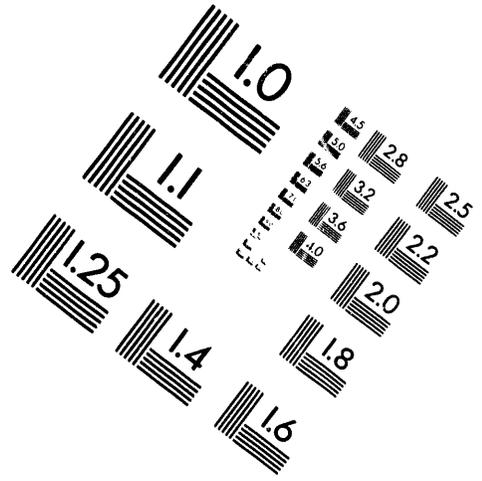
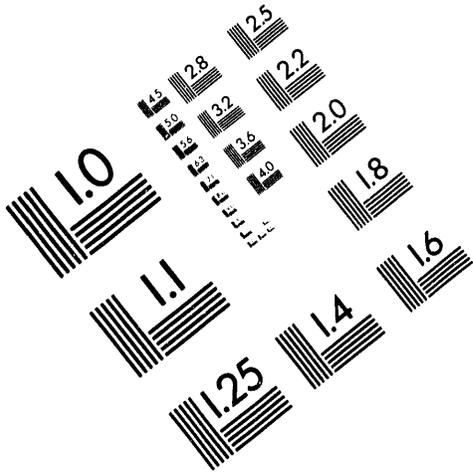




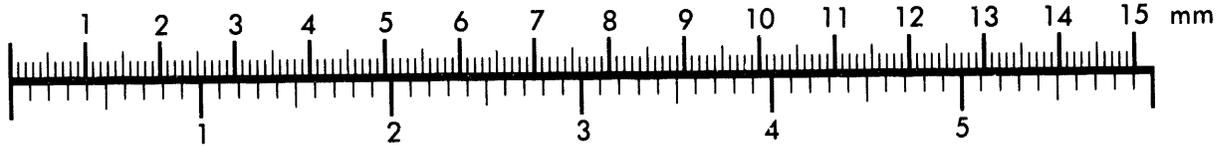
AIM

Association for Information and Image Management

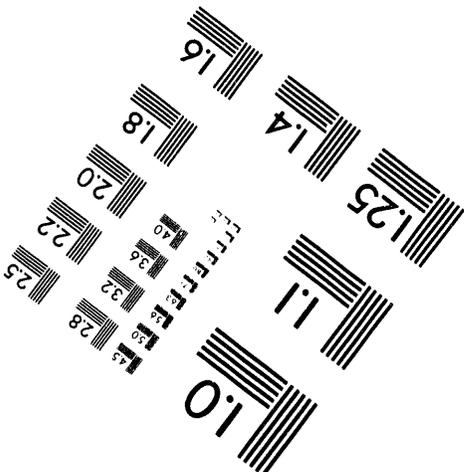
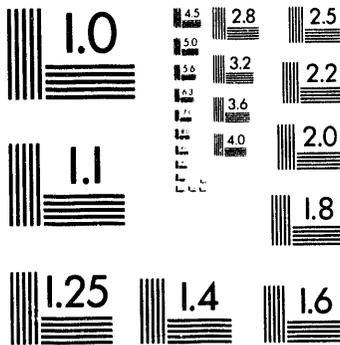
1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202



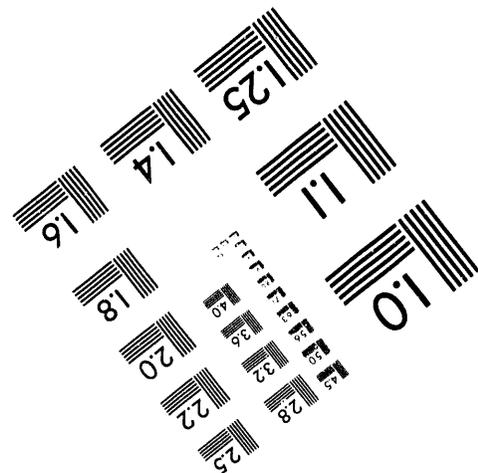
Centimeter



Inches



MANUFACTURED TO AIM STANDARDS
BY APPLIED IMAGE, INC.



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INTERNATIONAL NUCLEAR SAFEGUARDS
INSPECTION SUPPORT TOOL (INSIST)

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International Nuclear Safeguards Inspection Support Tool (INSIST)

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Abstract

The United States Department of Energy (DOE) is committed to providing technologies to the International Atomic Energy Agency (IAEA) to meet escalating monitoring and inspection requirements associated with the Non-Proliferation Treaty (NPT). One example of technology provided to the IAEA is the information management and remote monitoring capabilities being customized for the IAEA by the International Safeguards Division of the Office of Non-Proliferation and National Security. The ongoing Safeguards Information Management Systems (SIMS) program is an interlaboratory effort providing the IAEA with a range of information management capabilities designed to enhance the effectiveness of their nuclear inspection activities. The initial commitment involved the customization

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of computer capabilities to provide IAEA with the basic capability to geographically organize, store, and retrieve the large quantity of information involved in their nuclear on site inspection activities in Iraq.

This initial system, the International Nuclear Safeguards Inspection Support Tool (INSIST), was developed by DOE's Pacific Northwest Laboratory (PNL). To date, two INSIST workstations have been deployed at the IAEA. The first has been used to support the IAEA Action Team in the inspection of Iraqi nuclear facilities since August 1993. A second, and similar, workstation has been deployed to support environmental monitoring under the IAEA 93+2 Programme. Both INSIST workstations geographically integrate analog (video) and digital data to provide an easy to use and effective tool for storing, retrieving and displaying multimedia site and facility information including world-wide maps, satellite and aerial imagery, on site photography, live inspection videos, and treaty and inspection textual information. The interactive, UNIX-based workstations have a variety of peripheral devices for information input and output. INSIST software includes commercial-off-the-shelf (COTS) modules and application-specific code developed at PNL.

1 Introduction

The United States Department of Energy (DOE) is committed to providing technologies to the International Atomic Energy Agency (IAEA) to meet escalating monitoring and inspection requirements associated with the Non-Proliferation Treaty (NPT). One example of technology provided to the IAEA is the information management and remote monitoring capabilities being customized for the IAEA by the International Safeguards Division of

the Office of Non-Proliferation and National Security. The ongoing Safeguards Information Management Systems (SIMS) program is an interlaboratory effort providing the IAEA with a range of information management capabilities designed to enhance the effectiveness of their nuclear inspection activities. The initial commitment involved the customization of computer capabilities to provide IAEA with the basic capability to geographically organize, store, and retrieve the large quantity of information involved in their nuclear inspection on site activities in Iraq.

The initial system, the International Nuclear Safeguards Inspection Support Tool (INSIST), was developed by DOE's Pacific Northwest Laboratory (PNL) and is being used as the core for future SIMS development. To date, two INSIST workstations have been deployed at the IAEA in Vienna, Austria. The first has been used to support the IAEA Action Team in the inspection of Iraqi nuclear facilities since August 1993 as directed by the United Nations Security Council (UNSC) under resolutions 687, 707, and 715. A second, and similar, workstation to support environmental monitoring under the IAEA 93+2 Programme was deployed in January 1994.

A unique aspect of INSIST is that it integrates analog video and digital processing techniques in a georeferenced configuration. This integrated approach offers the advantages of analog processing (i.e., rapid speed, established standards, and more convenient storage) in combination with the quantitative analysis capabilities of interactive digital processing. Another important advantage of video processing is the user acceptability factor. Video represents a technology that is broadly accepted and routinely used by the general public.

INSIST is an effective tool to geographically store, organize, retrieve, and display multimedia site and facility information including world-wide maps, satellite and aerial imagery,

photography, live inspection videos, and treaty and inspection textual information. The system represents an integration of existing commercial software and DOE technologies and has been designed to provide a framework on which to build data analysis functions and to further aid the IAEA in their inspections of Iraqi and other international nuclear facilities.

Based on IAEA experience using current INSIST capabilities, and considering anticipated requirements, future enhancements to INSIST under development at PNL include integration of a commercial Geographic Information System (GIS) and a Relational Database Management System (RDBMS) into the system. Another enhancement under consideration involves porting the INSIST functionality to a PC hardware and software platform to support the users' networking interests.

This paper briefly describes the INSIST design requirements, the system hardware and software, system interaction via three primary windows, the supported INSIST data types and how data is organized and accessed by INSIST. This paper also describes the lessons learned from the two deployed systems and future enhancements that are under development at PNL.

2 System Design Requirements

Based on the current level of IAEA computer capabilities, the rapidly increasing amount of relevant nuclear treaty information, and the scheduling and logistical complications associated with on site inspection activities, the INSIST design requirements focussed on the following features:

- Geographic organization of information,

- Simple user interface,
- Effective integration of multimedia information,
- Graphic display and visualization of data,
- Rapid access to both graphic (maps, video, etc.) and textual information,
- Easy input of inspection data and information,
- On-line product and report generation capabilities,
- The ability to accommodate single frame still video photography acquired during on site inspections.

3 System Description

To meet the basic user requirement noted above, the following combination of software and hardware was decided upon.

INSIST was developed in an X Window System environment on a UNIX-based computer. Application specific code for the system was developed at PNL using the C programming language. This code includes software to display analog and digital images in the reference and video windows, to control the video peripherals, to create the user interface, and to create the underlying data structures.

The system is connected to several video peripherals via a video signal multiplexor to produce the analog video display capability unique to INSIST. These peripherals include the following:

- a read-only videodisc player to retrieve and display videodisc maps and charts;
- a WORM (Write Once Read Many) laserdisc recorder to store and retrieve custom inspection data and map sets including satellite imagery, aerial photography, still frame video photographs, and full motion video clips;
- a specialized computer video card to provide video display and processing on the UNIX workstation;
- a still video player to display video frames taken by a hand held still video field camera;
- a large-screen T.V. monitor for briefing purposes.

Custom photographs, maps and images are digitized for use in the system using a flatbed scanner. Hardcopy output of both text and graphics can be produced with a color PostScript printer.

4 System Interaction

The INSIST user interface consists of three primary windows; a control panel window, a reference window, and a video window. In addition to the primary windows, action windows and dialog boxes are displayed to provide and obtain information from the user. All user interface boxes and windows were created with industry standard Motif widgets. Currently, 100% Motif Style Guide compliance has not been achieved, although this is the ultimate goal. Use of an industry standard interface will allow for a simpler transition to INSIST from other packages as well as providing a guideline for future development. Figure 1 contains

an example of a typical INSIST user interface, showing the three primary windows. A description of these windows follows.

4.1 Control Panel Window

The Control Panel Window is located in the upper left corner of the screen and contains the main menubar and the INSIST status display area. The status display area provides the user with the status of the INSIST session by displaying the currently selected configuration file, reference map, map set, geographic coordinates (latitude and longitude), and reference map classification category.

4.2 Reference Window

The Reference Window displays a digital reference image and is typically located in the lower left corner of the screen. The reference image provides the user a macroscopic view of the area of interest and is designed to portray anything from a map of the world, to a site diagram or a blueprint of an equipment item.

Two rectangular shaped boxes are overlaid on the reference image to show first, the entire area covered by the current map set, and second, the area covered by the currently selected video frame being displayed in the video window. An example of the two rectangular overlays can be seen in the reference window in Figure 1.

Images displayed in the reference window are divided into several classification categories. These categories allow individual features in the reference image to be identified and to have INSIST data types associated with each. As an example, each building in a reference image of a site diagram would be a different classification category.

As the user moves the cursor on the reference window the geographic coordinates of the cursor location and the classification category associated with the area under the cursor are reported in the status display area of the control panel window. The user can update the area selected and displayed in the video window by clicking on any location on the reference image in the reference window,

4.3 Video Window

The Video Window displays analog video frames from the various map sets supported by INSIST, as well as video-based inspection photos and live video. Like the reference window, when the user moves the cursor on the video window, the geographic coordinates of the cursor are reported in the status display area of the control panel window. Additionally, if the user moves the cursor over an icon overlaid on the video window, the description associated with the icon is reported in the status display area. By clicking at the top, bottom, left or right edge of the video window, the user can pan the displayed video frame north, south, west, or east, respectively.

5 Data Types and Organization

The INSIST workstation provides multimedia data management and is capable of storing, retrieving and displaying the following multi-source inspection data items:

- Still video frames,
- Live video,
- Text files,

- Map and image data.

In addition to these built-in data types, INSIST can store and intelligently retrieve documents via a commercial text retrieval system; query and display tabular data related to an inspection or facility via a commercial Relational Database Management System (RDBMS); and query, display, and perform analytical functions on spatial data via a commercial Geographic Information System (GIS). Together, the built-in INSIST data types, the text retrieval system, the RDBMS, and the GIS provide a multimedia storage, retrieval, and display capability for all inspection data types.

INSIST data types can be associated with an icon geographically positioned on the INSIST video window as well as with different classification categories on the INSIST reference window. By clicking on a geographically positioned icon in the video window or on one of the classification categories in the reference window, an action dialog window is displayed which contains a list with descriptions of all data items associated with the selected icon or classification category. From this action dialog window, the user can select a data item to view. Once a data item has been selected, INSIST performs the actions necessary to display that item. For example, a document can be associated with a site represented by an icon geographically positioned on a map displayed in the video window, a live video clip can be associated with a building on a site diagram reference image, and a still video image can be associated with an equipment item in a room of a building.

Through use of reference window classification categories and video window icon overlays, INSIST enables geographical data to be organized in a hierarchical fashion. For example, from the reference image of the world, a country can be selected. From a particular country (with an associated map set of video frames), an icon overlaid on the video window can be

used to select a site or facility in that country. From a reference image of a selected site, classification categories representing the various buildings on the site can be identified. From a reference diagram of a selected building, a classification category representing a room in the building identifying equipment items can be selected. This capability can be used for both map-based hierarchical data sets as well as for equipment diagrams. For example, a blueprint of a centrifuge has been incorporated into INSIST as a reference image in the reference window for accessing video-based photos of more detailed centrifuge components.

Maps and images in INSIST are organized into groups called map sets that are stored as analog video frames on either the system videodisc recorder or the read-only videodisc player. The video frames are indexed and georeferenced by INSIST. The following types of map and image data are supported:

- Videodisc maps (world wide, country specific)
- Commercially available satellite imagery
- Scanned paper maps and aerial photos

6 Lessons Learned and Future Developments

The first INSIST workstation was successfully deployed at the IAEA as a tool to support pre-inspection planning and post inspection analysis for the IAEA Action Team Iraqi inspection activities. The IAEA has acknowledged the contribution of INSIST in assisting in dismantling the Iraqi nuclear weapons program and to nuclear non-proliferation in general. Data input requirements associated with this tool have been a major limiting factor in the operational use of the system, however the introduction of still frame video cameras has

significantly improved the procedures and efficiency of collecting and inputting inspection data. Other factors effecting the operational use of the INSIST workstation include the complexity of a UNIX-based workstation (in regard to operations and maintenance) and the limited time available for inspector training. Finally, there exists a need to distribute INSIST data and functionality across existing PC-based hardware and software platforms if the INSIST workstation is to be a framework for more comprehensive data management within the IAEA Action Team.

We are currently investigating the possibility of creating an all digital version of INSIST that would not be dependent upon the video equipment needed by INSIST. In addition, we are porting this digital version of INSIST to a PC-based hardware and software platform. This will lower the cost of the system and provide a desk-top INSIST capability to take advantage of existing PC-based hardware, software and local area networks.

To take advantage of the speed and advanced functionality of the UNIX-based INSIST workstation and the cost effectiveness of an all digital PC-based INSIST, we are further investigating networking the two types of systems into a Client/Server configuration using a standard TCP/IP ethernet network.

IAEA activities involving environmental monitoring have required the integration of analytical capabilities into INSIST. The second INSIST workstation recently deployed at the IAEA in support of the 93+2 environmental monitoring Programme, supports not only multimedia data management (equivalent to the first workstation) but also Geographic Information System (GIS) technologies to accommodate environmental sampling data. The GIS handles the spatial and tabular data collected in conjunction with the IAEA's environmental sampling activities. In addition, the GIS provides the ability to perform distance

and area measurements, produce contour lines, and handle vector data (i.e. point, line, and polygonal data). The GIS is closely integrated with a Database Management system to store attribute information associated with the GIS spatial data objects. Because this is at a prototype stage of development, user experiences have been limited.

A third INSIST workstation containing RDBMS enhancements is scheduled for deployment to the United Nations Special Commission (UNSCOM) in New York to support its role in inspections of Iraqi Nuclear, Biological Weapon, Chemical Weapon, and Ballistic Missile sites. This workstation will more closely integrate the functionality of the commercial RDBMS and the INSIST data items previously described. This enhancement will allow INSIST to associate records in the database with icons in the video window and classification categories in the reference window. In a similar manner, fields in the database will contain pointers to access other INSIST data types. This will allow the RDBMS to access and display geographic data items.

INSIST is a dynamic system that can be customized for many applications. Other commercially available software modules like the GIS and RDBMS can be incorporated into INSIST by adding them into one of the main menubar pulldowns. By simply pointing and clicking, the user can seamlessly access one of the added modules.

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