Left: Lucent facility in Lisle, IL
Below: Lucent facility in Naperville, IL

Fraternal Twins
Communicate Corporate Vision

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Lucent Technologies, a 1996 spin-off from AT&T, is the world leader in research and development (R&D) of innovative communication systems. Lucent includes the prestigious Bell Labs that has produced 11 Nobel laureates since 1937 and has invented or developed thousands of key technologies, including: the transistor, photovoltaic "solar" cells, optical communications, the cellular phone system and communication satellites.

To develop an independent corporate identity, Lucent established a real estate initiative, Project Atlas, programming the uniform development of their spaces and creation of a new corporate image. The architectural firm, Kevin Roche John Dinkeloo and Associates, developed the Project Atlas master plans and designed all of the buildings for various Lucent locations in this country and abroad. This included the construction of two major research and development buildings located in the western suburbs of Chicago, Naperville and Lisle, IL, as well as renovations of Lucent's existing facilities at those locations.

At the Illinois locations, Lucent and the architects assembled a complete design and construction

team in the Fall of 1997. The targeted opening date for the buildings was the Fall of 2000. Under this aggressive timetable, the challenge facing the project team was to design, develop and construct efficient and cost-effective buildings meeting Lucent's program.

In terms of cost, schedule and Lucent's objectives, the successful completion of this project was facilitated by Lucent's decision to introduce the team-partnering concept. To foster an environment of cooperation and collaboration among the team members, several working sessions were held to build team unity and improve communication and cooperation among the team. The successful completion of these complex projects is a testament to the value of the partnering process.

The two-site development, totaling 2.5 million sq. ft. of construction, brings together 4,000 employees currently scattered among many buildings in the vicinity. The Naperville and Lisle sites will each include R&D buildings of approximately 600,000 gross sq. ft. including office, laboratory, product display and support space, parking for 1,800 cars and enclosed pedestrian bridges to adjacent existing Lucent buildings. Both new R&D facilities have two identical five-story office/lab wings flanking a central entry/conference center element that features a glass and steel lobby structure. Unique building identities are established by dramatic yet very different entry designs.

Structural Framing Systems

Although the sites are in close proximity, subgrade conditions differ dramatically. Naperville soil conditions allow for shallow spread footings bearing on soil at 4,500 lbs. per sq. ft. At Lisle, soil conditions necessitate a deeper system of 14" diameter auger cast piles to reach suitable bearing of dense to very-dense sand and gravel. The piles have an allowable capacity of 70 tons per pile. Fortunately, the schedule impact of slower foundation installation at Lisle provided an opportunity for the Construction Manager to sequence the bidding at the two sites, resulting in more competitive bids. This construction sequence also meshed well with Lucent's plans for phased occupancy of the two sites.

To resist lateral loads, the office wings utilize an eccentrically braced lateral load resisting system located at the elevator/toilet cores. The floor plate of each wing is a 140' x 320' rectangle. Elevator cores are located at the ends of each wing to integrate with the site and building circulation paths. This arrangement results in an extremely efficient lateral load resisting system while allowing for brace-free open space throughout the interior office area.

The architect designed the R&D wings from the inside/out to maximize the efficiency of the typical workstation layout. The office wing column grid was developed around grouping of the typical workstation modules, which required large, column free bays. Along with the aggressive construction schedule and cost consid-

Naperville lobby roof truss and entry arch. Roof rafters in progress

Lisle lobby and entry canopy framing with temporary erection scaffolding inside lobby

erations, this led to composite steel framing for the building. The final typical bay sizes selected were 41′-1-½ ″ by 36′ and 41′-6″ by 36′.

To facilitate coordination of HVAC distribution and to minimize the total depth of construction, the girders frame in the short (140′) dimension of the wing. Each girder has a major penetration to allow the main duct to run within the depth of the structural framing. The typical floors have also been designed to allow Lucent to switch between office and laboratory functions-allowing Lucent to adapt the space to meet the needs of changing technology. For ease of access, all mechanical and electrical services are fed to the offices/laboratories from the ceiling plenum above.

To take full advantage of views to the exterior and create a workplace environment that encourages employee interaction, the architect designed the wings to include a 10′ perimeter cantilever that allows for a column-free corridor to wrap the entire floorplate. The bottom of the cantilevered beams taper upward toward the building exterior, allowing the ceiling line at the perimeter to rise, thus maximizing the exterior views and transmission of natural light to the interior. The resulting cantilevered framing was analyzed and designed to meet deflection and vibration serviceability requirements. The design and construction teams worked closely with the contractors to propose detailing solutions that would facilitate the erection of the cantilevered framing.

Sunshades cantilever from the face of the building to control the sunlight entering the perimeter corridor and interior office spaces. Curved aluminum support beams that cantilever from the structural steel framing of the corridor frame them. Light-filtering perforated stainless steel sheets span between the sunshade beams. In addition, a portion of the sunshade doubles as an exterior building maintenance catwalk.

With more than 4,000 tons of structural steel at each site, the project team decided to bid the steelwork as two separate projects. This decision created the advantage of a larger bidder list with increased competition resulting in cost savings for the project. Two projects with sequential start dates also allowed the team to proactively address potential issues at the Lisle site based on their earlier experiences at the Naperville project.

Engineers hired by the steel contractor designed the steel connections for both projects. The connection designs were based on performance criteria provided by the Engineer-of-Record, Thornton-Tomasetti Engineers. It is interesting to note that although both buildings are nearly identical, the steel contractor for each site was afforded the flexibility to choose different connection details based upon the preferences of their respective shops. This approach to connection design resulted in both time and cost savings for Lucent.

Naperville Lobby Structure

A unique architectural image welcomes guests and employees at the Naperville lobby. Four cantilevered trusses running longitudinally support a curved glass canopy/roof. The main trusses are triangular in cross section. Because two of the trusses do not follow the generator lines of the roof's cylindrical surface, they required pipe members that curve in two axes. The intricate geometric requirements necessitated specialized computerized three-dimensional (3D) modeling to be employed by the architect, engineer and for detailing purposes by the steel fabricator. These advance 3D constructions facilitated the fabrication and

Interior rendering of Naperville lobby and corridors of conference area beyond.

erection of the 120′ long roof/canopy structure.

Since portions of the Naperville canopy are directly exposed to weather, the engineers, to improve the steel's resistance to brittle fracture, dictated special notch-toughness requirements. The two columns supporting the canopy trusses, detailed with a pinned base, allowed rotation about the longitudinal axis while locking rotation about the transverse axis. The pins, with bronze bushings impregnated with permanent lubricant, minimize the effects of thermal changes on the structural frame by allowing the column to flex at the base. The lobby steel was purchased using standard AISC tolerances, supplemented with additional tolerance requirements at critical locations and additional weld finishing requirements at highly visible/aesthetically critical joints. Approval samples were required of these critical welds for the architect/engineer's review. By selectively supplementing the code requirements, the design team was able to avoid invoking the Architecturally Exposed Structural Steel (AESS) requirements of the AISC specifications, thereby improving the economy of the structural frame while still meeting the architectural design intent.

Lisle Lobby Structure

The Lisle lobby architecture dramatically welcomes employees and visitors with a drum of exposed steel and glass, capped by a tensile net roof structure. Adding to the visual excitement of the lobby, the roof skylight, a 120′ diameter circle, is concave and tilts at a 45-degree angle. Because the circular roof is tilted, the vertical glass-clad drum supporting it is elliptical in plan. This creates an open, light-filled lobby that soars to 115′ at its high point. A unique entrance canopy with upturned edges is framed between the drum structure and a single freestanding pipe column across the entry drive.

Lisle lobby roof "pie" segment being erected

A horizontal tensile net would assume a symmetrical shape under gravity. The tilted roof requires net members with flexural stiffness to counteract the effects of self-weight acting at the 45-degree angle as well as wind and unbalanced snow loads. The roof structure has radial ribs of 8″ diameter pipe and circular rings of 6″ diameter pipe. The tight radius bends of the innermost rings required heat induction bending techniques. The central ring is an internally stiffened built-up box shape that joins the eighteen radial ribs at the middle of the roof. WT sections welded to the pipe net provide attachment points for the skylight mullions.

Drum columns are 16″ diameter pipe sections. The drum is braced by seven bands of 42″ deep horizontal Vierendeel trusses built of 8″ pipes. They add stiffness so that lateral loads are resisted without diagonal bracing. The design team worked closely with the curtain wall and skylight contractors to identify movements in the lobby structure for their use in designing the wall and skylight enclosure systems.

The roof structure was prefabricated in wedge (pie-shaped) sections and erected on a temporary staging platform until all field welding was completed. Similar to the Naperville lobby structure, AESS requirements were not mandated for the Lisle canopy resulting in cost savings for Lucent.

In order to maintain the clean appearance of the exposed structure, Lucent and the design team utilized the services of a specialty fire protection consultant to prepare an analysis of the unprotected structure when subjected to theoretical fire loads. The fire analysis and pertinent design features were then presented to the local building officials who reviewed the material and granted a code variance for the lobby, accepting the design as an equivalent form of construction meeting the intent of the building code.

The central entry structure also features a rear atrium skylight that is framed using tied arches. The bottom chord ties are small diameter high strength stainless steel rods. Special erection techniques were established to provide tension in the bottom chord members while insuring that connections of

stainless-on-stainless did not burr, strip or seize during installation.

Steel was the material of choice for the structural systems in Lucent's new research and development centers in Lisle and Naperville, IL. Steel framing was cost-effective in providing space-planning flexibility of large open bays within a very tight time frame. In the lobbies, exposed steel allowed the architect to create dramatic architectural spaces that established unique identities of "twin" facilities consistent with Lucent's innovative and high tech reputation.

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Steel Contractor/Fabricator
Lisle Wings:
Merrill Iron and Steel, Inc., Schofield, WI
Naperville Wings:
Zalk Joseph Fabricators, LLC, Stoughton, WI

Steel Contractor (Naperville Lobby):
MTH Industries, Chicago

Fire Protection Consultant:
Rolf Jensen and Associates, Chicago

Software:
SAP 2000, RamSteel, RamFrame, LARSA, Bentley Systems MicroStation/J, Pro/ENGINEER