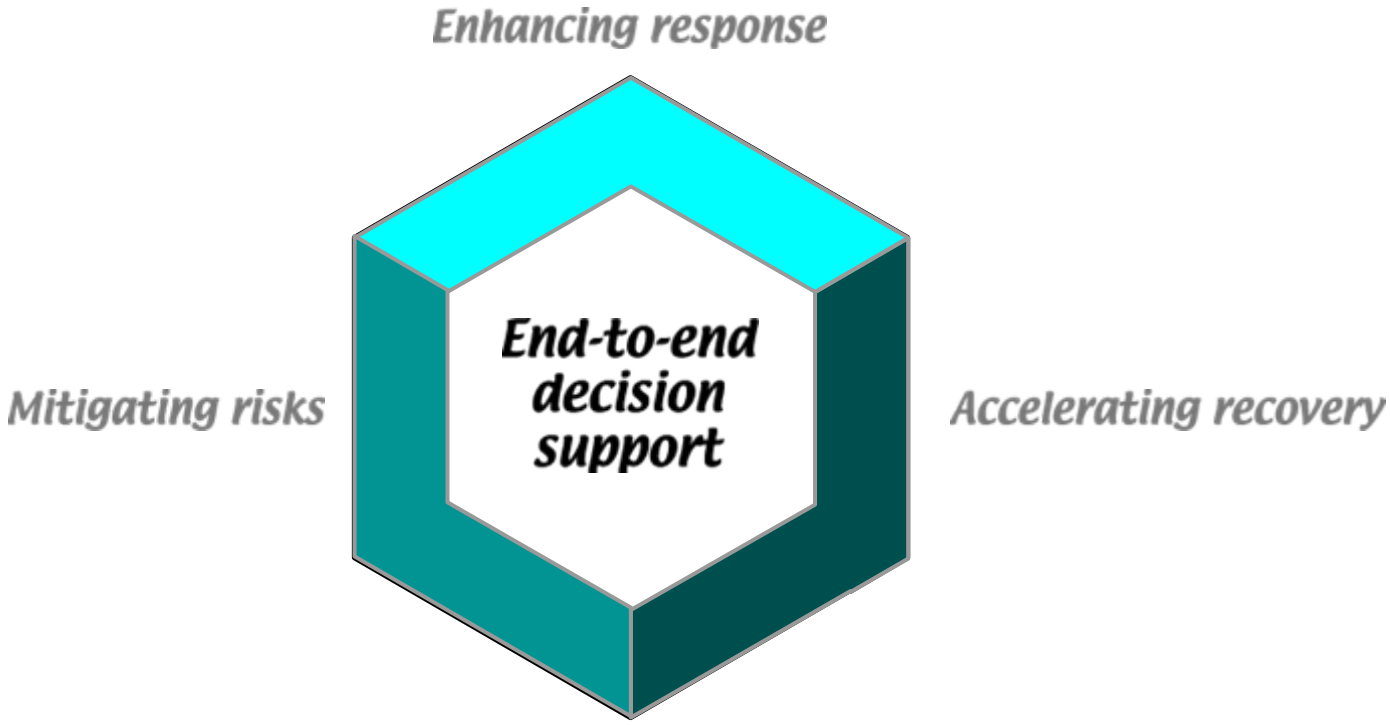
BROOM

Building Restoration Operations Optimization Model



A chemical or biological release in a critical facility would be devastating

- Severe economic, sociological, and/or security impact if closed for even short periods
  - Military Bases
  - Major Airports
  - Government Facilities
- Challenges facing rapid restoration and recovery
  - Interior Sample Design
  - Interior Sample Collection
  - Sharing Data
  - Visualization
  - Interpretation / Analysis

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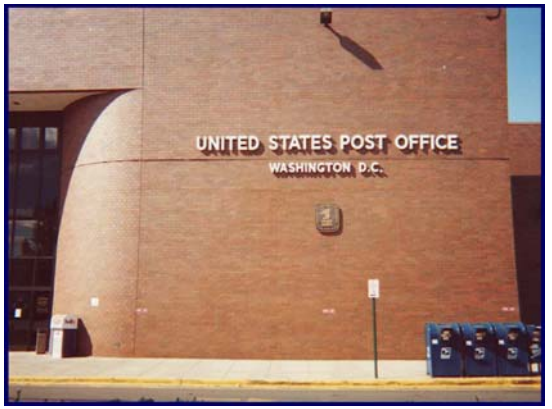
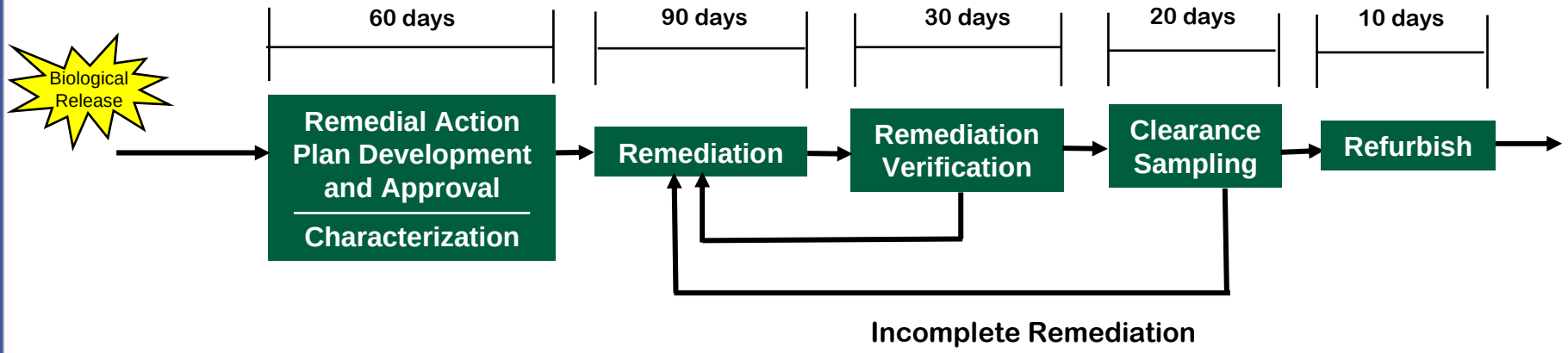
2001 Anthrax Letters

- Postal facilities, senate buildings, and news organizations were contaminated
- Very little experience decontaminating large indoor facilities
- CDC reports that over 125,000 samples were tested at LRN laboratories costing $25-30 mil.
- Many facilities were closed for years and restored at great cost
  - Capitol Hill (4 mo, $42 mil.)
  - Brentwood (26 mo, $130 mil.)
  - US Postal Facilities (3+ yr, $800M)



Previous Restoration Activities



Environmental sampling is a significant component of the restoration and recovery process. Improvements will…

Reduce recovery time and enhance decision making

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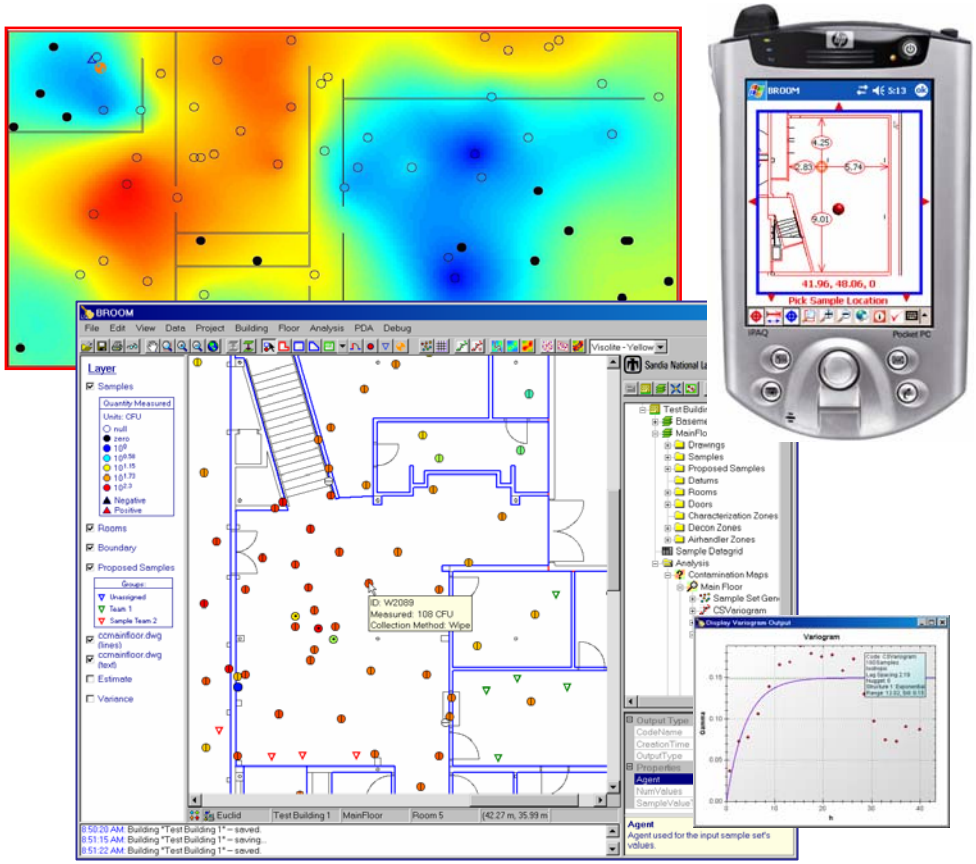
Integrated Solution

- Planning
- Electronic Data Collection
- Data Management
- Visualization
- Interpretation
- Analysis



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Why is integration important?

- Save Time and Money
  - Load floor plans into database
  - Carry out large scale sampling plans
  - Effortlessly transfer field data
  - Automatically chain of custody
  - Results/maps quickly displayed
  - Take fewer samples
- Improve Data Quality
  - Indoor laser positioning
  - No transcription errors
  - Ensure the right data is collected
- Easily Share Data and Analyses
  - Central Relational Database

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What is BROOM?

Software to improve the efficiency of restoration operations and enhance decision making

- Desktop
  - Design Sampling Plans
  - Access Sampling Results
  - 2D and 3D Visualization
  - Contamination Maps
  - Confidence Maps
- PDA
  - Display Facility Floor Plan
  - View Sampling Plan
  - Collect Surface, Bulk, and Filter Samples

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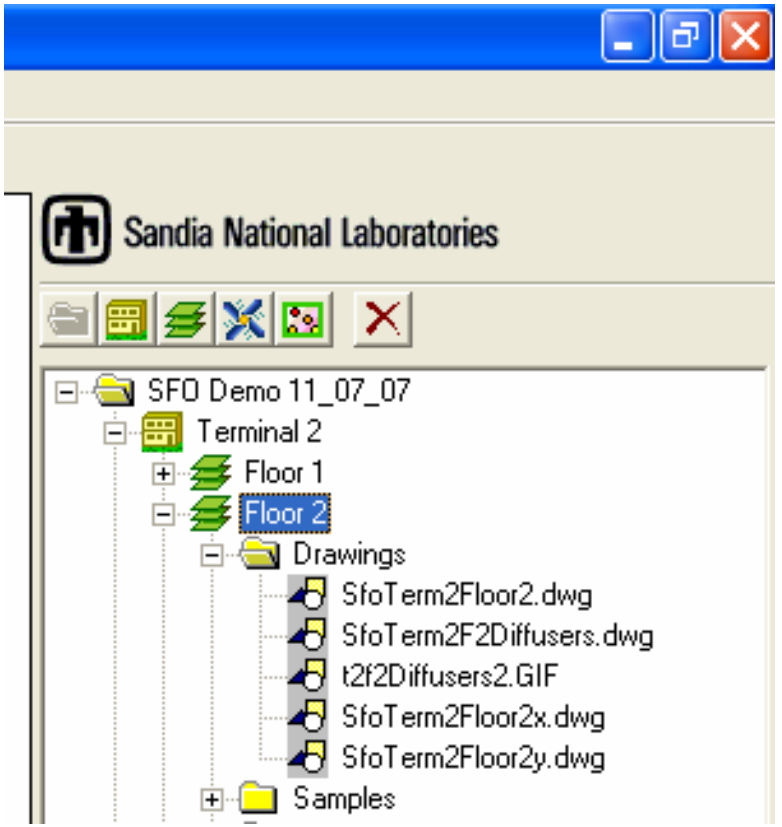
Planning

- Organize facility drawings
  - Large facility may have 100's to 1000's drawings
  - Structured way to store and retrieve relevant drawings
  - Remote storage
- Design initial response sampling plans
  - Confirm event
  - Determine extent
  - Define characterization/HVAC zones
  - Sample design tools

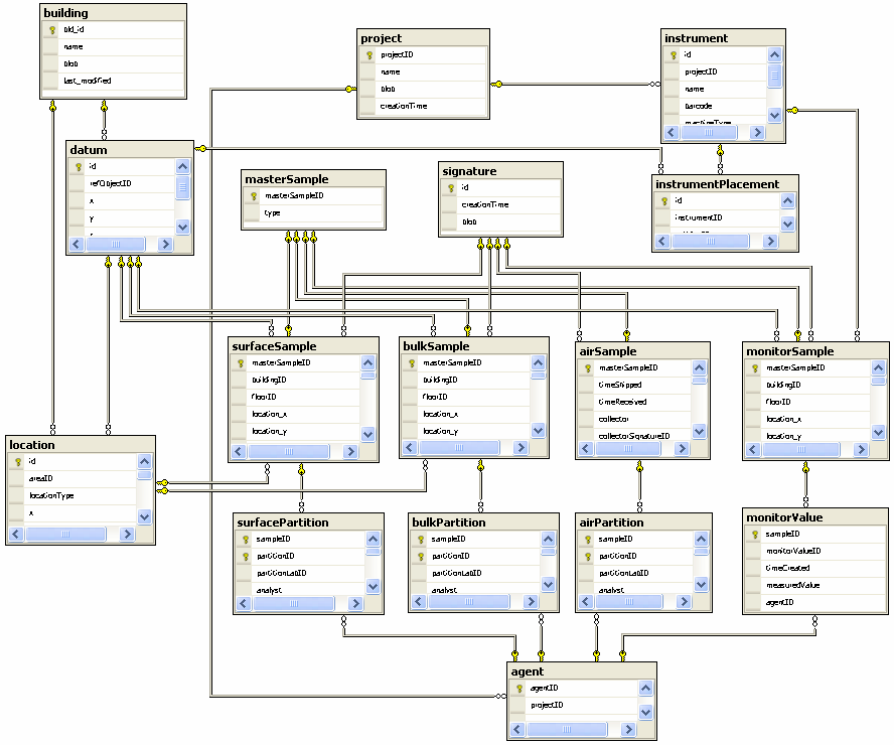


Electronic Data Collection

- Eliminate manual data entry
  - Dealing with many thousands of samples of various types
  - Barcodes improve data tracking
  - Save time and improve accuracy
- Implement sampling plan
  - Download floor plans
  - Display sampling plan
- Accurate position record
  - Integrated laser range finder
- Initiate chain of custody record
  - Save time
  - Improve security

Data Management

- Relational Database
  - Remote secure access to ALL data
  - Supports multiple concurrent users
- XML Import / Export Utilities
  - Interfaces with analysis laboratories
  - XML is supported by numerous applications



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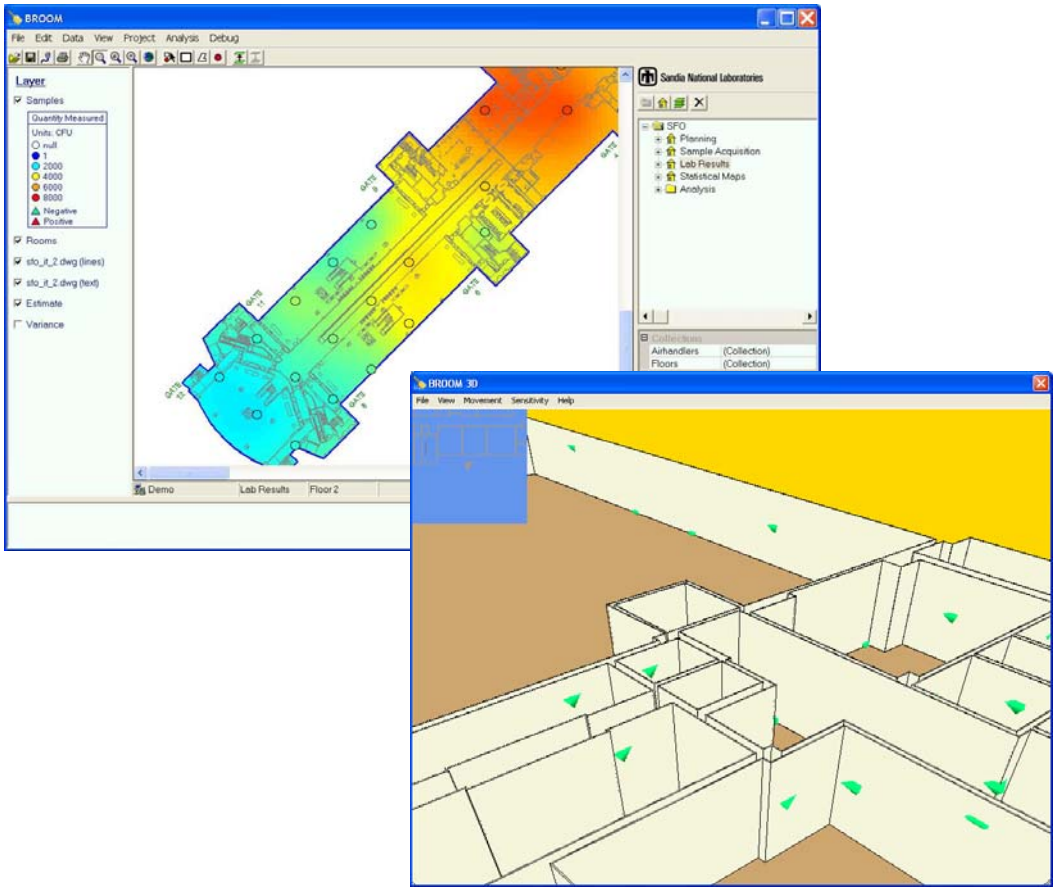
Visualization

- 2D GIS
  - Point and click data retrieval
  - Zoom, pan, rotate
- 3D DirectX
  - View vertical position

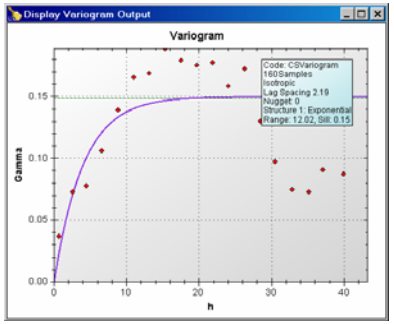


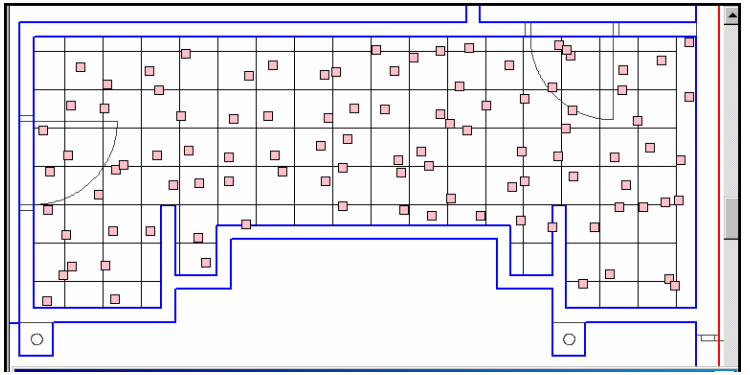
Interpretation

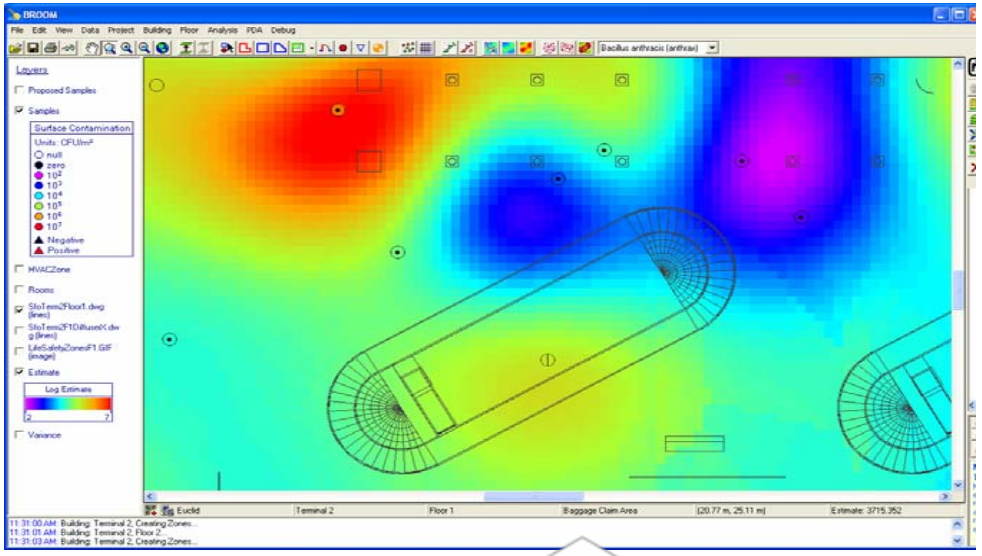
- Use sampling efficiency and collection area to estimate the true surface contamination
  - Able to compare one-to-one samples collected on different surfaces with different methods
  - More precise representation of contamination levels
- Database maintains known collection, extraction, detection efficiencies

Analysis

- Sample Design
  - Random
  - Grid
  - Visual Sample Plan
- Statistics
  - Min, max, mean, σ, σ^2
  - Histogram
  - Spatial
- Mapping
  - Inverse Distance
  - Kriging
    - Ordinary
    - Indicator
- Advanced Topics
  - Acceptance Models
  - Optimized Design
  - Shortest Path Kriging
  - GeoReferencing

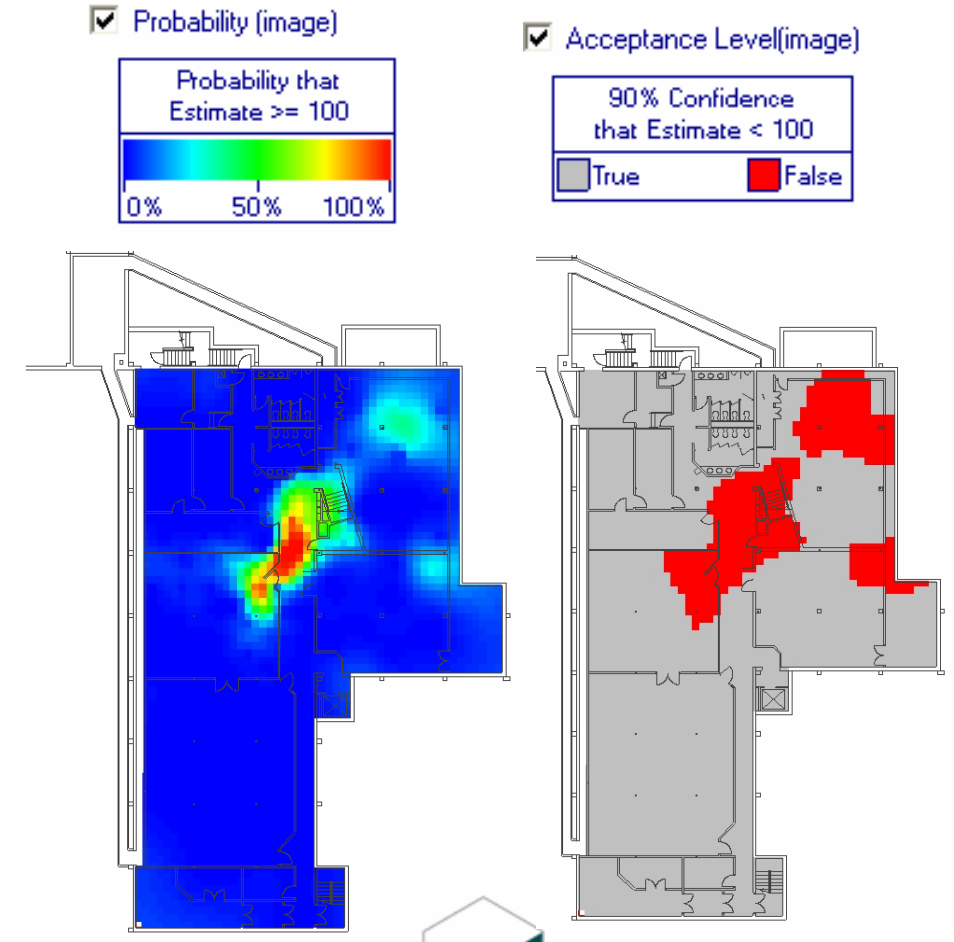






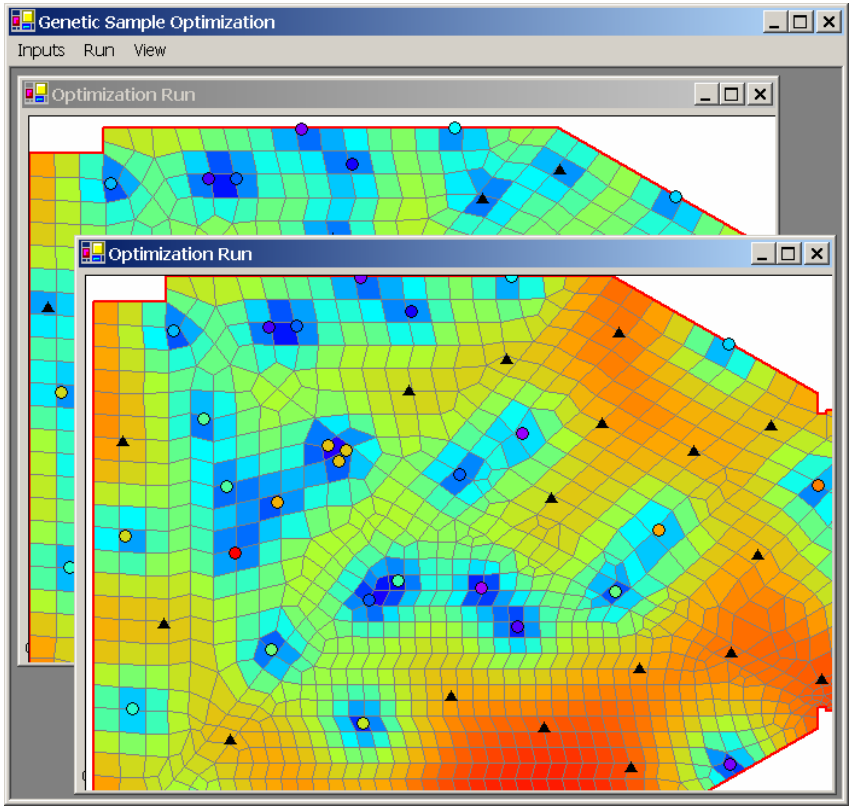
Acceptance Modeling

- Determine the probability of exceeding a specified threshold
  - Local mean (estimate)
  - Kriging variance
  - Normal score transform
- Display where the threshold level is met to a given degree of confidence.



Sample Optimization

- Objectives
  - Minimize overall uncertainty
  - Target specific threshold
  - Target hotspots



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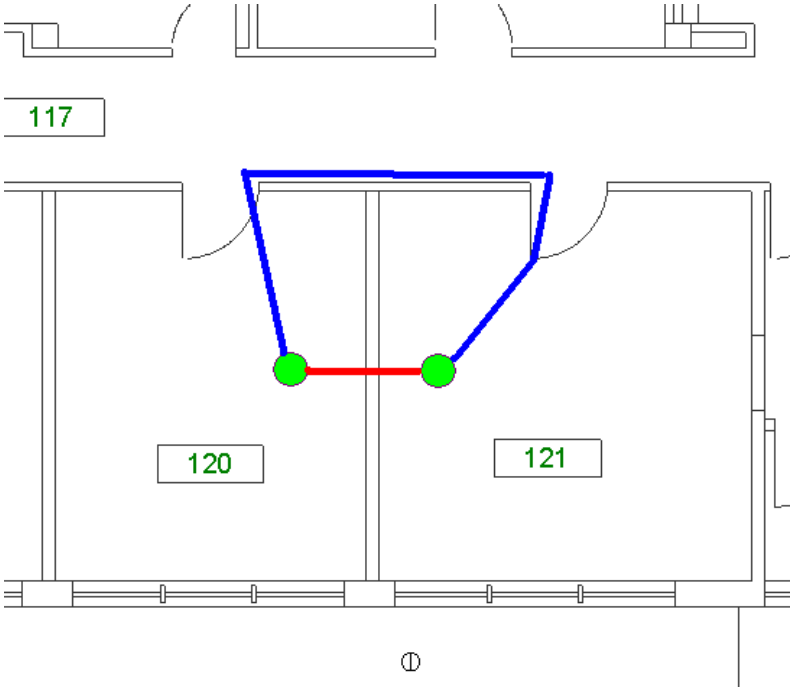
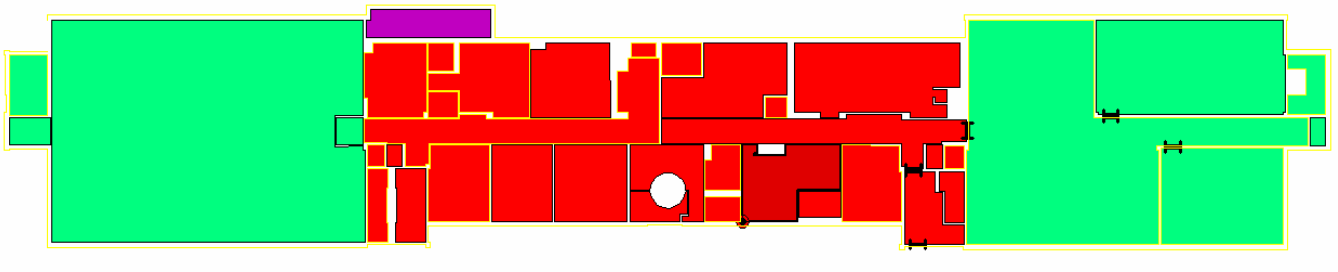
Shortest Path Kriging

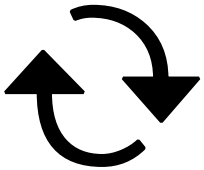
- Modified ordinary kriging
- Distance between two points is the shortest travel distance taking into consideration structural barriers
- Produces better uncertainty estimates and improved contamination maps

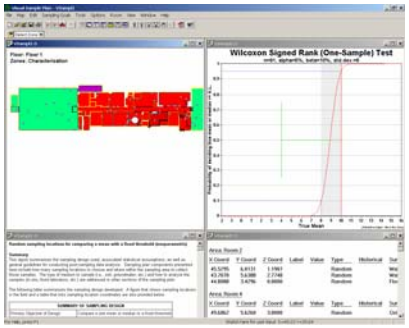


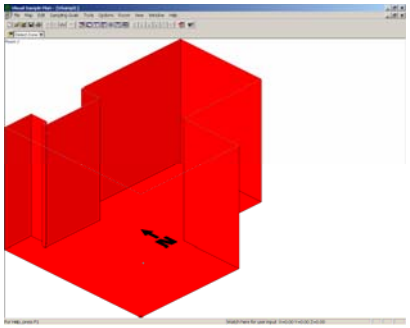
VSP (PNNL) Integration

VSP
Visual Sample Plan









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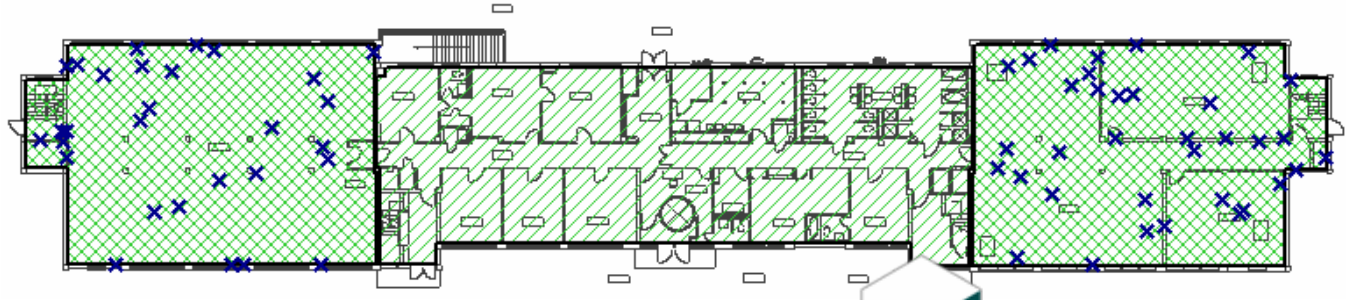

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BROOM Field Testing

- **Anniston, AL – Nov ’04**
  - EPA ClO_2 fumigation test
  - BI data management
  - RF positioning test
- **Albuquerque, NM – Jan ’05**
  - BROOM exercise
  - Sandia HazMat sampling team
  - RF/Laser positioning test
- **Albuquerque, NM – Feb ’05**
  - NIOSH/Sandia joint exercise
  - Aerosol release
- **San Francisco Airport – Jan ’06**
  - DHS demo for national audience
  - Sample and BI data management

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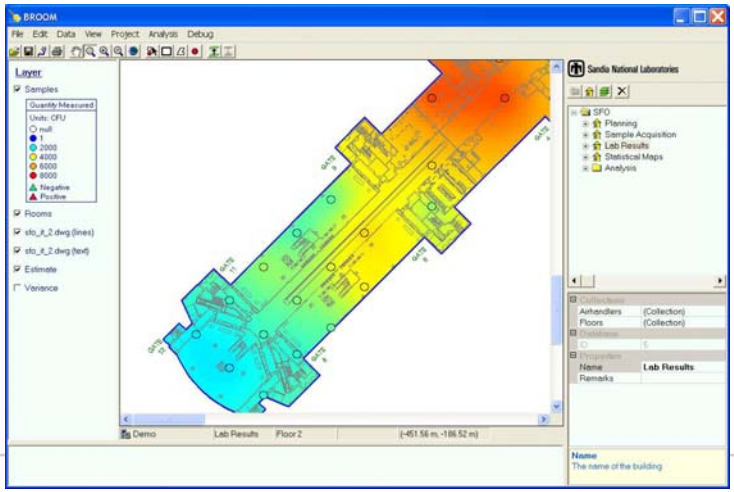
Benefits/Uniqueness

Integrated software package designed to improve end-to-end restoration operations

- Save Time and Money
- Improve Decision Making
- Promote Interagency Sharing



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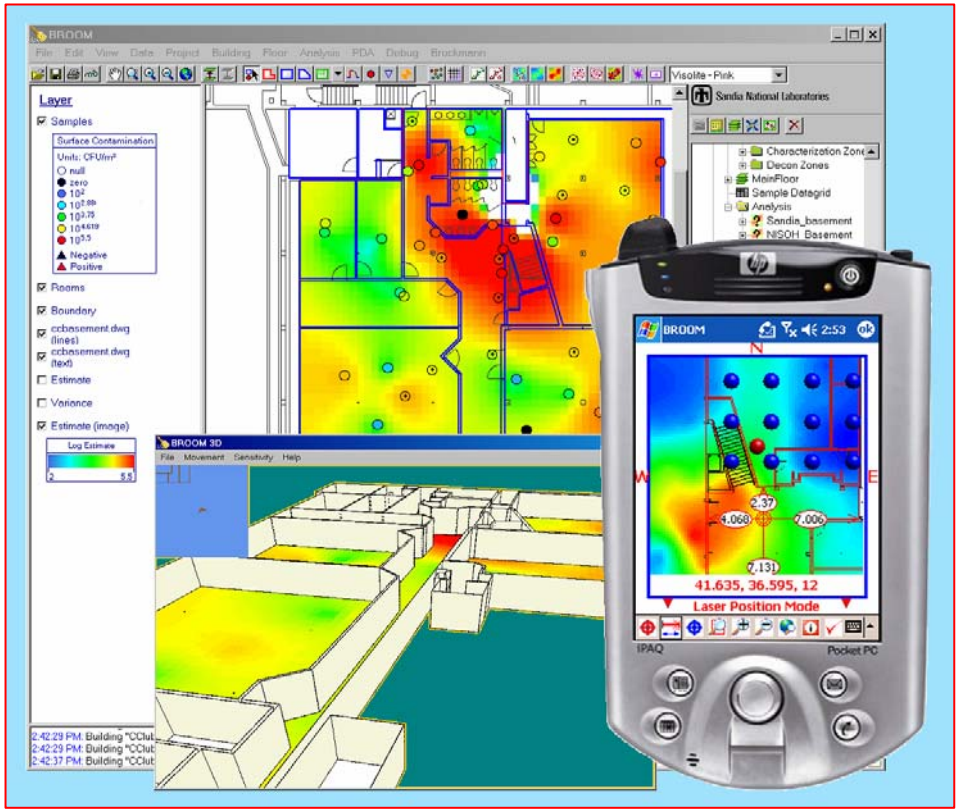

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