well as improving ventilation.

**ORIGINAL ELECTRICAL PLUMBING AND LIFE SYSTEMS**

The original electrical systems, innovative at the beginning of the 20th century, serviced both the third rail track DC power and the Terminal/Train Shed services. Similar to the other MEP systems, under Penn Central's ownership, this infrastructure was only marginally upgraded over the years. In the 1980s, Metro North undertook some improvements but the basic original infrastructure remained. Many of the plumbing systems were sporadically replaced on an as-needed basis. One system not requiring replacement was the robust roof drainage piping over the main waiting room, in perfect condition since it was constructed from a cast-iron alloy no longer manufactured.

***Original equipment***

**WALDORF ASTORIA POWER PLANT**

The railroad's original power plant located on 50th Street between Lexington and Park Avenues, the eventual site of the Waldorf Astoria hotel, provided steam, hot water, compressed air, domestic hot and cold water, fire suppression water and electricity. Distribution of these services through the train yard and to the Terminal ran through tunnels underneath the lower track level as noted earlier. These hot water heating and steam systems once served 24 aboveground buildings, while 28 buildings received electric power.

To supplement this plant, about 6 years after the terminal opened, the railroad constructed a new coal-fired boiler plant on the lowest level of GCT at approximately 43rd Street. With the construction of the Waldorf Astoria in 1929 and demolition of the main Waldorf Astoria plant, the railroad purchased all steam and electricity from the local utility company (eventually Con Edison) and decommissioned most of the 43rd Street boiler plant. Today, standing on the south 42nd Street sidewalk across from GCT, one can easily view the original boiler plant chimney rising above the adjacent Grand Hyatt hotel.

**OUR PROJECT**

The new design included a new 3000-ton cooling plant, upgraded HVAC system with new cooling towers on the roof as shown, air conditioning systems throughout including cooling provisions for all retailers, various new exhaust systems, main concourse automatic smoke removal, upgraded domestic water system, and sprinklers. The

***New rooftop cooling towers***

electrical upgrade included a new 13.8 kV high voltage loop, feeders, transformers, diesel generator for back up electric service, fire alarm system, and a facility-wide central automatic temperature control system.

Fortunately, the Terminal's ample shaft space allowed for future expansion without affecting any of the historic architecture. The four large hollow columns/shafts at the corners of the Main Concourse and Waiting Room would contain our new air conditioning ductwork. One challenge was how to condition the 125 foot high concourse efficiently which we accomplished by creating a stratified zone, delivering cool air at a 15 or 20 foot height and returning the air at floor level. This avoided needless cooling of the large vertical space above the occupant level.

Upgrading GCT's systems required development of bid packages that met the timing and annual financial constraints of the public agency. It often required installing new services adjacent to existing ones to ensure uninterrupted operation of the terminal and service continuity.

Late in the installation, one of our field engineers informed me that they discovered someone living on one of the upper floors in the southwest corner D Hall shaft. Apparently, as workers were installing a large kitchen duct for the new lower level restaurant dining facilities, they discovered wooden planks across the shaft, a mattress and blankets as well as clothing hanging from various pipes. Metro North police waited patiently until an eastern European man in his seventies arrived in the evening to open up the shaft access door to his rent-free abode in one of NYC's prime real estate locations. After questioning, he admitted to living in the shaft for 22 years, almost from the time he first arrived in the United States.

The restoration of this landmarked building also included providing the infrastructure for 150,000 sq.ft. of retail stores and restaurants, a significant undertaking which fortunately my partner Howard Holowitz more than adequately managed, as I had a full plate with the other work. Many of the retailing design concepts for the retail stores were skillfully conceived by the redevelopment team credited with the revitalization of Union Station in Washington, DC.

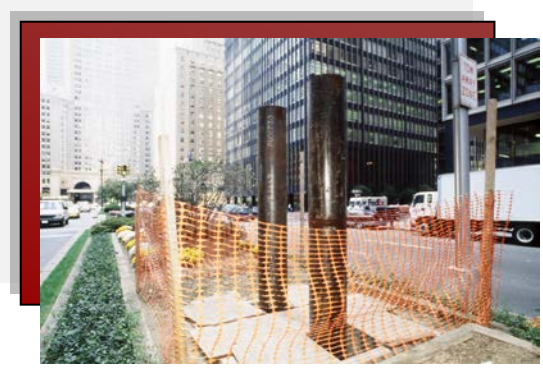
**IMPROVING GRAND CENTRAL TERMINAL'S LIFE SAFETY**

Perhaps one of our most important tasks was to make GCT, fire safe and now it is sprinklered and monitored by a fire alarm system. One obvious surface where sprinkler heads are restricted of course is the famous main concourse ceiling. Its significant height would also nullify sprinkler effectiveness, as well. To address this, we commissioned a fire and smoke computer simulation to determine the size of an automatic emergency smoke exhaust system to remove the smoke above occupant level. In the unfortunate event of a fire, this should allow travelers and visitors to exit safely through the many ground level exits. Those previously unused "roundels" located in the concourse ceiling are now utilized for this

***Original roundels***

automatic smoke exhaust system.

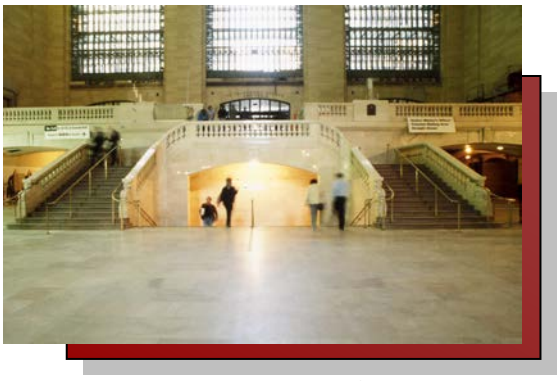
Early in the program, we started design of a new backup/emergency generator located in the Madison Avenue yards alongside the other backup generators. The day after the first 1993 World Trade Center terrorist underground explosion occurred, Metro North identified another location for this generator to prevent all of them from being disabled in a similar incident. This site turned out to be near the original private elevator used by President Franklin D. Roosevelt to discreetly access the Waldorf Astoria from the Presidential train when he came to NYC. Perhaps our only "noteworthy" architectural contribution to New York City as engineers was the generator exhaust and inlet stacks that now exist in the middle of Park Avenue just slightly south of the Waldorf Astoria. These chimneys were not without some controversy as one might expect. Among others, the NYC Parks Department objected to them arising in such a prominent location. Metro North attorneys eventually extracted a 19th century legal document to prove that they had the right to install these stacks – especially in the interest of life safety. We engaged an architectural firm to design an ornamental enclosure to somewhat mask their appearance and to make it appear that they were always there.



***New stacks on Park Avenue before an architectural enclosure was added***

**FOND MEMORIES**

One decision that resonated with me occurred at a weekly meeting. The contractors promoted a substantial cost saving option to install a less expensive generic stone for the west and new east balcony steps in lieu of matching the original 1913 stone since installing the identical surface required reopening one of the abandoned East Tennessee marble quarries. During the meeting, the architect Jack Beyer of Beyer Blinder Belle persuasively advocated the installation of the matching Tennessee Pink stone. Donald Nelson, the railroad president overseeing the meeting (the successor to Peter Stangl) stated that Metro North had not come all this way restoring this great edifice to lower the project quality by using a generic stone. The original quarry was reopened and stonemasons were flown in from Italy (since there were no stonemasons in Tennessee) to cut and dress the stone that now adorns the steps. Today when I walk by those stairs, I feel great pride that Goldman Copeland was part of this important project for 15 years.



***West Concourse Stairs***