

Ensuring Data and Information Comparability Using Expert Systems

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What is an Expert System?



- ☠ An expert system is an interactive computer program that incorporates the knowledge of one or more people into a series of decision trees so that answers (**as advice**) to specific questions are the same ones that a human would give.
- ☠ Advantages include:
 - ◆ Help and advice when a human expert isn't available
 - ◆ Answers are consistent (versus human answers)
 - ◆ Ensures that all important factors are considered so that none are forgotten during decision making
 - ◆ Get right to answers needed quickly and efficiently

Water Monitoring Expert Systems

☠ Two expert systems for water quality monitoring have been produced:

◆ Environmental Monitoring and Measurement Advisor (**EMMA**) - produced in 2002 under a NSF SBIR grant.

☞ Supports the National Environmental Monitoring Index (**NEMI**)

☞ 3 modules: **1** Planning What, When, Where, & How; **2** Selecting best method(s); **3** Calculates numbers of samples needed

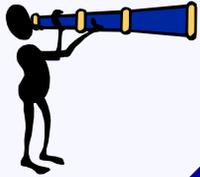
☞ NSF grant required a commercial product but the second module is free to use at www.EMMA-expertsystem.com

☞ EPA and USGS have a CRADA with Instant Reference Sources

◆ EPA's **CBR Methods Advisor**

☞ Support to NEMI-CBR database of methods for anti-terrorism

☞ Response, Planning & Training for threat analysis, site entry, sampling and water analysis



Three “Planes” of Information

◆ The top level "Executive/Emergency Plane"

☞ Gives the user advice and answers for his or her specific needs as quickly as possible.

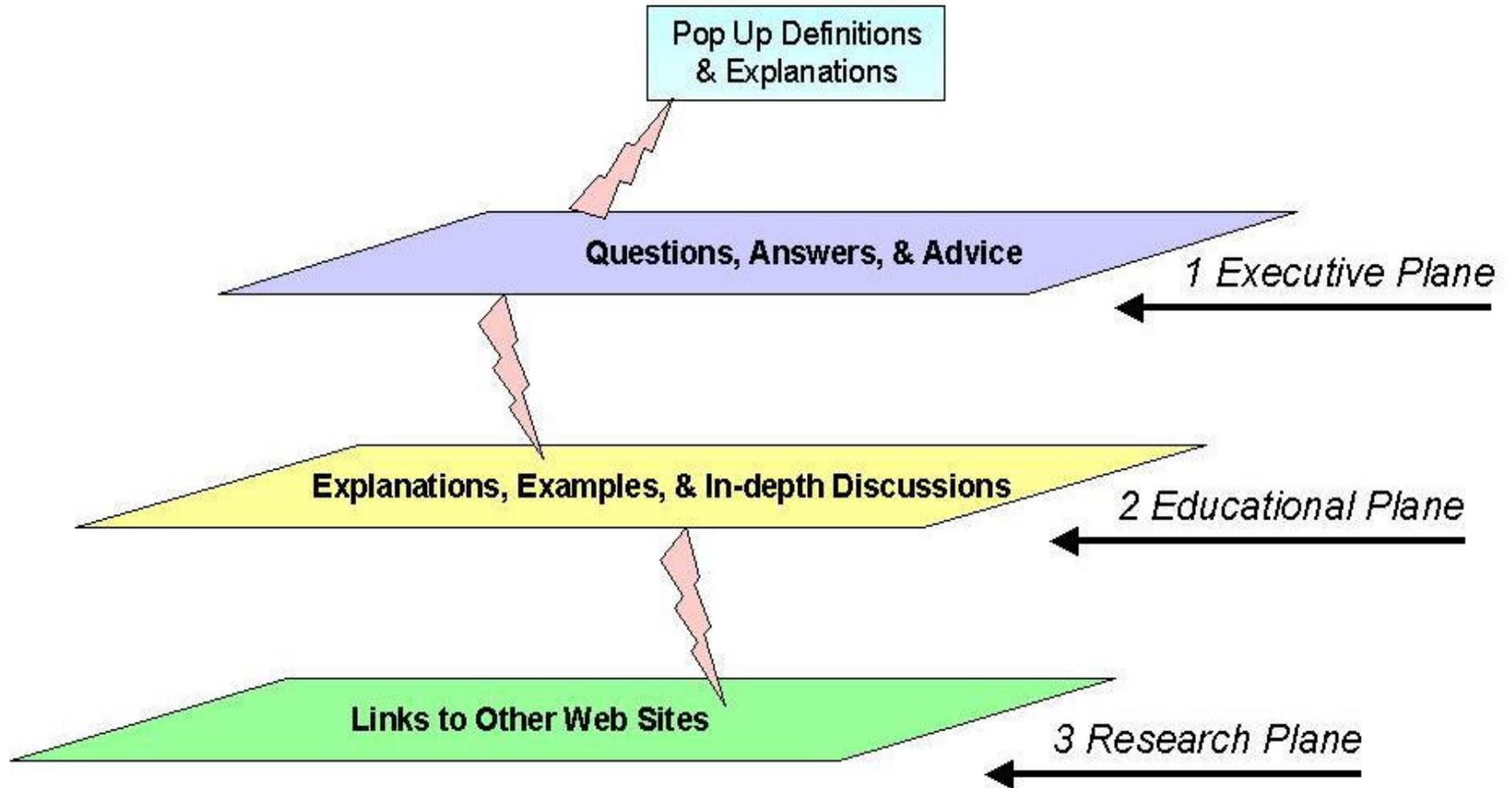
◆ The second level "Educational Plane"

☞ Provides explanations and ancillary information to help users to understand what is being asked of them, why it is being asked, and what the consequences of their actions may be.

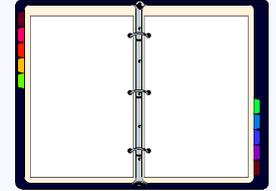
◆ The third level "Research Plane"

☞ Reached by internal and external hyperlinks from the second plane - contains extensive in-depth discussions and links to other web sites such as those of US EPA, USGS, CIA, etc.

Planes of Information Illustrated



Dual-Screen Viewing



- ☠ Special programming is used to provide two “frames” for viewing the expert system.
 - ◆ The expert system question and answer software appears in a **left** screen frame.
 - 📄 It drives a particular project planning or training session through its questions and “decision trees” that provide advice and answers.
 - ◆ Associated with each question is information on what, why, when, where, how, etc. in the **right** screen frame.

Example of Dual Screen Use



CBR Methods Advisor

EPA's Water Security Division Expert System for NEMI-CBR

Initial Site Entry Advice

Before the site characterization team enters the area to collect samples in a low hazard area the site area(s) should be defined and secured. Additionally, consider setting up a staging area at the perimeter of the site to control entry, exit, and decontamination operations if necessary. Sites that are determined to be hazardous will come under control of HazMat officials and a staging area will be located far outside of the protective action zone as detailed in the Explanation Box. Once the site zones have been established then the next steps can be taken.

OK

Restart

Back

Exsys CORMD

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Explanation

The Three Steps in Approaching a Site for Investigation

Source: Module 3, Section 4.2 (Approaching the Site) of the Response Protocol Toolbox

Once the site characterization plan has been customized to a particular situation, the site characterization team will be dispatched to the investigation site. The next stage of the process is the approach to the site, which is primarily intended to ensure that conditions are safe for the team to proceed with the characterization. This stage will also provide information to refine the site hazard assessment, as discussed in Section 4.1.3. During the approach to the site, site zones are established, field safety screening is conducted, and the conditions at the site are observed. These three steps are described in the links below.

Step 1 - Establish Site Zones. Define and secure several types of zones, as necessary.

Step 2 - Perform Field Safety Screening. Use field test kits to determine potential hazards.

Step 3 - Make an Initial Observation of Site Conditions. Learn how to safely look for indicators of intentional contamination.

- [Click here to learn how to establish site zones \(Step 1\).](#)

Expert System Side

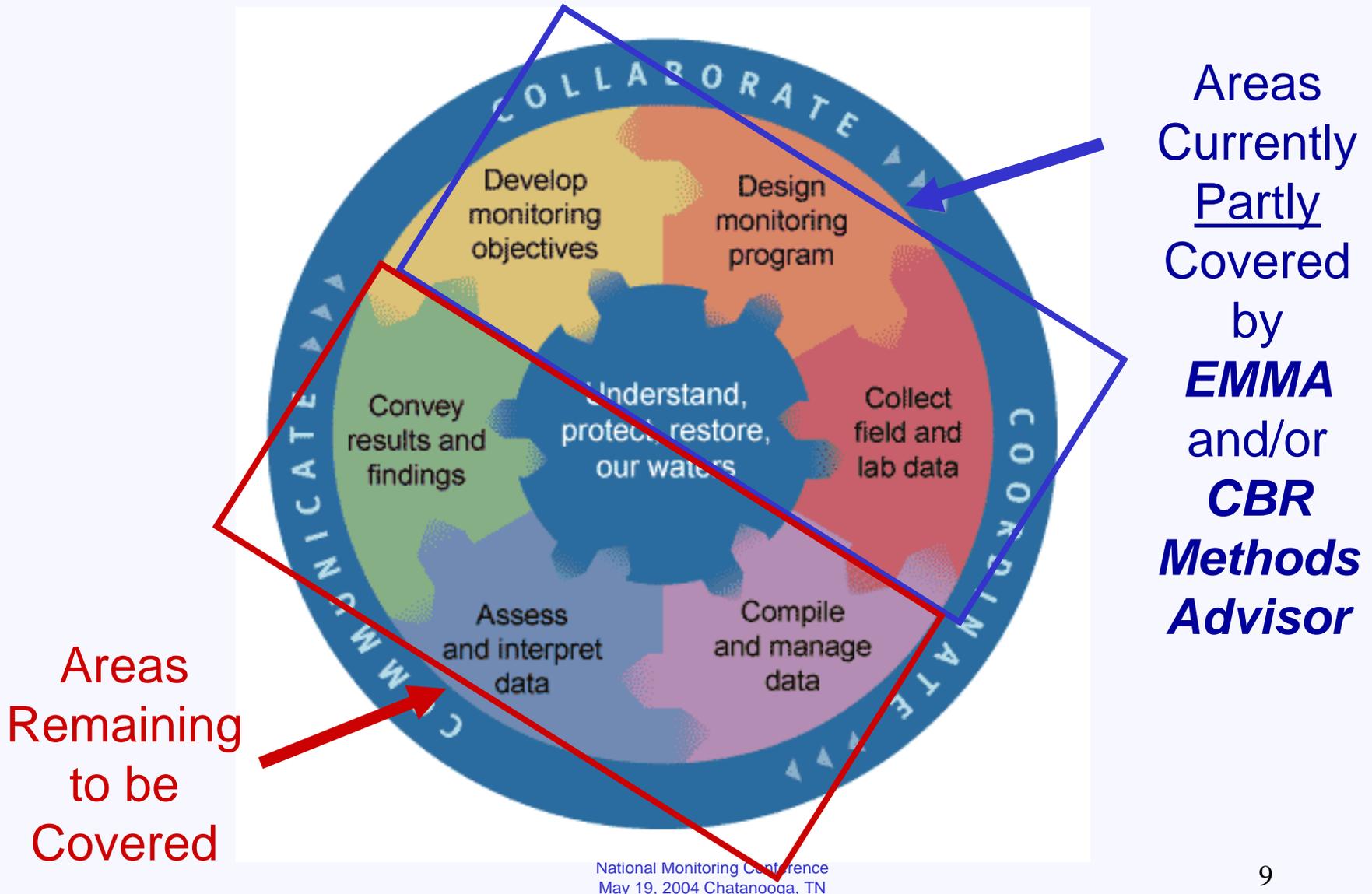
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Explanation Box Side

National Council's Monitoring Framework



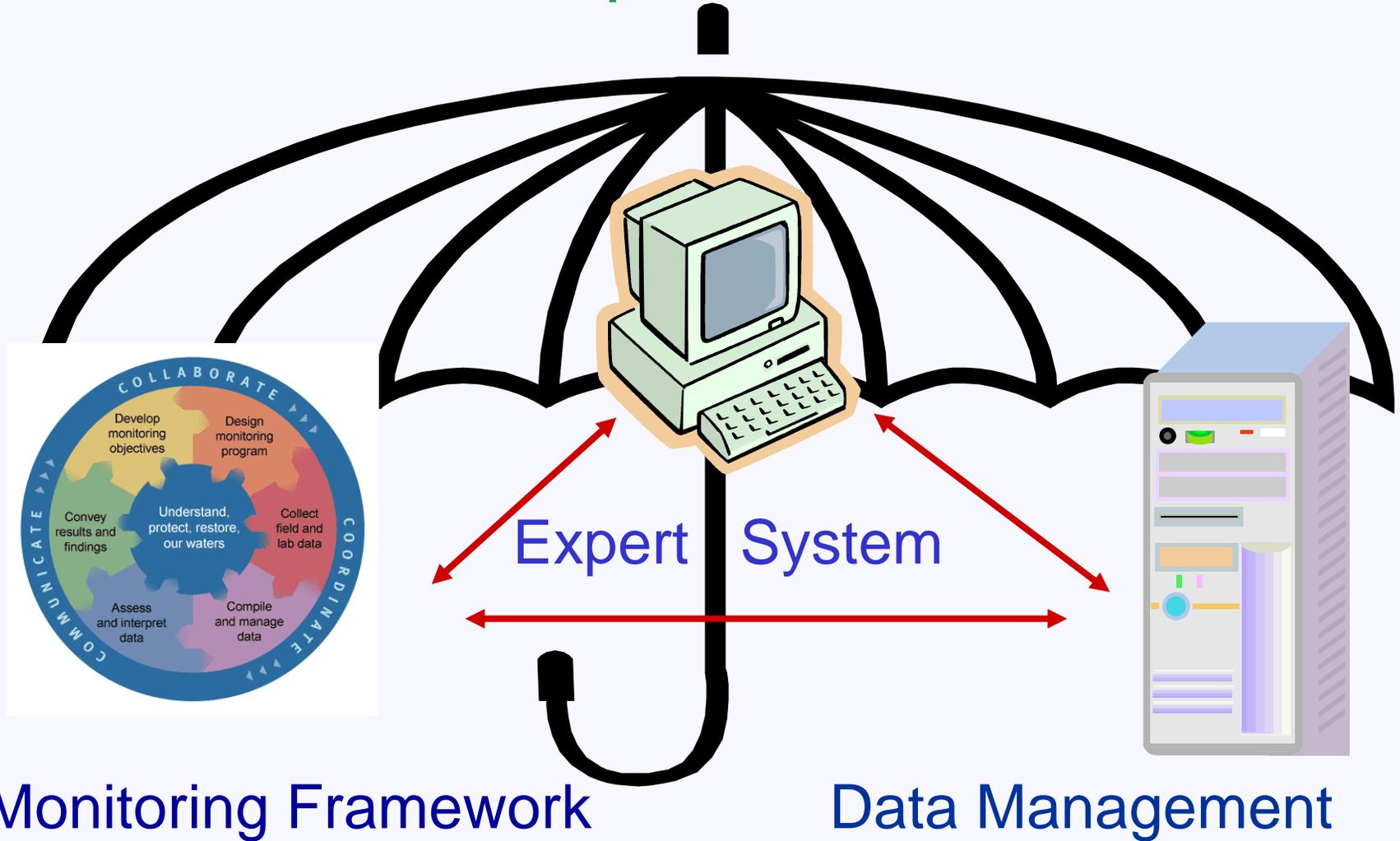
Expert Systems for Monitoring Framework Areas



How Expert Systems Could Support Water Monitoring

- ☠ Incorporate the algorithms already developed from NSF and EPA funding into a comprehensive expert system used for planning, training, and execution of water monitoring projects.
 - ◆ Special features would include dual screen viewing and multi-level depth of information given as a user desires
 - ◆ Development would incorporate knowledge of experts versed in many areas for multi analytes and organisms
 - ◆ Product would cover all areas of the Water Quality Monitoring Framework
 - ◆ Tools for entering and sharing data, statistical analysis, modeling, preparing reports, etc. would be launched from the appropriate modules that direct the Monitoring Framework.

Conceptual Model



Monitoring Framework

Data Management

What an Expert System Would Do

1. Develop Monitoring Objectives

- ◆ Type of objective, regulatory requirements, DQOs, resources

2. Design Monitoring Program

- ◆ Determine what, when, where, frequency, type of sampling, QA/QC

3. Collect Field and Lab Data

- ◆ Select sampling & analytical methods (DL, interferences, False + / -)

4. Compile and Manage Data

- ◆ Data entry, preservation, search, retrieval, and metadata

5. Assess and Interpret Data

- ◆ Statistical analysis, models, comparisons, trends, patterns

6. Convey Results and Findings

- ◆ Reports, formats, diagrams, summaries, tables, graphs, plots

Advantages of Developing an Expert System for Water Monitoring Projects

- ☠ Could be freely available from an Internet site
- ☠ Would facilitate consistent and comparable data quality across many different organizations and programs
- ☠ Updates and information expansion easily accommodated
- ☠ All important factors in planning and executing a project would be considered and documented
- ☠ More cost-effective project plans would result
- ☠ Project plans would always fit available budgets
- ☠ Help would be available when experts are not
- ☠ Training would be facilitated using built-in links and forms