Modeling Infrastructure Systems to Facilitate Maintenance

Big Ten & Friends Conference

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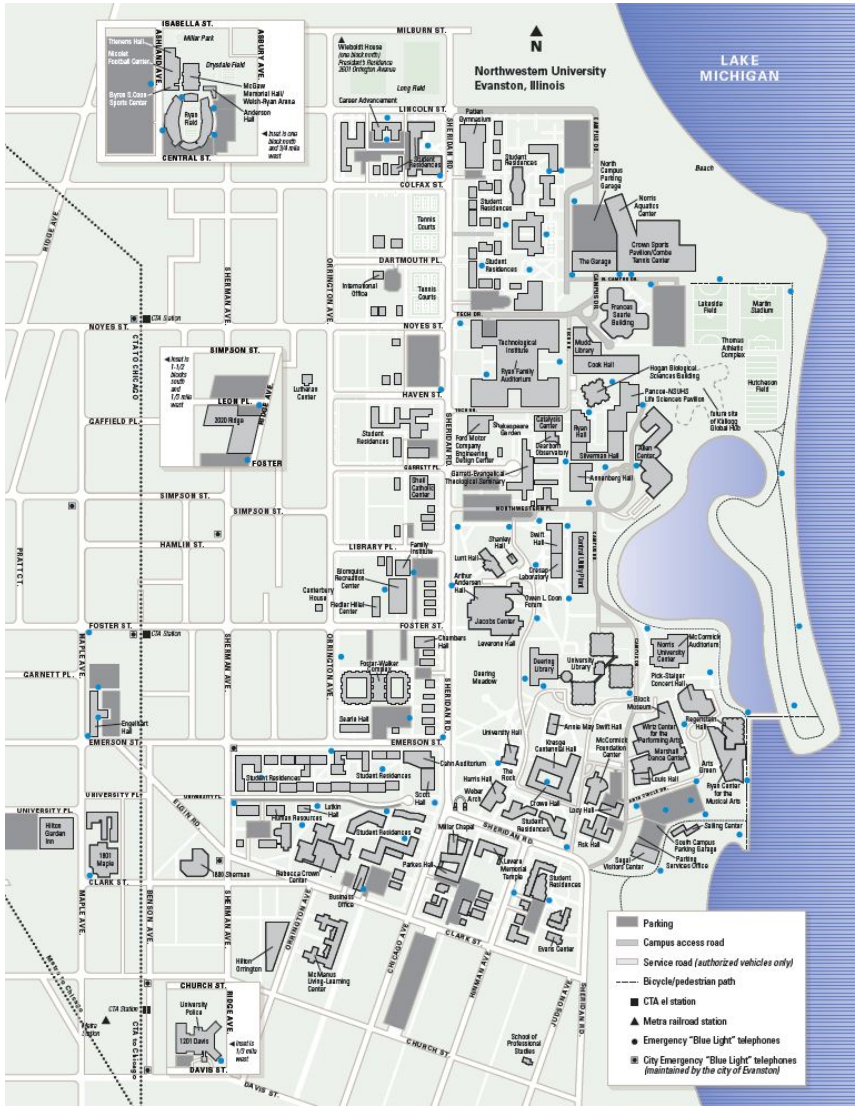
Grumman/Butkus Associates

- Founded by Dave Grumman in 1973 as an **energy consulting firm** in Evanston, IL
- Now an award-winning, 100-person-plus **full-service MEP firm** with a focus on sustainable engineering (studies, design, Cx, RCx, LEED consulting)
- **Key sectors:** Higher education, commercial/institutional, healthcare, hotels/resorts, laboratories, high-rise residential, senior living
- More than **three decades of work** on the Northwestern University campuses (Evanston and Chicago)

Northwestern University Campus

- Two campuses
- 280-acre campus in Evanston, Illinois, bounded by Lake Michigan to the east, residential neighborhoods to the north and west, and business district to the south
- 200+ buildings
- 12 million GSF
- 125 buildings built before 1955



Energy Consumption and Plant

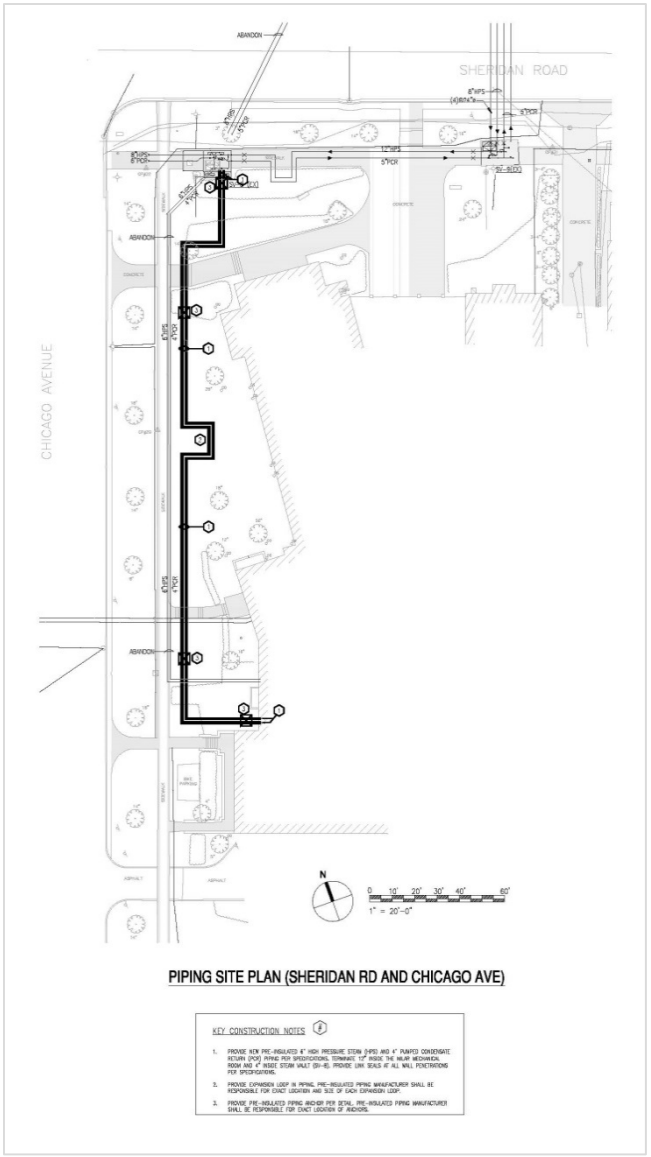
- Over 250 million kWh
- Over 20 million therms of natural gas
- Central Utility Plant (CUP)
  - Built in 1960s
  - Provides steam and chilled water throughout campus
  - Four, 450,000 lb/hr steam generators
  - 25,000 tons of cooling
  - Heat rejection to Lake Michigan

Energy Distribution

- Steam HW and chilled water distributed through a network of tunnels and direct-buried utilities.
- 4 miles of tunnel
- 40 underground vaults
- 25 miles of steam, condensate, hot water and chilled water piping

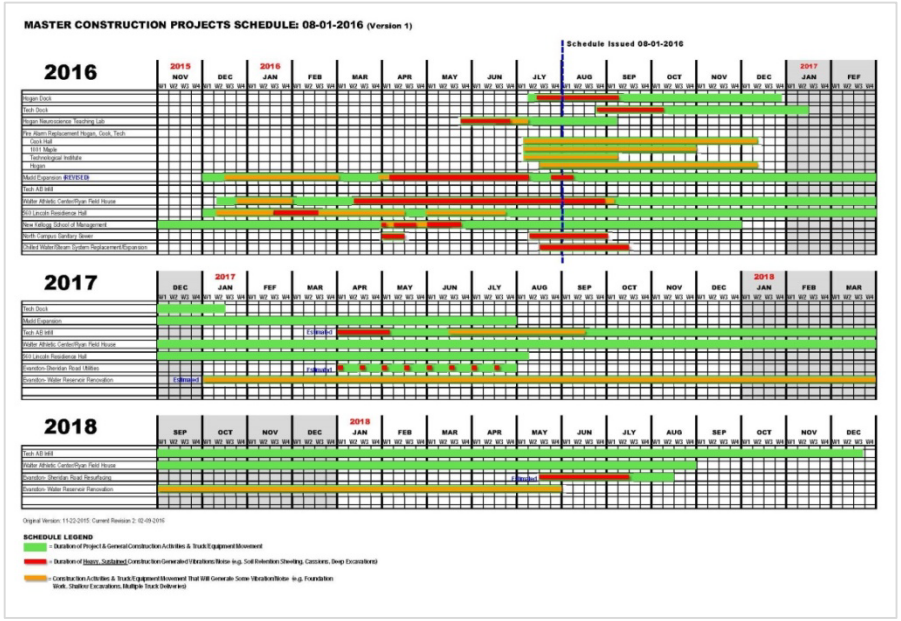
Documentation

- Scanned archives of design and as-built drawings
- 10 million documents in the system
- Approx. 50% scanned
- Well organized and maintained, but static
- Organization based on building #
- Buildings floor plans for space management
- 2012 utility had no system for management



Need for a Better System

- Dozens of major construction projects underway at any given time
- Major plans for campus expansion/ renewal
- Need for a dynamic model of infrastructure
- Need to simplify operations
- Need to capture institutional knowledge!



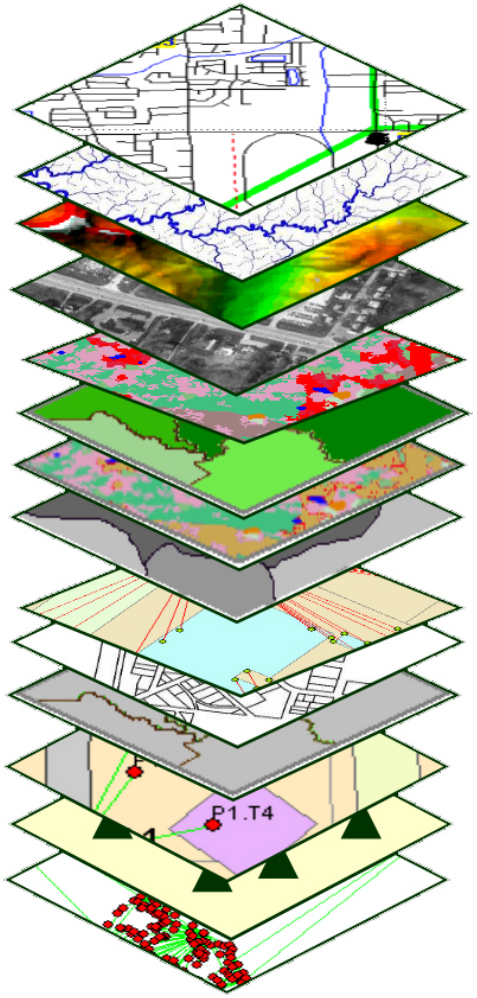
System Selection Process

- Partnership with G/BA: 30-year working relationship
  - Fully integrated into system management
- Goals: Improved operations
  - Systems integration overlap
    - Horizontal
      - ✓ Owner – Consultant – Software – Database - Documentation
    - Vertical
      - ✓ Planning – Design - Construction – Operations – Maintenance

- System selection
  - Combine existing information into one platform
  - Access of information
    - Desktop
    - Smart device
    - Data storage and remote access

Geographic Information System

- A system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data
- Integration of information from multiple sources
- Dynamic information
- Editable, customizable
- Relates disparate information by using location



GIS Development

- Site survey and map development
  - Develop campus survey control for all collected information
  - Established benchmarks and campus coordination system
- Complete campus surface survey of all utilities
  - Over 5,000 surface features collected
  - Verified utility location with locates
- Tunnels, vaults, and mechanical rooms surveyed
- Initial goal: Survey where the assets are and what they they are

Systems Included

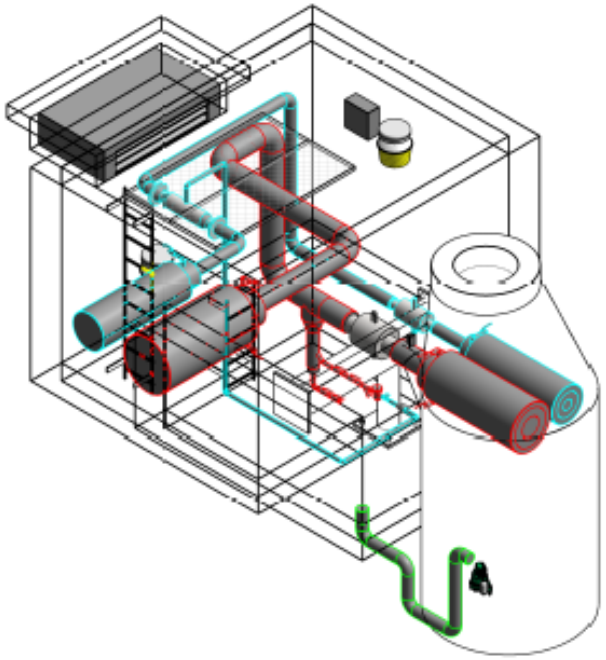
- Steam
- Condensate return
- Hot water loop
- Chilled water
- Domestic water
- Storm and sanitary sewer
- Fire protection loop
- Compressed air
- Power
- Communication

Other Information Included

- Pavement
- Bike racks
- Monuments
- Signs
- Street lights
- Irrigation
- Landscape
- Topography
- Property line

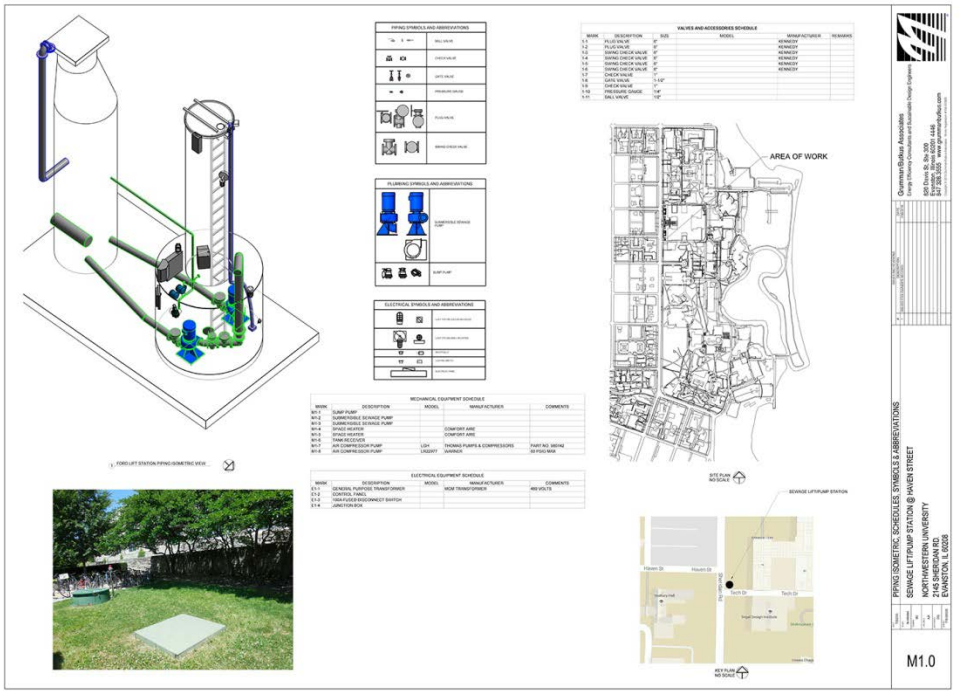
Infrastructure Modeling

- Approximately 40 utility vaults
  - 3D drawings created using Revit
  - Valves, expansion joints, service items scheduled
  - Photos
  - Electrical and plumbing devices



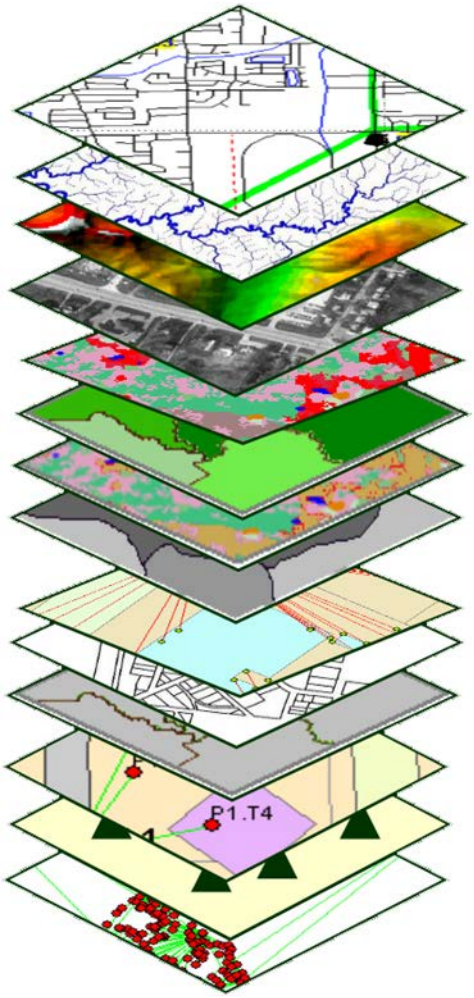
Infrastructure Modeling

- Similar Revit models developed for utility tunnels and lift stations
- Utility distribution: Mechanical models developed
- Models linked to GIS system and accessible by drilling down into each element
- Models developed by field measurement



GIS System Use

- Tremendous amount of information becomes accessible from anywhere
- Integration of various systems and information in one place
- Maps and apps from a single source of data pulled from all of our systems
- Huge advantage for asset lifecycle management
- Useful in different ways for:
  - NU planning, design construction
  - NU operations and maintenance
  - Consultants



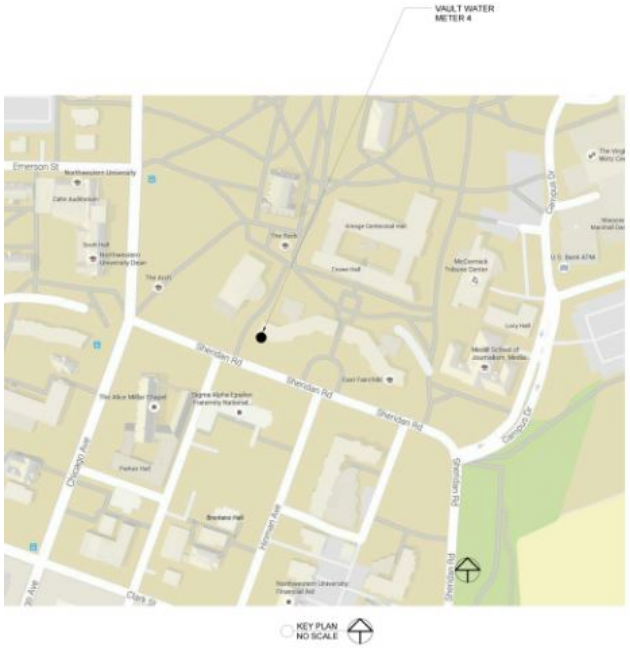
Real-Time Information

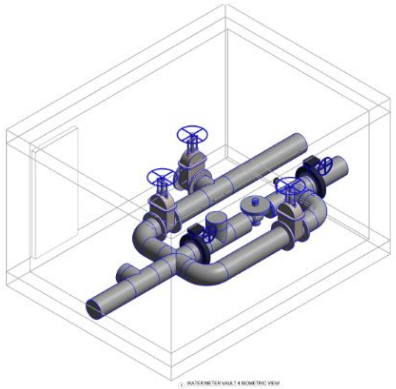
- Visualize, analyze and manage the asset
- GIS populated with planned projects based on design data for pre-installation operation management
- Converted to as-built information

- No more waiting for as-builts to be reviewed, approved, and archived
- Spot trends and patterns and give real, truthful answers regarding the asset

System Maintenance

- Corrections submitted real-time by all users
- As-builts and design documents uploaded when available
- Develop new process to eliminate unnecessary steps and expedite delivery
- App developed for map corrections
- Payback 2 to 3 years





Future Expansion

- Building floor plans georeferenced
- Assets within buildings
- Integration with CMMS system

Live Look at System

- M.C. Escher:
  - "Work is a game, a very serious game."
  - "We adore chaos because we love to produce order."