BROOM
Building Restoration Operations Optimization Model

Enhancing response

End-to-end decision support

Mitigating risks

Accelerating recovery
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
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)
Environmental sampling is a significant component of the restoration and recovery process. Improvements will...
Reduce recovery time and enhance decision making.
Integrated Solution

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

Accelerating recovery
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
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, $\sigma$, $\sigma^2$
  - 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
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
BROOM Field Testing

- **Anniston, AL – Nov ’04**
  - EPA ClO₂ 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
Benefits/Uniqueness

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

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

Accelerating recovery
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