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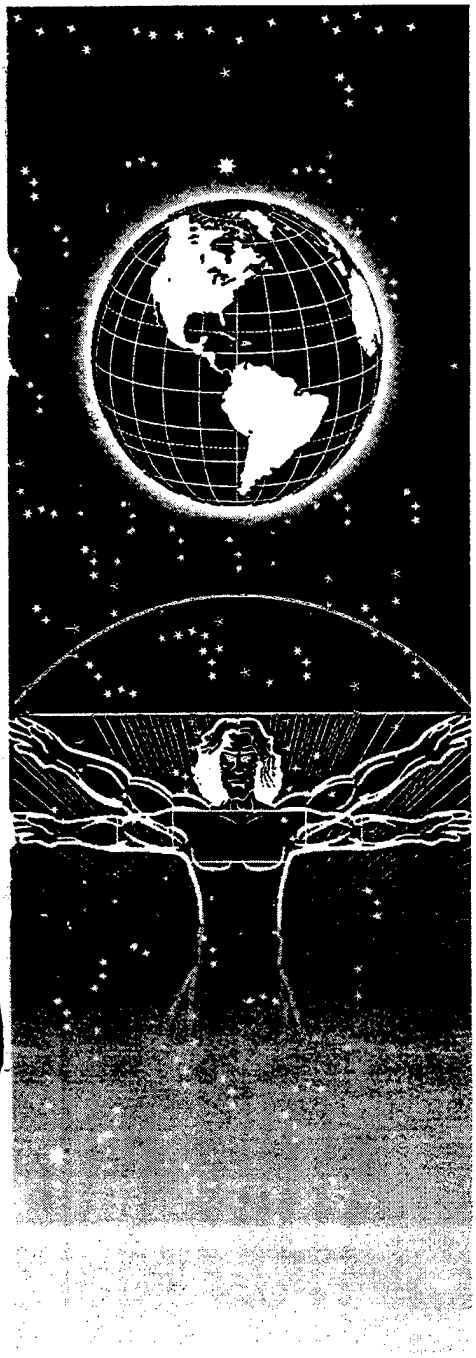

UNITED STATES AIR FORCE RESEARCH LABORATORY

PRELIMINARY OPERABILITY ASSESSMENT OF THE INTERACTIVE IMAGERY EXPLOITATION (INIMEX) IMAGERY ANALYST INTERFACE

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The voluntary informed consent of the subjects used in this research was obtained as required by Air Force Instruction 40-402.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

MARIS M. VIKMANIS
Chief, Crew System Interface Division
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A preliminary user interface assessment of the Interactive Imagery Exploitation (InImEx) system was conducted to serve as a foundation for the development of the InImEx human-computer interface (HCI) concept. Four imagery analysts, assigned to the National Air Intelligence Center, Wright-Patterson Air Force Base, Ohio, served as subject matter experts (SMEs). One additional SME was obtained from the Systems Engineering and Integration Division of Adroit Systems Inc., Dayton, Ohio, a contractor supporting AFRL/HECA in the areas of operability/usability assessment, systems engineering, and technical analysis. This additional SME had extensive imagery analysis experience both in his current occupations and during prior military assignments. The overall finding was that the InImEx HCI, based on a "zoomable user interface," offered significant potential for acceptance by the USAF intelligence community. Although the maturity of the imagery exploitation toolset represented by the version of InImEx available for use in this assessment was quite limited, the underlying concepts of georegistered, hierarchical data/imagery sets, lenses, and semantic zooming were, in general, very well received by the SMEs. The evaluation produced both general findings and specific recommendations for the further maturation of the InImEx capability.

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PREFACE

This in-house effort was accomplished by the Air Force Research Laboratory's Human Effectiveness Directorate, Crew System Interface Division, Information Analysis and Exploitation Branch (AFRL/HECA), Wright-Patterson Air Force Base, Ohio. It was carried out under Work Unit 7184 10 44, "Crew-Centered Aiding for Advanced Reconnaissance, Surveillance and Target Acquisition." Mr. Gilbert Kuperman was the Work Unit Manager.

The authors wish to thank Dr. Robert A. Hummel, Defense Advanced Research Projects Agency, Special Projects Office, Arlington, Virginia, Program Manager of the Interactive Imagery Exploitation (InImEx) Project, for his commitment to giving imagery analysts control over automated target cueing and recognition aids. Dr. Hummel afforded the AFRL team the opportunity for this early exploration into the InImEx operator interface.

Special thanks are due to the dedicated personnel of the National Air Intelligence Agency, Wright-Patterson Air Force Base, Ohio, who offered their expertise in support of this assessment. Additional thanks are due to the personnel of the Systems Engineering and Integration Division of Adroit Systems Inc., Dayton, Ohio, who acted both as consultants and subject matter experts in the design and conduct of this study.

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INTRODUCTION

The number of intelligence collection assets in the DoD is increasing rapidly, with an attendant increase in the quantity and quality of imagery that must be exploited. The vast increase in the amount of intelligence imagery has led the intelligence community to look for new techniques to increase the efficiency of image analysts (IAs). In addition, the number of IAs in the DoD is dwindling significantly along with the overall military drawdown. One approach being explored is to automate as much of the image analysis process as possible. Such approaches as Automatic Target Recognition (ATR) and cueing are being developed to lighten the workload on IAs in the future. However, although ATR has made considerable advancement in recent years, it is not yet at the point where automatic recognition is sufficiently robust for general operational use. One hybrid approach being investigated is computer assisted ATR using man-in-the-loop interactive exploitation.

The Interactive Imagery Exploitation (InImEx) program is sponsored by the Defense Advanced Research Projects Agency (DARPA) and is being performed under contract number F33615-97-C-1097 by Lockheed Martin Astronautics. It is being monitored by the U.S. Air Force Research Laboratory at Wright-Patterson Air Force Base, OH. A critical aspect of the InImEx program is IA user involvement. A spiral development approach is being taken with periodic "Mockups" being delivered for evaluation by image analysts and feedback to the developers. In the future, an InImEx prototype will be provided to an operational organization for a period of time for evaluation and feedback. This Technical Report documents the results of a human factors interface usability evaluation done on an early development version of the InImEx software.

InImEx is being developed to combine ATR algorithms from DARPA's MSTAR and Image Understanding (IU) programs (Keydel *et al.*, 1997; Mossing and Ross, 1998; Velton *et al.*, 1998), such as target recognition and temporal analysis with an improved Human Computer Interface (HCI) paradigm in an attempt to greatly improve exploitation throughput. InImEx makes the assumptions that the standard WIMP/WYSWYG approach is inefficient and obsolete for georegistered data sets, and that more efficient user interface paradigms now exist. Therefore, InImEx abandons the traditional graphical user interface (GUI) approach in favor of a zoomable user interface (ZUI) approach based on the Pad++ Zoomable User Interface (ZUI) software developed by Bederson at the University of Maryland and his colleagues at New York University, the University of New Mexico, and the University of California, San Diego (Bederson and Hollan, 1994, 1995; Bederson, Hollan, *et al.*, 1996; Bederson and Meyer, 1998; Bederson, Stead, and Hollan, 1994; Furnas and Bederson, 1995; Perlin, 1993). Pad++ uses ***zooming*** as a primary method of manipulating data, which now gives the operator a 3rd dimension to work in. However, navigation principally involves familiar 2-dimensional concepts. The Pad++ space is conceptually infinite in three dimensions and is ideally suited for implementing the electronic sandbox concept, in which multiple data types are organized in a layered format that allows all data types to be co-registered. This concept has been explored for some time in other Geographic Information System (GIS) domains, in which the predominate

data being used are spatially georeferenced. Most applications involving the use of maps and data on sites of interest are amenable to this approach, including the analysis of intelligence data.

Thus, the primary goals of InImEx are to:

- Give the IA ready access to georegistered context information: maps, current and historical imagery, reports, and collateral data such as signals intelligence, etc.
- Give the IA an intuitive and efficient user interface so the analyst can incorporate large amounts of information into an analysis task.
- Give the IA intuitive methods for navigating within a 2D world space, and for navigating through a spatio-temporal world space. The IA must maintain a good sense of spatial context.
- Give the IA intuitive methods for selectively viewing and navigating through this information. The IA must maintain a good sense of task-specific information context.
- Give the IA insight into and control over interactive or semi-automated analysis aids. This project focuses on: (a) interactive aids for cueing and identification of vehicles utilizing model-based vision, and (b) semi-automated aids for wide area search and facility monitoring using image understanding technology.
- Provide the user context, which is not currently available for ATR algorithms.
- Provide IA insight and control over MSTAR algorithms.
- Share this context and MSTAR algorithm results with a distributed user base.

The ZUI concept has three principle components: A unified Geo Surface, the basic zoom capability, and Lens tools. Each of these will be discussed in turn.

(1) The unified Geo Surface consists of layers of data which are georegistered. The surface is essentially infinite in three directions. Spatially, the data can extend infinitely in concept and cover the entire earth in reality. A third dimension is introduced by the conceptually infinite number of layers of data which can be vertically stacked on top of each other. Each layer would contain a different type of data. While the concept is built around the idea of georeferenced data, such data types as text, graphics, animations, etc can be placed on layers on the Geo Surface. This third dimension gives IAs enormous flexibility and power in accessing the information they need.

Types of data which might be included as a layer on the Geo Surface include imagery (any phenomenology), maps, charts, geo-spatial features such as roads, hydrology, bathymetry, DTED etc. Other types of intelligence such as signal intelligence (sigint) hits, threats, site models and obstruction data could also be included. Since this information is georegistered, if the location is known for one of these types of data it is also know for all of the other types. The IA doesn't have to go looking for the Area of Influence (AOI) for each different type of data required during a given exploitation task. This data organization fits in very well with the Electronic Sand Box concept. The concept of an electronic sand box was developed as a method of organizing and displaying imagery and the support data required for effective image exploitation as a result of a DARPA study panel on Interactive Exploitation. The structure of the Electronic Sand Box and its concomitant Pad++ space are shown in Figure 1 and Figure 2.

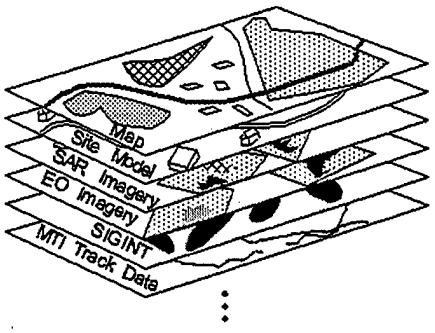


Fig. 1. Electronic sandbox.

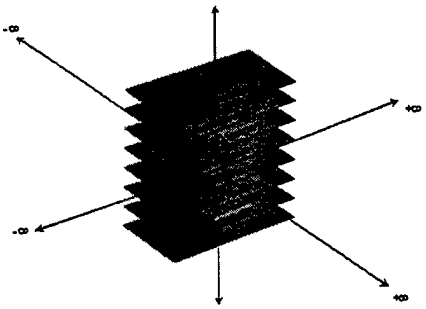


Fig. 2. Pad++ space.

(2) The zoom component consists of two parts. The first is the more traditional zooming capability. The Pad++ substrate allows for essentially an unlimited range of zooming. Zooming over scale factors of 10,000 or more are readily achievable. This provides all of the capability normally associated with an electronic light table (ELT) zoom capability but greatly exceeds the scale factors normally seen. For example, the ability to view the entire United States and then zooming smoothly in to a particular military site and even into a particular pixel on a vehicle is readily achievable.

This gives an IA the capability to roam over large distances much more effectively. The IA can zoom out roam or pan a relatively 'short' distance and then zoom in to get the resolution desired. Furnas and Bederson (1995) have shown that this is a much more efficient way to pan than the traditional technique of panning over large distances. This is illustrated in Figure 3. The top of this diagram represents the zoomed-in state, with the bottom showing the zoomed-out state. Each arrow represents a unit of cost, primarily defined by the time required to execute the pan. As can be seen in this example, the traditional approach costs 16 units, while the newer approach costs only 5 units. This phenomenon comes about because zoom is a logarithmic process while translation or panning is linear. This approach also has the advantage that the IA can maintain context and see exactly where he is going, rather than guessing and hoping that he is panning in the correct direction using the traditional approach.

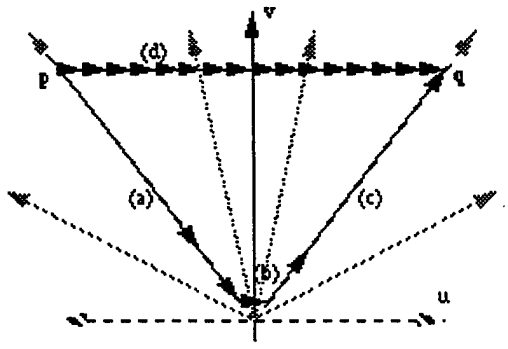


Figure 3. Zooming

The more innovative aspect of zooming is the idea of semantic zooming. As implied, this is a capability in which the meaning of the information changes as zooming proceeds. Figure 4 shows an image sequence that demonstrates the concept of semantic zooming. As the screen is zoomed the operator sees:

1. An overview of the US with sites of interest designated by symbol and name.
2. The screen is zoomed on the Eglin site. The symbol and name disappears and a box indicating the boundaries of the site of interest appears.
3. Zooming in further addition information appears. A high scale topological map now represents the bounded site.
4. As the screen is zoomed the map scale changes to be more consistent with the area being displayed on the screen.
5. The map scale changes again and additional information appears. A lens that displays imagery underlying the topographic map is now displayed. Another lens indicating that targets have been identified by an ATR on another image chip is now displayed. Note that at this point three fundamental different types of information is being displayed simultaneously.
6. The target ID lens has been zoomed on. Additional information about the results of the ATR process is now being displayed i.e. the fact that the ATR algorithm has identified 25 targets in this particular image.

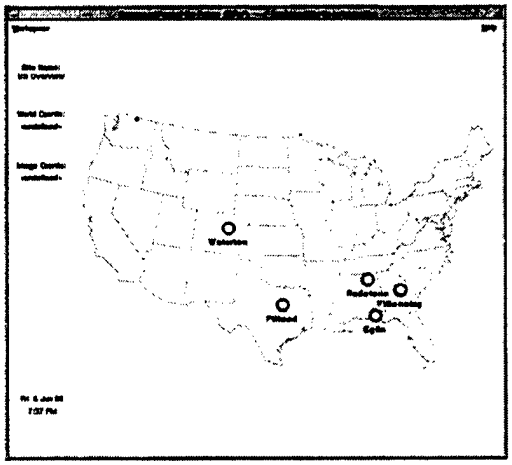


Figure 4a

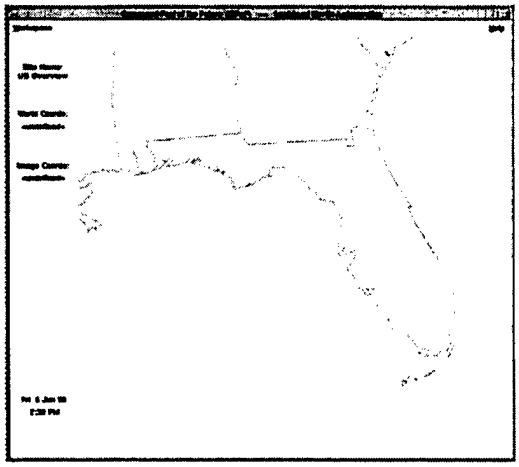


Figure 4b

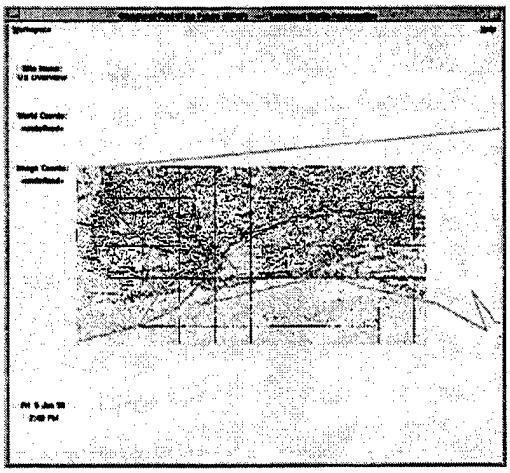


Figure 4c

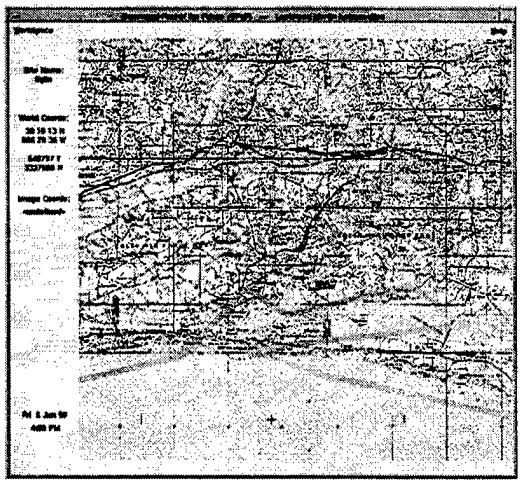


Figure 4d

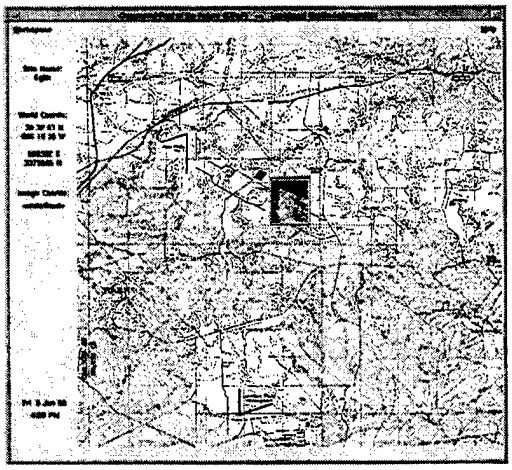


Figure 4e

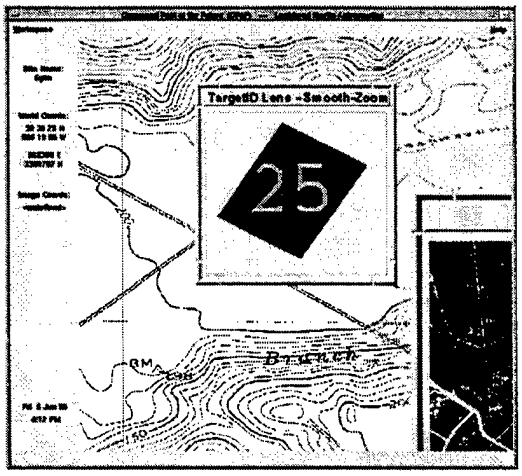


Figure 4f

Figure 4 (a-f). Semantic Zooming.

Note that in this process each zoom level display presents different semantic content. This zooming could proceed for an unlimited number of levels. In fact in this particular example the target ID lens contains several more semantic levels that could be accessed by zooming further. Figures 5a-e demonstrate the concept of semantic zooming using the InImEx automated target recognition component.

Figure 5(a)

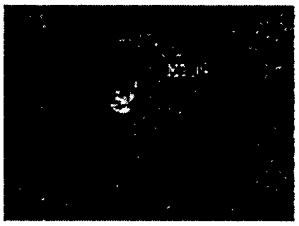


Figure 5(b)

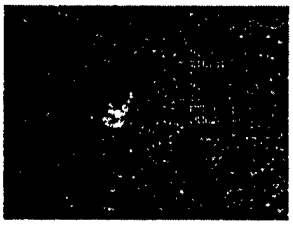


Figure 5(c)

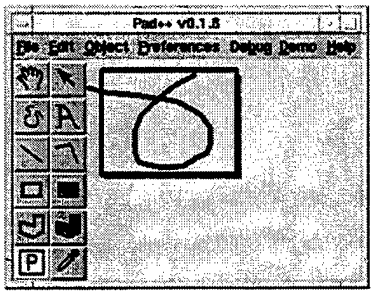
Figure 5(d)

Figure 5(e)

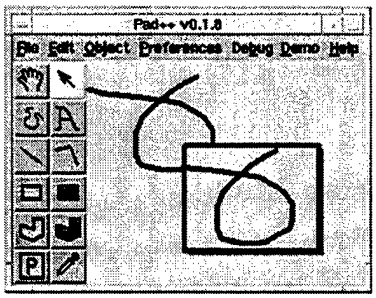
Fig. 5(a-e). Zooming with ATR. This sequence of display fragments shows a form of semantic zooming of the results from a automated target identification system that analyzed the SAR image shown in the background. These display fragments are from inside the view of a lens that is too large to be visible here.

(3) Lenses are the third major component of the ZUI concept. Many ELTs have a magnifier 'lens' which allows an IA to pan around an image magnifying the portion of the image under this 'lens'. In Pad++ terminology, the 'physics' of this lens is to magnify an image. Pad++ has developed a way to attach other physics to lens in order to provide a wide variety of functionality. using the lens paradigm. Using the idea of lens physics, virtually any ELT, image processing, graphics, or word processing function can be bound to a lens. This includes existing commercial software.

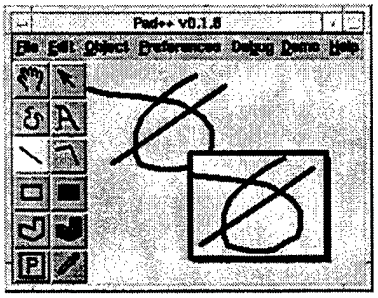
Portals are the basic Pad++ construct from which lenses are developed. Portals are implemented as a shape, usually a rectangle, through which the IA can look at specific data. The portal concept is shown in Figure 6. A portal provides a view of the particular layer of the database. The idea of viewing into a data base layer is important. The portal is not looking at a copy of part of the database but is looking at the actual data. This means that database updates are seen through the portal as they occur. There is no need to take an action to refresh the portal. The IA can zoom on the data shown in the portal while other data on the screen is static. The portal can be stuck to the screen so that the view remains available to the IA as the IA pans over large areas of data. This would allow the IA to compare imagery at widely spaced locations in applications such as trying to identify an unknown target by comparing it with a known target at a distant location.



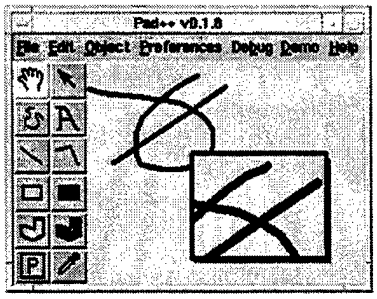
Initial Portal Is Rectangle



Contents Move With Portal



Portal Contents Not Copy
Draw on 'Original' It Appears In Portal



Portal Is Independent
Zoom, Pan etc..
Without Changing Original

Figure 6. Portals

A simple, but important, ELT function of mensuration implemented as a lens is shown in Figure 7. Figure 8 shows an image processing lens which will allow the IA to change image brightness and contrast.

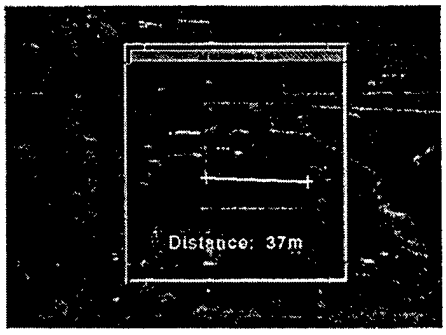


Figure 7. Mensuration Lens

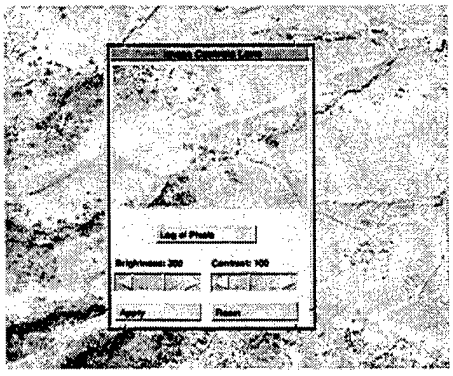


Figure 8. Image Processing Lens

Some other examples of lenses implemented in the prototype InImEx system include the following:

Figure 9 shows the Temporal Image View lens. This lens makes use of the time dimension to indicate when imagery was taken of a particular site. By clicking on the box forming the bar on the timeline the image corresponding to that point in time can be indicated and viewed. This capability has applicability to site monitoring applications where change in force disposition over time is important information to extract from a set of sequential images. When combined with the Target ID lenses, this becomes a particularly powerful method for change detection of fixed or semi-fixed sites.

Figure 10 shows how a lens can permit an IA to view support data without losing context. In this example the IA is viewing imagery, but wants to know what information is contained on a topographic map. By using the Raster View lens, the IA can look at a small area of the imagery and determine the relief of the area.

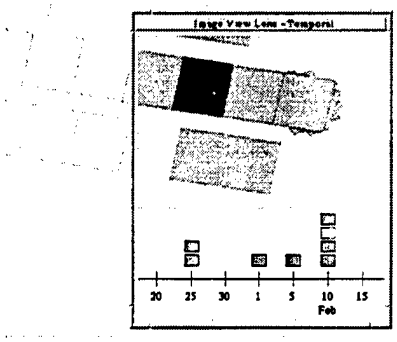


Figure 9. Temporal Image View Lens

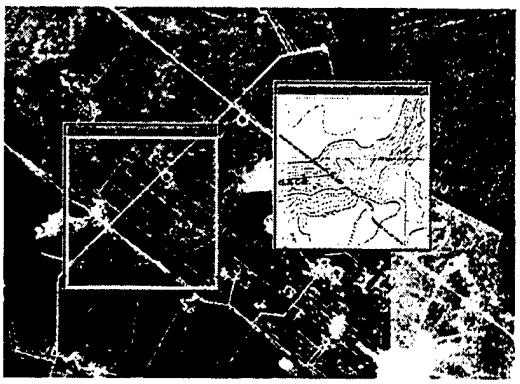


Figure 10. Raster View Lens

In summary, InImEx is introducing a new paradigm for image exploitation that incorporates existing IA tools along with new tools such as automated target recognition. InImEx addresses ABIS documented requirements in the areas of automated target recognition, real time cognition aided displays and improved human computer interface and cognitive support.

InImEx has demonstrated the following novel claims:

First image exploitation application using a zoomable user interface.
First illustration of sophisticated lenses for image exploitation.
First coherent set of lens tools for the image analyst.
New types of stacked lenses whose operations combine.
First zoomable tool palette and task-step tool organizer.
The next section provides a more detailed description of the capabilities being incorporated in the InImEx system.

INIMEX CAPABILITIES

It is important that basic ELT tools be incorporated into InImEx. This is true for two reasons. Firstly, these functions are required to do the IA job and, secondly, this provides a familiar frame of reference to ease the transition for IA's from the traditional ELT paradigm to the InImEx paradigm. In a study done by the U.S. Air Force (Adroit Systems Inc., 1997), a wide variety of IA tools were evaluated for their utility for both wide area search and detailed analysis scenarios. Air Force and Army IA's were asked to rank the utility of the tool set. The ability to zoom on imagery was ranked first for both scenarios. InImEx is incorporating most of these tools, prioritized by their utility. InImEx is also incorporating tools that are new to most AI's, such as ATR and interactive online target folders.

Lenses are user interface tools that provide a window with different views of the InImEx data surface. Lenses reside on the InImEx surface. A lens shows a particular visual representation of a particular subset of objects that overlap the lens, and the user interacts with objects through a lens, or in some cases interacts with the lens through various kinds of controls embedded in the lens itself. What a lens displays is called a view, since it is a view onto the InImEx surface.

Mensuration

Mensuration, the ability to measure real-world distances (meters typically), is a basic requirement for the IA. Types of distances can range from the dimensions of a vehicle, building, or facility to the movement of a force element on the battlefield. Since everything in InImEx is georeferenced (as in the sandbox), distances on the screen are always proportional to distances in the real world. InImEx provides a simple mensuration lens, as shown in Figure 11. The user drags the endpoints of a line segment -- through the lens -- and the lens always shows the length of the line segment. Other mensuration lenses could present shapes (e.g., polygon) and display relevant measurements.

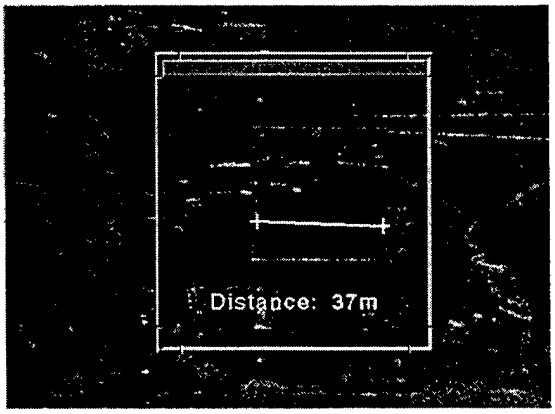
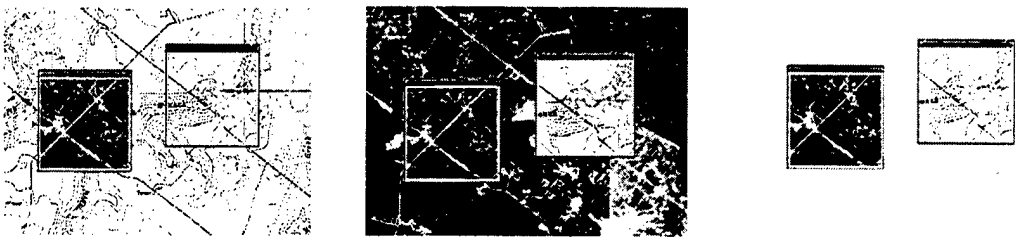


Fig. 11. This mensuration lens shows the length of a line segment manipulated by dragging the segment's endpoints through the lens.

Latitude/Longitude Coordinate Determination (UTM, WGS)[1]

It is crucial for an IA to maintain a feeling for the spatial context in which he is working. Since InImEx fully implements the sandbox concept, coordinates and distances on the InImEx surface correspond directly with world coordinates and distances, specifically the internal coordinate system is latitude/longitude in WGS-84. The world coordinates of the mouse are always displayed, in multiple forms, on the far left side of the screen.

Analysts often prefer to see a reference map or overview image in the background of the screen in order to help maintain an idea of where they are located in the world. Unfortunately there can only be one background at a time, and such a background can confuse the appearance of the primary data the analyst is studying. Two lenses, a rastermap viewing lens and an image viewing lens, provide simultaneous display of both types of data, as illustrated in Figure 12. An important aspect of this example is that the user can scan one of the lenses around on the screen, for example by following a road with the rastermap lens, and thus simultaneously combine a (registered) view of the overview image and the rastermap.



(a) (b) (c)

Fig. 12(a) A rastermap is displayed globally (by clicking through the rastermap viewing lens) while an image view lens lets the user see specific details in an EO image.
Fig. 12(b) The EO image is displayed globally while a rastermap lens provides a selective view of the map.
Fig. 12(c) The user utilizes both lenses, freeing up screen space for other more important data or tools.

Image Chipping Tool

A surface portal is a generalization of a lens that provides an independent view of any area of the Pad++ surface at any zoom. The view may show any set of the display layers on which all Pad++ objects reside. Figure 13 shows an example of a surface portal used within InImEx, a kind of spatial bookmark called a teleportal. The teleportal shows a view of the bookmarked area, and clicking through the teleportal causes the main display (itself a view) to be transformed

[1] UTM = Universal Transverse Mercator (USGS The Universal Transverse Mercator (UTM) Grid Fact Sheet Number 157-99, February 1999)
WGS = World Geodetic System (NIMA Technical Report TR8350.2, "Department of Defense World Geodetic System 1984, Its Definition and Relationships With Local Geodetic Systems," Third Edition, 4 July 1997.)

via an animated pan/zoom to the bookmarked area. Once there, the teleportal view is reset to the position and zoom before the teleport motion was initiated. Normally, all lens and surface portal tools in InImEx reside on the georeferenced surface. The teleportal has a different property enabled, called stickiness, that effectively causes the tool to be glued to the glass of the display screen as the main display's view changes. If the teleportal was not sticky it would remain at the previous geolocation, an option available to the user through the popup property menu shared by all lenses.

Other than teleporting to a bookmarked location, a surface portal can simply serve as a convenient visual reference. For example, one can provide a thumbnail overview of the current site under analysis, or one can provide a close-up of specific vehicles located in some imagery from a week ago and suspected of being the same vehicles found today at a different location on the battlefield. The collection of world views provided by a set of surface portals that an analyst has created during a session can readily be inserted as image chips into a report creation tool. Alternatively, a *cut/paste portal* would paste an image chip of its own current view into a report creation buffer whenever a button built into the cut/paste portal is pressed.

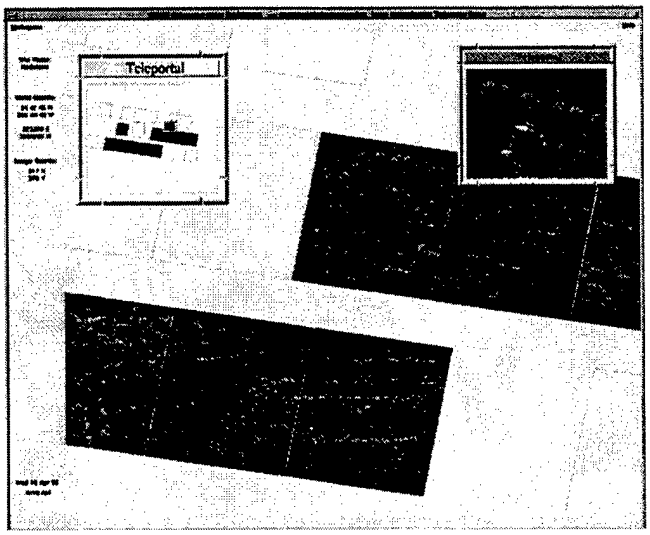


Fig. 13. Teleportal Lens. The teleportal tool is essentially a Pad++ portal widget with window dressing and one mouse binding. The portal displays a view of a bookmarked area, and clicking the mouse through the portal causes the main display to be transformed to view the bookmarked area.

Contrast
Brightness
Edge Sharpening
Pixel Sharpening
Gray Scale
Edge Detection

The user's conceptual model for a lens, as described so far, is that the lens provides a view of (or operates on) only the data directly underneath the lens. Most image processing operations require intense numerical computations that seldom can be accomplished in anything close to real time, especially when images have as many as ten thousand rows and columns. Lenses enable an analyst to view image processing results in real time, such as an image enhancement. This is possible because the lens actually only performs the operation on the portion of the image visible underneath it. In practice, an analyst is usually zoomed in on a small portion of an image, so any image processing lens will cover only a very small portion of the entire image. By scanning a small-sized lens over areas of interest the analyst can perform analysis operations over a large area in real time. Thus, operations such as contrast and brightness (Figure 14), edge sharpening, pixel sharpening, edge detection, etc., are all done via lenses within InImEx.

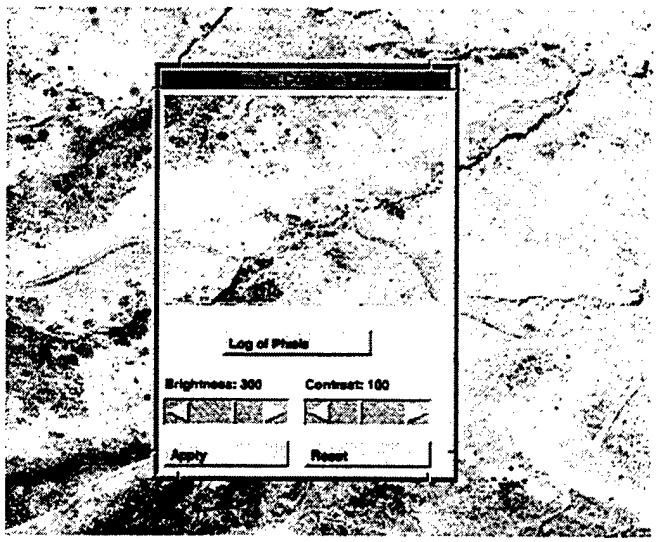


Fig. 14. Image Control Lens. The image controls lens gives the user a fast preview of the brightness and contrast settings for an image. The preview is only for the image area inside the lens, rather than for the entire image.

Rotation

Image rotation is another image processing operation, as above, and thus rotated images will be viewed inside lenses.

Dynamic Tasking

InImEx includes more complex lenses that could be used to review new imagery as it arrives in near real time. The footprints (i.e., outlines) of incoming imagery would immediately be inserted into InImEx's database system and would be seen on the InImEx surface, if that area is currently visible. The analyst can query when the footprints in an area were collected by using

a *timeline image selection* lens, as shown in Figure 15. This lens associates image footprints displayed in the upper panel of the lens and collection times as depicted by icons on a timeline in the lower panel. The timeline panel is a view of a separately zoomable timeline surface, which supports semantic zooming over different timeline scales (i.e., hour, day, week, month, year).

The georeferenced InImEx surface is an ideal medium for entering dynamic tasking requests. The user would click on the desired collection areas through a *dynamic tasking* lens.

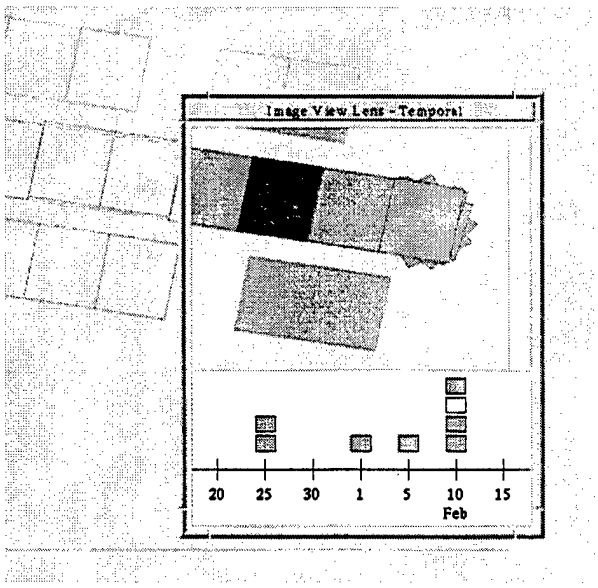


Fig. 15. Timeline Image Lens. The timeline image selection lens shows image footprints and corresponding icons on a timeline that show when the images were collected.

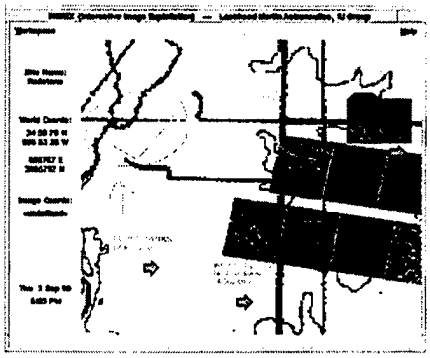
Imagery Header

The set of lenses available to the user must provide a huge variety of functions. How to provide this variety of functionality in the user's mind and hands is a fundamental design question. At one end of the spectrum, the user could be provided with a set of complex, monolithic lenses. Each lens would provide a number of related functions, selectable through various kinds of option selections built into the lens. At the other end of the spectrum, the user could be provided with a set of primitive lenses, several of which must be stacked to compose a complex function. The monolithic approach to lenses is straightforward, but the stacked primitive approach to lenses is more natural for certain functions. Conceptually, a stack of lenses implements a sequence of operations on a set of input objects: The bottom-most lens selects a set of input objects (overlapping the lens' view), applies an operation to the set, and outputs a set of objects. The objects output from a lens are rendered and may be passed as input to a lens stacked above. One example is a stack of image processing lenses, where each lens operation is essentially specified by a parameterized operator.

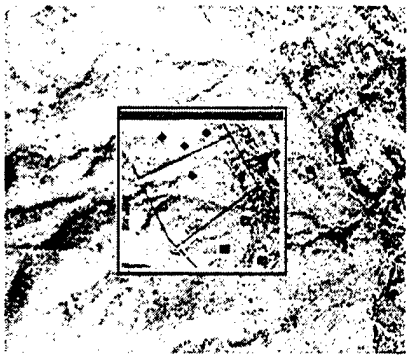
Collection date and time information stored in an image header can be visualized by a temporal range selection lens, which can also be utilized to select a collection of images based on a time range. This kind of lens could be stacked under an image exploitation lens under a plotting lens. More generally, multiple database query/visualization lenses can be stacked to compose a complex database query on other data fields in the image headers for all the image objects underneath the lens. Pre-defined or user-customized lenses provide displays of the most commonly desired image header information (date, time, depression, squint, etc.).

Annotation

User created annotations are simply another type of data object embedded inside the InImEx geosurface, as illustrated in Figure 16. Simple hand-drawn annotations are supported, as is standard military symbology. More sophisticated embedded annotations are possible, such as a folder containing more detailed analyst notes. Annotations are usually organized into layers, and like other data layers such as vector maps, are best viewed using lenses.



(a)



(b)

Fig. 16(a-b). Annotation Lens. User-created annotations are another type of data object embedded on the InImEx surface. Annotations can be made (a) globally visible, or (b) they can be viewed more selectively through lenses. Clicking the mouse through a lens displaying an annotation layer toggles the global display of that annotation layer.

Change Detection
Automatic Target Cueing

InImEx uses an approach similar to *profiles* developed in the RADIUS project (Firschein and Strat, 1997), but also extended to a wide area search problem domain. The IA will associate a region in the world and an algorithm (MSTAR or an IU module) to be run on images covering that region. The IA could also specify conditions detected by the algorithm for which the analyst is to be notified. Notifications will appear as iconic alert symbols embedded in the InImEx surface. The analyst could also peruse these alerts via lenses, or ask that the system automatically sequence (using animated pan/zoom moves) through a set of alert locations.

Scene Comparisons

Various lens tools can be used to compare two scenes or two images. For example, lens A can display image A, and lens B can display image B, and reference image X may be displayed globally in the background. Comparisons are made by scanning the lenses over specific areas of interest. Figure 7 showed a similar arrangement used to compare one EO image with one rastermap. A single lens with a built-in "wipe bar" could also be used to display two images side by side or blended together inside a single lens. These same lens tools can be used to compare entire scenes of objects, instead of just two image objects.

Automatic Target Recognition, Imagery Key Tools Online

The first interactive-ATR tools for SAR imagery were designed within the classic windows, icons, menus, pointers (WIMP) user interface design paradigm. One such I-ATR tool is shown in Figure 17. A top-level window contains all elements of the interface, including several panels where distinct types of data are displayed, an extensively populated menu bar with submenus, and a scattering of other commands and options embedded within the panels. This I-ATR tool was also designed primarily for developers of ATR technology, rather than for an image analyst.

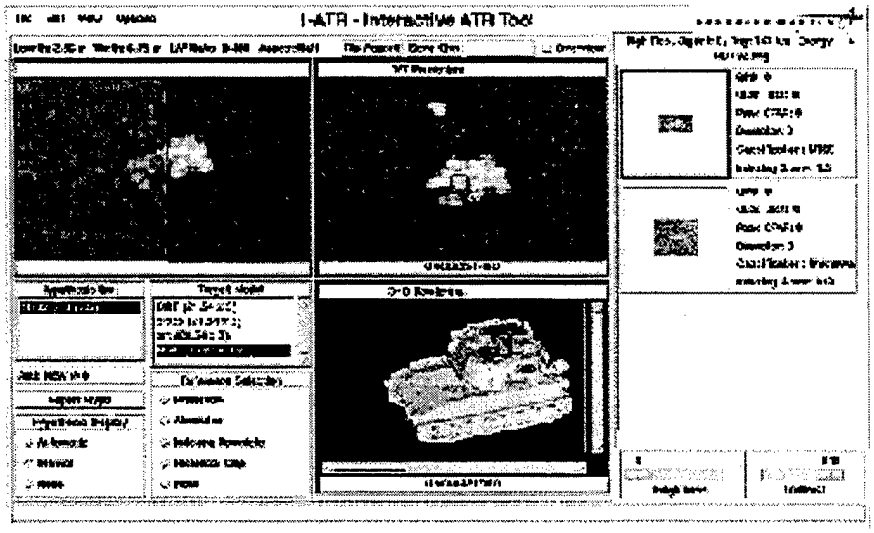


Fig. 17. Window-based Lens. Example of a developer-oriented window-based interactive-ATR user interface that is neither zoomable nor designed for an electronic sandbox.

InImEx is developing I-ATR tools for the image analyst, based on the Zoomable User Interface (ZUI) design paradigm and the electronic sandbox concept. While the target user and the interface are very different, the core functionality is similar to earlier SAR I-ATR tools. Typically, the analyst is looking at a single target vehicle in a recently collected SAR image. The I-ATR tool lets the analyst select a specific vehicle type, manipulate the state of that vehicle's model (orientation, turret angle, presence of external fuel tanks, etc.), and the analyst then sees a

predicted SAR image based on the specified model state. The analyst can interactively change the model state and compare predicted SAR images with the observed SAR image until the analyst is confident about his identification of that vehicle.

Exploitation problem domains that InImEx is addressing are installation and force monitoring (IFM) and wide area search for time critical targets (WAS/TCT). At various points during a particular exploitation effort, the IA will need to focus inward on specific vehicles and identify them. This is the point where the IA may chose to utilize an I-ATR tool to aid and speed up his work. I-ATR tools used at this point are just another part of the unified analyst workstation, so they are readily called up and provide familiar user interfaces consistent with the rest of the unified analyst workstation. All images within InImEx are warped so they are properly georegistered.

An I-ATR tool's functionality must match the needs of analysts with varying levels of experience in identifying vehicles. SAR IAs will typically have an initial idea of the category of a vehicle, if not an initial guess at the identification of the vehicle. For example, a modern Soviet-design main battle tank has a signature that can often be readily recognized. However, much more detailed analysis is required to determine the exact type of tank (e.g., T-72 vs. T-62). I-ATR tools can be invaluable to help the IA make this final decision. As another example, when a long gun barrel is visible, the vehicle category is narrowed down (e.g., tank or artillery), and then the analyst might use an I-ATR tool, such as an on-line recognition key, to quickly narrow the category down further. In practice, the MSTAR system will have processed and identified every vehicle in every image, so the analyst may generate his own initial identification (without the I-ATR aids) and then call up the MSTAR-generated identification, with explanatory displays such as an annotated display of MSTAR's guess at the vehicle state, and this display may provide sufficient additional information to help boost the IA's level of confidence in his identification. If not, the I-ATR tools can be used to explore different vehicle configurations until the IA is satisfied with his reasoning.

The I-ATR tools being developed within InImEx will be hosted inside a set of lenses. One lens will display a view of the 3D model, and will allow the model state to be changed by directly manipulating the model. Other associated lenses will show the predicted SAR image and extracted features. Selecting a feature will highlight the model facets that account for that feature, and selecting a model facet will highlight any associated features in the predicted SAR image. From any given model state, the IA can ask the MSTAR system to search for a better model state, and can watch the automatic search process via the lens displays. The IA can interrupt at any time, modify the model state, and have MSTAR resume the search process. In addition, the IA can take over control of some model state parameters, while letting the MSTAR system try to optimize the remaining parameters.

Figure 18 shows an initial lens that permits manipulation of the vehicle model state. Several I-ATR lenses (model state, predicted SAR image, extracted features, etc.) can be associated in different ways. All use techniques, still under development, for constructing *composite lenses.* A set of lenses can be associated by stacking them so they overlap. All the stacked lenses operate on one vehicle detection and one model state. A set of lenses can be associated by logical connections, called a locked set of lenses. For example, all lenses with a green marker

placed on the lens header are associated. Finally, a set of lenses can be docked, in which case they are physically abutting one another.

The target identification hypotheses generated by the MSTAR system are currently created off-line before the time that imagery is first ingested into the InImEx system. Depending on the specific system configuration and desired output, the MSTAR target identification system can require many minutes to process a single SAR image chip of a detected target. Some MSTAR functions run at speeds close to those needed for interactive uses and effort is being made to speed up some functions.

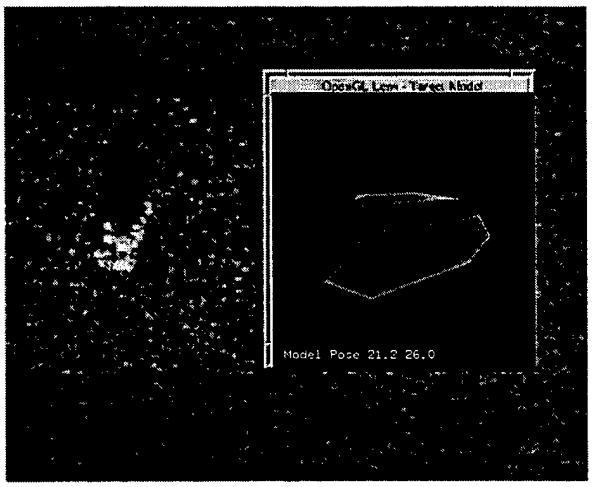


Fig. 18. Target Identification Model. Lens that displays an OpenGL rendered view of a vehicle model associated with a specific target identification. The user will be able to manipulate the hypothesized target model state and generate new predicted SAR images and MSTAR results for the modified model state.

One of the more striking and useful aspects of a lens is that different lenses can show different graphical representations of an object. The InImEx application domain contains many types of objects for which the user may want to see different visual representations at different times. For example, a set of lenses can provide different visual representations of a vehicle identification hypothesis, as shown in Figure 19.

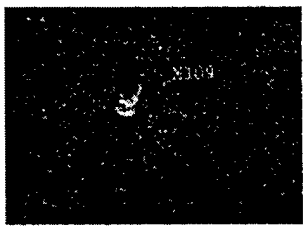


Figure 19(a).

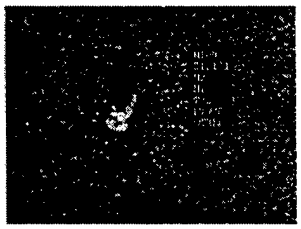


Figure 19(b).

Figure 19 (c)

Figure 19 (d)

Fig. 19(a-d). Vehicle Identification Hypothesis. This set of lenses provides different visual representations of the identification hypothesis data for vehicles.

The next section describes the methodology used in the human factors evaluation of the prototype InInEx system.

METHODOLOGY

Subjects

A total of five subject matter experts (SMEs) participated in the evaluation of the InImEx system and its user system interface. All five SMEs had significant experience performing intelligence analyst tasks, and four of the five are currently working as intelligence analysts at the National Air Intelligence Center at Wright-Patterson Air Force Base, OH. The fifth is currently retired from active intelligence analyst duties, after a 20+ year career in this field. One additional previous intelligence analyst also provided helpful comments in an informal review of the InImEx prototype system. This SME's comments are included among those listed in Appendix B.

Procedure

All subjects were provided a brief verbal introduction to the InImEx prototype system, including a description of its general purpose and functionality. Following this, all subjects stepped through the same sequence of being shown each individual InImEx function, manipulating the function themselves using a predefined intelligence scenario, and then evaluating its usefulness and the manner in which it was implemented. This standardized approach guaranteed that each subject was exposed to the same computer screens, in the same sequence. The entire interview questionnaire is provided in Appendix A to this report, along with a detailed description of the evaluation scenario.

The following standard two questions were asked for each InImEx function and were rated using the attached scale:

(1) "***Lens Function Identifier - Name of the Lens***": This lens function is important to the tasks to be performed by an image analyst.

```
1          2          3          4          5
+----------+----------+----------+----------+
Strongly Disagree          Neutral          Strongly Agree
```

Comments:_____

_____

_____

(2) The way in which this lens operates is appropriate for the function it performs.

```
1          2          3          4          5
+----------+----------+----------+----------+
```

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

This approach allowed both a standard quantitative assessment of each function, as well as the opportunity for all subjects to verbally explain their numerical ratings and provide suggestions for improvements. The entire interview session with each subject was videotaped for possible future reference. In addition, for certain selected InImEx functions, additional focused questions were asked of the subjects. Both the standard and the additional questions and their numerical average (mean) responses are reported in the Results section, below.

RESULTS

The quantitative results of the SME evaluations of the prototype InImEx system were entered into the STATISTICA data analysis software program and in MS Excel databases for data storage and analysis. Means and standard deviations of the responses for all five subjects to each of the individual questions were then determined.

The following provides the means of the quantitative ratings given by the SMEs for the questions related to their assessment of the overall InImEx prototype system and, subsequently, for each of the individual InImEx functional capabilities. The detailed verbal comments from the subjects for both their overall assessment of the prototype InImEx system and for each individual lens capability are provided in Appendix B. A large amount of quantitative and verbal data were collected during the interviews with the SMEs, although not every SME provided a rating for every question. The means reported below account for the fact that occasionally there were questions for which data were not provided. It is also important to remember that the version of InImEx being evaluated was only a preliminary prototype version.

The following rating scales were used for the "Overall Capabilities" questions, as appropriate for each question:

```
   1          2          3          4          5
   +----------+----------+----------+----------+
Strongly Disagree          Neutral          Strongly Agree
```

```
   1          2          3          4          5
   +----------+----------+----------+----------+
Poor                  Sufficient          Very Good
```

Quantitative Evaluation of <u>Overall</u> InImEx Capabilities:

1. Overall, how do you rate InImEx's potential as an Analytical Tool?

Mean Response = 3.4
Standard Deviation = 1.82

2. How does InImEx rate compared to other exploitation tools that you have used?

Mean Response = 2.8
Standard Deviation = 1.79

3. InImEx speeds up the time it takes to complete mission tasks.

Mean Response = 2.6
Standard Deviation = 1.14

4. InImEx improves my ability to perform my mission.

Mean Response = 2.6
Standard Deviation = 1.14

5. Overall, how do you rate the InImEx user-system interface?

Mean Response = 3.2
Standard Deviation = 1.64

6. Overall, InImEx has user-system interface controls and functions that are easy to understand and use?

Mean Response = 3.4
Standard Deviation = 1.34

7. The lens approach is effective and easy to use.

Mean Response = 3.2
Standard Deviation = 1.3

8. How do you rate the "zoom" functionality employed by InImEx?

Mean Response = 3.0
Standard Deviation = 1.58

9. There are too many lenses.

Mean Response = 4.2
Standard Deviation = 1.3

10. The amount of lenses should be decreased by combining lenses with like functions?

Mean Response = 4.8

Standard Deviation = 0.45

11. Should some of the lens functions be employed by mouse interactions instead? (For instance, would clicking on an image footprint with the mouse be more effective than pulling up a lens to turn on the pixel data?) YES = 1, NO = 0

Mean Response = 1.0
Standard Deviation = 0.00

12. Would a menu-bar to launch lenses be useful, instead of changing to a different screen to pick a lens? YES = 1, NO = 0

Mean Response = 0.6
Standard Deviation = .55

13. Would combining lenses, to reduce the overall number of them, be useful? YES = 1, NO = 0

Mean Response = 1.0
Standard Deviation = 0.00

14. Do any additional capabilities need to be added to InImEx? YES = 1, NO = 0

Mean Response = 1.0
Standard Deviation = 0.00

The following rating scale was used for all of the "Individual Capabilities" questions:

```
    1          2          3          4          5
    +----------+----------+----------+----------+
Strongly Disagree          Neutral          Strongly Agree
```

Evaluation of <u>Individual</u> InImEx Capabilities:

1. ***Site Lens***: This lens function is important to the tasks to be performed by an image analyst.

Mean Response = 4.6
Standard Deviation = .55

2. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 4.0
Standard Deviation = 1.00

3. I would rather have the raster and vector data automatically load the first time that I select a site.

Mean Response = 3.0
Standard Deviation = 1.87

4. ***InImEx Functionality Description:*** This function is important to understanding the tasks performed by an image analyst.

Mean Response = 4.4
Standard Deviation = .55

5. The way in which this capability operates is appropriate for the function it performs.

Mean Response = 4.2
Standard Deviation = .84

6. ***Toolbar/Lenses:*** This function is important to the tasks performed by an image analyst.

Mean Response = 5.0
Standard Deviation = 0.00

7. The way in which the Toolbar/Lenses function operates is appropriate for the function it performs.

Mean Response = 3.5
Standard Deviation = 1.00

8. ***Footprint Lens:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 4.0
Standard Deviation = 1.73

9. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 3.6
Standard Deviation = 1.52

10. ***Mensuration Lens:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 4.8
Standard Deviation = .45

11. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 3.4
Standard Deviation = 1.14

12. ***Image Layer View Lens:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 3.6
Standard Deviation = 1.67

13. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 3.4
Standard Deviation = 1.52

14. ***Target ID Lens – Zoom:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 4.6
Standard Deviation = .55

15. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 3.4
Standard Deviation = 1.34

16. ***Target ID Lens – Temporal Zoom:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 4.67
Standard Deviation = .58

17. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 4.0
Standard Deviation = 1.00

18. ***Target ID Lens – Detection:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 5.0
Standard Deviation = 0.00

19. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 4.75
Standard Deviation = .50

20. ***Target ID Lens – Best ID:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 3.6
Standard Deviation = 1.67

21. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 3.8
Standard Deviation = 1.64

22. ***Target ID Lens – ID List:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 4.0
Standard Deviation = 1.73

23. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 4.0
Standard Deviation = 1.73

24. ***Target ID Lens – Change ID:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 4.6
Standard Deviation = .55

25. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 3.6
Standard Deviation = 1.52

26. All of the Target ID Lenses should be kept separate.

Mean Response = 3.8
Standard Deviation = 1.79

27. ***Target Report lens – Graph:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 3.0
Standard Deviation = 1.22

28. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 2.6
Standard Deviation = 1.52

29. ***Target Report Lens – Table:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 3.2
Standard Deviation = 1.79

30. The way in which this lens operates is appropriate for the function it performs.

Mean Response =3.2
Standard Deviation = 1.79

31. ***Target Report Lens – Detail:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 2.4
Standard Deviation = 1.67

32. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 2.4
Standard Deviation = 1.67

33. ***Ground Truth Lens***: This lens function is important to the tasks performed by an image analyst.

Mean Response = 3.6
Standard Deviation = 1.52

34. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 4.0
Standard Deviation = 1.00

35. ***Target Model Lens:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 4.5
Standard Deviation = .58

36. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 4.0
Standard Deviation = 1.41

37. ***Site Model Lens:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 4.8
Standard Deviation = .45

38. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 4.5
Standard Deviation = .71

39. ***Reference Point Lens:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 4.6
Standard Deviation = .55

40. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 3.0
Standard Deviation = 1.83

41. ***Annotation Ink Lens:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 4.2
Standard Deviation = .84

42. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 3.25
Standard Deviation = 2.06

43. ***Annotation Shape Lens:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 4.2
Standard Deviation = 1.30

44. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 2.2

Standard Deviation = .84

45. ***Image Layer View Lens:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 2.0
Standard Deviation = 1.41

46. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 3.5
Standard Deviation = .71

47. ***Image View Lens – Single SAR:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 4.0
Standard Deviation = 1.22

48. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 3.6
Standard Deviation = 1.95

49. ***Image View Lens – Temporal:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 4.75
Standard Deviation = .50

50. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 4.25
Standard Deviation = .96

51. It is better to have both the ImageView Lens – Temporal and the Target ID Lens – Zoom Timeline (Temporal Zoom). Both of these lenses are needed.

Mean Response = 1.67

Standard Deviation = 1.15

52. ***Hyperlink creation/recall capability:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 4.2
Standard Deviation = .84

53. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 3.8
Standard Deviation = 1.10

54. ***Layer Controls Lens:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 4.2
Standard Deviation = .84

55. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 4.2
Standard Deviation = .84

56. ***Vector map lenses:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 4.2
Standard Deviation = .84

57. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 3.6
Standard Deviation = 1.14

58. ***Lens Merging Capability:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 4.2

Standard Deviation = .84

59. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 4.2
Standard Deviation = .84

60. ***Friendly Units Lens:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 3.0
Standard Deviation = 1.87

61. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 4.0
Standard Deviation = 1.22

62. ***Enemy Units Lens:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 4.8
Standard Deviation = .45

63. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 3.2
Standard Deviation = 1.64

64. ***Friendly Battlespace Lens:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 3.5
Standard Deviation = 1.73

65. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 3.2
Standard Deviation = 1.64

66. The Friendly Units Lens, the Enemy Units Lens, and the Friendly Battlespace Lens should be kept as separate lenses.

Mean Response = 3.6
Standard Deviation = 1.67

67. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 5.0
Standard Deviation = 0.00

68. ***Symbology Editing Lens:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 3.8
Standard Deviation = 1.64

69. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 2.4
Standard Deviation = .89

70. ***Image Control:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 4.6
Standard Deviation = .55

71. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 2.4
Standard Deviation = 1.67

72. I would prefer to have the software automatically center the cursor when I zoom in on an area

Mean Response = 5.0
Standard Deviation = 0.00

73. ***Navigation Portal Lens***: This lens function is important to the tasks performed by an image analyst.

Mean Response = 4.6
Standard Deviation = .55

74. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 3.6
Standard Deviation = 1.52

75. ***Teleportal Lens:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 4.4
Standard Deviation = .89

76. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 4.0
Standard Deviation = 1.41

77. ***Surface Portal Lens:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 3.2
Standard Deviation = 1.79

78. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 3.0
Standard Deviation = 1.22

79. ***Raster Map Layer View Lens:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 3.2
Standard Deviation = 1.30

80. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 2.8
Standard Deviation = .84

81. ***Image View Lens – Single Raster Map:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 3.4
Standard Deviation = .89

82. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 3.0
Standard Deviation = 1.58

83. ***Image View Lens – Single EO:*** This lens function is important to the tasks performed by an image analyst.

Mean Response = 3.6
Standard Deviation = 1.67

84. The way in which this lens operates is appropriate for the function it performs.

Mean Response = 2.6
Standard Deviation = 1.82

85. ***Reference Point Lens distance function:*** This function is important to the tasks performed by an image analyst.

Mean Response = 4.0
Standard Deviation = 1.22

86. The way in which this function operates is appropriate.

Mean Response = 3.4
Standard Deviation = 2.19

CONCLUSIONS AND RECOMMENDATIONS

Overall, the Intelligence Analyst subject matter experts who participated in the evaluation of the prototype InImEx system indicated that the functional capabilities and implementation approach of this system were potentially quite valuable and were well worth additional developmental effort. In particular, the use of a zoomable user interface (ZUI) made sense to them for analyzing graphic intelligence data and the concept of semantic zooming made the system more intuitive and, thus, easier to use. The following are the most common general observations and suggestions from the subject matter experts.

General InImEx Observations/Suggestions:

There should be a visual indicator, like an hourglass, to let the operator know when something is processing.

Zooming – Need a simple way to go from 1X to 2X to 8X (for example) in one step. There is no compelling requirement to have an infinitely incremental zooming capability. This takes more time for the system to redraw the picture at every level of zoom.

Centering – Need a one-step function to do "auto-centering."

Function keys – Suggest that consideration be given to selecting certain high usage functions and have these implemented as buttons vertically along the left side of the display. Auto-centering could be one of these buttons.

Image Viewing Lenses – It is too confusing to have so many related image viewing lenses. Suggest having just one image viewing lens, with a pull-down menu that gives easy access to options related to image viewing. The same comment applies to selecting and viewing the "target" lenses.

Need an "Undo" button on the screen, perhaps in the area along the left side of the display.

Recommend having single-button access to "Snapshot" major analysis results/products.

Need standard intelligence products that the system produces. Options for consideration include:

- Map depiction of geographic area with targets identified
- IPRs
- SUIPRs
- SIDs

Should be able to just click on an image and get standard "header" data, such as the creation date, coordinates, type of image, etc.

Need more use of standard computer terminology, such as cut, paste, copy, edit, etc.

The corners of the lenses, that are used for re-sizing, need to be marked. Not intuitive.

Combine lenses with similar functions. Some lenses have duplicate capabilities. Beside, there are just too many lenses.

Lenses should be combined, decreased to a manageable number and launched from a tool bar that is always present. Changing screens to look for the all of the lenses borders on ridiculous.

The lens functionality may have been taken to an extreme. Integration of other functionality would be make InImEx more capable.
Example: Give the capability to open an image by clicking the image outline square.
Having to use a footprint lens to open the image is overkill.

Annotations – This function gets confused as to whether it is annotating or moving the image.

Annotation – Needs undo function.

Single View Lens (Sticky Function) – Sticky should be moveable by moving window.
It works if you move the background, but not if you move the lens. It would be better to be able to move the sticky around for target/feature comparison.

Symbology Lens – Needs to give the capability to delete units symbols.

Annotation Shape Lens – Supposed to recognize only designated shape, but will identify every annotation whichever shape that was chosen to look for. It does not distinguish shapes like it is supposed to.

Footprint Box – Needs to show corners of image if outline falls within a red-square area.

Surface Portal Lens – Displays itself, inside itself. It was meant to provide a portal to everything except itself. This is an obvious mistake that detracts from its capability.

Target ID Lens – Doesn't always show target results. Works sometimes.

Target Report Lens – When sifting through a stack of images, the lens has to be moved from the image stack before they will update the image ID & other information.

Target Report Lens – Can't change between images with this lens; needs to be a capability.

Reference Points – There should be a Minimum & Maximum for these. They can be too big or small to be useful.

Temporal Zoom Lens – Pulling a different lens to the front causes an error.

Image View lens – When picking a stacked image to view, the lens doesn't refresh. It only refreshes itself when the operator physically moves the lens.

Target ID Lens (Zoom Timeline) – Called Target ID Lens (Zoom Timeline) in the tools menu, is called the Temporal Zoom Lens in the user guide. This can be confusing.

SUMMARY

Five highly skilled Intelligence Analysts participated in an assessment of the functionality and usability of the prototype **In**teractive **Ima**gery **Ex**ploitation (InImEx) prototype system. This was accomplished by first familiarizing the subject matter experts with the contents and mode of operation of this system, and then by having them quantitatively assess both the overall system and each of its functional capabilities. In addition, the verbal comments and suggestions from the subject matter experts were recorded.

The subject matter experts who participated in this evaluation generally liked the prototype InImEx system and they believed that there were many positive aspects of this system that make it well worth additional developmental effort. Overall, their response to the zoomable interface concept was quite positive, and they provided many detailed comments which should be considered in the next version of InImEx released for field testing.

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APPENDIX A

SURVEY QUESTIONNAIRE FOR INIMEX CAPABILITIES AND
USER-SYSTEM INTERFACE EVALUATION

AIR FORCE RESEARCH LABORATORY
AFRL/HECA
Wright-Patterson AFB, OH

This survey instrument explores the capabilities provided by a new Image Analyst (IA) soft copy exploitation workstation program, the Interactive Imagery Exploitation system (InImEx). InImEx is being developed to provide imagery/intelligence analysts with a new analytical toolkit, using a new type of user-system interface. The analytical capabilities are designed to be appropriate for IA functions performed by Advanced Synthetic Radar Aperture systems (ASARS), Electro-Optical (EO) systems, and other image exploitation systems. The new interface uses zoomable lenses rather than a menu system for implementing the analytical capabilities. The developers are very interested in your evaluation of this system and its user-system interface.

The purpose of this survey is to collect inputs from the eventual system users (i.e., IA's). These inputs will then be prioritized and cataloged such that they provide a quantitative feedback instrument to those organizations and personnel that are responsible for fielded equipment. The following survey instrument is based on a five point scale (when that scale applies) or no scale at all (when that is appropriate). The survey data will remain anonymous as to origin and authorship, providing you an unconstrained opportunity to make your preferences and concerns known. This is an excellent chance for you to impact the design of equipment you will operate in the future.

- -

EVALUATION OF INDIVIDUAL LENS CAPABILITIES

"Start" – Show SME Reviewer the US Overview Map. Set size and location for easy viewing

Review "Workspace" Control Functions & Mouse Buttons

Describe the Three Different Sites, Explain "Links," and Zoom in to Eglin using "Eglin: Overview" Link

Describe "Site Lens" / Have subject load Raster map

Show how to zoom, pan, and resize lenses using Site Lens

Zoom in and out to show different scales of maps

Close Site Lens (Mention to Subject – "Right Click any place on upper bar")

1. Site Lens: This lens function is important to the tasks to be performed by an image analyst.

```
1          2          3          4          5
+----------+----------+----------+----------+
Strongly Disagree          Neutral          Strongly Agree
```

Comments:_____

_____

_____

The way in which this lens operates is appropriate for the function it performs.

```
1          2          3          4          5
+----------+----------+----------+----------+
Strongly Disagree          Neutral          Strongly Agree
```

Comments:_____

_____

_____

I would rather have the raster and vector data automatically load the first time that I select a site.

```
1          2          3          4          5
+----------+----------+----------+----------+
Strongly Disagree          Neutral          Strongly Agree
```

Comments:_____

_____

_____

Zoom out to US Overview

Zoom in to Redstone Overview and Load Raster Map

Zoom to upper left wet of images (center screen display)

Bring up "Options"/ "Lenses Menu" to display "Lenses" on top bar

Display Lenses Menu (all 3 windows), close this, use Space Bar to bring up lens of Lenses

Give Overview of "Lenses"

Use "Zoom up One Level"

Zoom in on "Task Graph for WAS (Wide Area Search)" and Describe

Zoom up One Level & Select "All Tools by Categories"

Click on "Description", Allow Subject to read "Description" then close it ("Done")
Also show "Help" function

2. *Description:* This function is important to understanding the tasks performed by an image analyst.

1	2	3	4	5
Strongly Disagree		Neutral		Strongly Agree

Comments:_____
_____
_____

The way in which this capability operates is appropriate for the function it performs.

1	2	3	4	5
Strongly Disagree		Neutral		Strongly Agree

Comments:_____
_____
_____

3. *Toolbar/Lenses:* This function is important to the tasks performed by an image analyst.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

The way in which the Toolbar/Lenses function operates is appropriate for the function it performs.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

Select Footprint Lens

Use Footprint lens to select the eight images in upper left hand side of Redstone display

Explain the difference between red and green image squares

Move Footprint lens around

Click inside Footprint lens, but outside of images) to toggle raster map off

Close Footprint lens

4. Footprint: This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

Move upper left image to center of screen and zoom in on image (Medium zoom only – should still see left-most images of strip display

Select Target ID Lens – Zoom

Place lens over image – will see blue background, red #16

Zoom in on 16 targets and describe display at each level of detail

With tanks being displayed in detail (large size), bring up and discuss Mensuration Lens

5. Mensuration Lens: This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

Close Mensuration Lens

Zoom out and move to multiple target site at lower right corner of Redstone (last green image on right)

Zoom in on this image

Bring up Footprint Lens, toggle background global display to off, and select all green images

Close Footprint lens

Bring up Image Layer View Lens and pan across strip images along left side of site

Describe/discuss this lens

6. This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

Bring up Target ID Lens – Zoom and move this lens around over images

Show ability to move images up and down the stack

7. Target ID Lens – Zoom: This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

Close Target ID Lens – Zoom

Bring up Target ID Lens – Temporal Zoom (Zoom Timeline)

Place this lens over site and demonstrate/discuss this capability

8. Target ID Lens – Temporal Zoom: This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

Close Target ID Lens – Temporal Zoom

Bring up Target ID Lens – Detection

Zoom in to medium zoom (image layers cover screen) and describe/discuss capability

9. Target ID Lens – Detection: This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

Close Lens.....Bring up Target ID Lens – Best ID

Describe/discuss this lens

10. Target ID Lens – Best ID: This lens function is important to the tasks performed by an image analyst.

1	2	3	4	5
Strongly Disagree		Neutral		Strongly Agree

Comments:_____

_____

_____

The way in which this lens operates is appropriate for the function it performs.

1	2	3	4	5
Strongly Disagree		Neutral		Strongly Agree

Comments:_____

_____

_____

Close lens.....Bring up Target ID Lens – ID List

Describe/discuss this lens

11. Target ID Lens – ID List: This lens function is important to the tasks performed by an image analyst.

1	2	3	4	5
Strongly Disagree		Neutral		Strongly Agree

Comments:_____
_____
_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

Close this lens.....Bring up Target ID Lens – Change ID

Describe/discuss this lens

12. Target ID Lens – Change ID: This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

Close this lens.....Bring up Target Report Lens – Graph and zoom out until all image layers are viewable (** Note: Target Report Lenses sometimes have a problem and display a blank report)

Describe/discuss this lens

13. All of the Target ID Lenses should be kept separate.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

14. Target Report lens – Graph: This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

Close this lens and bring up Target Report lens – Table

Describe/discuss this lens

15. Target Report Lens – Table: This lens function is important to the tasks performed by an image analyst.

```
1          2          3          4          5
+----------+----------+----------+----------+
Strongly Disagree          Neutral          Strongly Agree
```

Comments:_____

_____

_____

The way in which this lens operates is appropriate for the function it performs.

```
1          2          3          4          5
+----------+----------+----------+----------+
Strongly Disagree          Neutral          Strongly Agree
```

Comments:_____

_____

_____

Close this lens and bring up Target Report Lens – Detail

Describe/discuss this lens

16. This lens function is important to the tasks performed by an image analyst.

```
1          2          3          4          5
+----------+----------+----------+----------+
Strongly Disagree          Neutral          Strongly Agree
```

Comments:_____

_____

_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

Close this lens

Bring up and describe Ground Truth Lens – see p. 44 of user's manual

17. Ground Truth Lens: This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

Close Ground Truth Lens

Bring up and describe function for Target Model Lens

18. Target Model Lens: This lens function is important to the tasks performed by an image analyst.

1	2	3	4	5
Strongly Disagree		Neutral		Strongly Agree

Comments:_____

_____

_____

The way in which this lens operates is appropriate for the function it performs.

1	2	3	4	5
Strongly Disagree		Neutral		Strongly Agree

Comments:_____

_____

_____

Close Target Model Lens

Bring up Site Model Lens

Describe/discuss function, but explain that no data are available in current version of InImEx (Note: Show picture from p. 39 of User's Manual)***

19. Site Model Lens: This lens function is important to the tasks performed by an image analyst.

1	2	3	4	5
Strongly Disagree		Neutral		Strongly Agree

Comments:_____

_____

_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

Close Site Model Lens

Bring up Reference Point Lens

Describe/discuss this lens

20. Reference Point: This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

Close this lens and bring up Annotation Ink Lens

Describe/discuss this lens

21. Annotation Ink Lens: This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments: _____

Close this lens and bring up Annotation Shape Lens

Describe/discuss this lens

22. Annotation Shape Lens: This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

Close this lens and bring up Image Layer View Lens

Describe/discuss this lens

23. Image Layer View Lens: This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

Close this lens and bring up Image View Lens – Single SAR

Describe/discuss this lens

24. Image View Lens – Single SAR: This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

Close this lens and bring up Image View Lens – Temporal

Describe/discuss this lens

25. Image View Lens – Temporal: This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

Bring up Target ID Lens – Zoom Timeline (Temporal Zoom) and compare capability versus Image View Lens - Temporal

26. It is better to have both the ImageView Lens – Temporal and the Target ID Lens – Zoom Timeline (Temporal Zoom). Both of these lenses are needed.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

Close these two lenses and bring up the Footprint lens. Click inside lens to turn raster map back on. Zoom out and center on Redstone hyperlinks. Zoom in on Redstone: Vehicle Alert on Monday, then Redstone: Activity last week. Bring up Target ID Lens – Temporal Zoom lens

Describe/discuss hyperlink creation/recall capability

27. Hyperlink creation/recall capability: This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

Click on US Overview: Overview

Click on Waterton: Overview

Use Site Lens to load both vector and raster map data

Click on Waterton: Site 1

Bring up Layer Controls Lens

Describe/discuss this lens (Load and show vector maps)

28. Layer Controls Lens: This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

Close Layer Controls Lens

Bring up Roads Lens, Built Up Areas Lens, and Hydro Lens

Describe/discuss vector map lenses and merging capability

29. Vector map lenses: This lens function is important to the tasks performed by an image analyst.

```
          1          2          3          4          5
          +----------+----------+----------+----------+
Strongly Disagree              Neutral              Strongly Agree
```

Comments:_____

_____

_____

The way in which this lens operates is appropriate for the function it performs.

```
          1          2          3          4          5
          +----------+----------+----------+----------+
Strongly Disagree              Neutral              Strongly Agree
```

Comments:_____

_____

_____

30. Lens Merging Capability: This lens function is important to the tasks performed by an image analyst.

```
          1          2          3          4          5
          +----------+----------+----------+----------+
Strongly Disagree              Neutral              Strongly Agree
```

Comments:_____
_____
_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

Bring up and demonstrate Friendly Units Lens

Bring up and demonstrate Enemy Units Lens

Bring up and demonstrate Friendly Battlespace Lens

31. Friendly Units Lens: This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

32. Enemy Units Lens: This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

33. Friendly Battlespace Lens: This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

34. The Friendly Units Lens, the Enemy Units Lens, and the Friendly Battlespace Lens should be kept as separate lenses.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

Bring up Symbology Editing Lens

Describe/discuss this lens

35. Symbology Editing Lens: This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

Bring up Teleportal Lens

Demonstrate/discuss this lens (** Note – This lens will be evaluated after going to the Eglin site)

Zoom out and switch to Site 2. Zoom in on area along bottom of Site 2 (Find "buttprints" area and zoom in close)

Bring up Bring up Image Control Lens and discuss

36. Image Control: This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

I would prefer to have the software automatically center the cursor when I zoom in on an area

1	2	3	4	5
Strongly Disagree		Neutral		Strongly Agree

Comments:_____

_____

_____

Close Image Control Lens

Zoom out to find and click on US Overview: Overview

Click on Eglin: Overview

Use Site lens to load raster maps

Bring up Footprint lens & display images in middle of site

Bring up Navigation Portal

Describe/discuss this lens

37. Navigation Portal Lens: This lens function is important to the tasks performed by an image analyst.

1	2	3	4	5
Strongly Disagree		Neutral		Strongly Agree

Comments:_____

_____

_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

Close Navigation Portal Lens

Demonstrate Teleportal Lens

38. Teleportal Lens: This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

Bring up Surface Portal

Demonstrate/discuss Surface Portal

39. Surface Portal Lens: This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

Bring up Raster map layer view lens

Display/describe/discuss capabilities accessed via right-button click in upper right hand corner of lens (Sticky, background, zoomable view, merge lenses)

Zoom in on area with overlapping images

40. Raster Map Layer View Lens: This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

Bring up Image View Lens – Single Raster map

Describe/discuss capability

41. Image View Lens – Single Raster Map: This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

Bring up Image View Lens – Single EO

Describe/discuss capability

42. Image View Lens – Single EO:

This lens function is important to the tasks performed by an image analyst.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

The way in which this lens operates is appropriate for the function it performs.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

Show distance function on Reference Point Lens

43. Reference Point Lens distance function: This function is important to the tasks performed by an image analyst.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____
_____
_____

The way in which this function operates is appropriate.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

_____

_____

GENERAL EVALUATION QUESTIONS:

The following questions are more general in nature and are designed to assess your *overall* reaction to the InImEx system. Please think carefully about your answers to these particular questions, since they will affect the overall InImEx development effort in the future.

- -

Overall, how do you rate InImEx's potential as an Analytical Tool?

1 2 3 4 5

+----------+----------+----------+----------+

Poor Sufficient Very Good

Comments:_____

How does InImEx rate compared to other exploitation tools that you have used?

1 2 3 4 5

+----------+----------+----------+----------+

Poor Sufficient Very Good

Comments:_____

InImEx speeds up the time it takes to complete mission tasks.

1 2 3 4 5

+----------+----------+----------+----------+

Strongly Disagree Neutral Strongly Agree

Comments:_____

InImEx improves my ability to perform my mission.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____

Overall, how do you rate the InImEx user-system interface?

1 2 3 4 5
+----------+----------+----------+----------+
Poor Sufficient Very Good

Comments:_____

Overall, InImEx has user-system interface controls and functions that are easy to understand and use?

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____

The lens approach is effective and easy to use.

1 2 3 4 5
+----------+----------+----------+----------+
Strongly Disagree Neutral Strongly Agree

Comments:_____

How do you rate the "zoom" functionality employed by InImEx?

1 2 3 4 5
+----------+----------+----------+----------+
Poor Sufficient Very Good

Comments:_____

There are too many lenses.

```
          1          2          3          4          5
          +----------+----------+----------+----------+
Strongly Disagree              Neutral              Strongly Agree
```

Comments:_____

The amount of lenses should be decreased by combining lenses with like functions?

```
          1          2          3          4          5
          +----------+----------+----------+----------+
Strongly Disagree              Neutral              Strongly Agree
```

Comments:_____

Should some of the lens functions be employed via mouse interactions by the user?
For instance, would clicking on an image footprint with the mouse be more effective than pulling up a lens just to turn on the pixel data?

YES **NO**

Comments:_____
_____
_____
_____

Would a menu-bar to launch lenses be useful, instead of changing to a different screen to pick a lens?

YES **NO**

Comments:_____
_____
_____
_____

Would combining lenses, to reduce the overall number of them, be useful?

YES NO

Comments:_____

_____

_____

_____

Do any additional capabilities need to be added to InImEx?

YES NO

Comments:_____

_____

_____

_____

APPENDIX B

INIMEX EVALUATION COMMENTS

Overall InImEx Assessment:

Overall Assessment - Potential of InImEx as an Analytical Tool	JM: [Inimex is] on the right track. Some capabilities are good e.g. Target ID, Modeling. Reference point (distance/angle) needs to be integrated with mensuration. EH: Easy to work with and understand. AA: Some of the functionality was limited.
InImEx compared to Other Exploitation Tools	JM: Need to be able to load imagery rapidly for P1. As good as any P2 tool currently available. AA: I was unable to test annotation and report preparation.
Speeds up Completion of Exploitation Tasks	JM: Probably not that good for p1 exploitation PW: Slowest, most cumbersome system I have ever used. EH: Too much time is spent zooming in and out for different areas. AA: Time is irrelevant to my mission tasks.
Improves Ability to Perform Mission	JM: Has potential, particularly for detailed (Phase 2, 3) analysis EH: Needs more exploitation capabilities.
User-System Interface	EH: Need an hourglass or similar display to show that the system is still working when processes are going on in the background and the display isn't changing. AA: I would prefer tool bars, but several lenses would complement the bars.
Controls	AA: With more experience and familiarity, they would become easier.
Lens Approach	JM: Took some time to get used to. AA: Lens approach is very good for visualizing multiple data elements (i.e., terrain maps imagery).
Zoom Functionality	JM: Unique EH: Takes to much time. AA: Zoom was smooth.
Too Many Lenses?	JM: Many different ways to do the same thing, Can some be consolidated? AA: An imagery analyst should be able to reduce the number of lenses pertaining to their tasks. AA: Several lenses should be sufficient.
Use Direct Mouse Click Instead of Selecting Lens?	JM: Direct manipulation would be better (for instance, the loading of imagery data).

Use Menu Bar to Launch Instead of Changing Screens to Select a Lens?	PW: Most Functions should be chosen by pull down menus, tool bars, etc. EH: If the lenses were combined, there would be less confusion on the menu screen, making it easier to use. AA: Prefer menu bar.
Would Combining Lenses be Better?	PW: The whole idea of lenses, covering only part of the image is bogus and time consuming. It would be much better if functions could be picked (or toggled) off a menu and applied to the entire image automatically. AA: Similar function lenses can be combined.
Additional Capabilities	JM: Yes – save file, print, reference-hyperlink needs to be expanded PW: Side by side change detection, annotations – circles, squares, text, etc., more mensuration functions, stereo viewing, simultaneous viewing of overview and close up images. Better, more comprehensive enhancement functions. – In short this a bad piece of software, the lenses, far from decluttering information, causes a form of tunnel vision which prevents enough information being seen at one time to permit the analyst to integrate it mentally! I have been exposed to many types of image manipulating software. Every one has been more logically thought out than this. Lenses are the wrong approach. I hope this program never comes into my S&T imagery shop. WN: More robust mensuration and image enhancement/manipulation tools are needed. AA: Need to have access to imagery keys of targets (i.e., tanks, aircraft). Need to incorporate a semi-automatic or assisted reporting function (i.e., generate target lists, coordinates, descriptions from the ATR nominations).

EVALUATION OF INDIVIDUAL LENSES:

Site Lens	JM: Depending on the size of the image, it helps to readily identify an image. Have a preferences setting that will set to automatically load [raster and vector data], if so desired. PW: Menu commands – load vector map, load raster map – would be better. Need scale on map (e.g. radius of coverage =35 nm ...) EH: Suggest preloading raster map when the analyst initially goes to a site. WN: Would like some basic data loaded automatically, such as name of site, BE number, etc. AA: Difficult to see hyperlink text. When zoomed, color was lost in the clutter. Rather than automatically loading the raster and vector data automatically the first time I select a site, I prefer the control offered in the current version.

Lenses Menu	JM: Too many options, liked that they were arranged by category, would also like to see it sub categorized by task like the task WAS. Should have color coding for categories. Should become easy to use once familiar with it. PW: Task graph is too generic, may be useful for training on prototype examples. Grouping is nice, need boxes around groups and heading titles for categories. You don't know what lenses are currently active. You can't close lenses from the lenses menu. EH: Especially useful for new people. Should "snap" to selected item instead of zooming, which is too small to see well. AA: How about using icons here? The current labels are not sufficiently descriptive; prefer either icons or an alternate terminology to reference capabilities.
Footprint Lens	JM: If viewer loaded automatically (i.e., without the lens), it would be more helpful PW: Don't like that you have to use a lens. There is no feedback through the lens (i.e., you can't see the image below it). Need feedback about what is on or off. Direct access via workspace would be better. Want dynamic resizing of lens and capability to auto center on mouse would be nice. EH: Should change color to indicate that the square has been highlighted. AA: Very good. Gives coverage available; relatively intuitive, selection is very easy.
Mensuration Lens	JM: Helps in identification, needs to be reliable. Really cool. PW: Function is very important for NAIC. Lens should be entire screen. Need reset capability (clear function) Lens adds a step. Need to be able to zoom inside the lens. Fonts get too big when you zoom. Lens and function of lens is lost when you pan. EH: Need more complex, sophisticated graphics display capability; more complex geometry (lines and angles), such as S&T Graphics. WN: Need to change line width based on zoom level. AA: Mensuration is very important; but current implementation is clumsy to use; need drag/drop/delete functions.
Target ID Lens – Zoom	JM: Do it all in the same lens to switch between frames/images PW: If ATR worked (i.e., accurate and reliable) it would be great. Like the idea of more levels of detail as you zoom in. Lens itself (like others) gets in the way. Okay if you need to restrict computational area (for ATR), otherwise lens is not needed. EH: Should incorporate ability to change image layers. AA: ***Very good. Bar graphs are useful. Some of the data are not useful or believable. Viewed as confusion table...attaching numbers does not add much. *** Check with AA on these comments *****
Target ID Lens – Zoom Timeline (Temporal	JM: Like a lot better than others so far. User friendly. PW: Mission critical – need to look at two side by side images

Timeline)	for change detection. Need registered crosshair to act as placeholders/location cues on two images simultaneously. Pretty good – best idea so far. EH: As compared to Image View Lens – Temporal, just need one, not both. A pull-down menu should offer the option of viewing ATR data or not. WN: Why have both Target ID Lens – Zoom Timeline (Temporal Zoom) and Image View Lens – Temporal? Should combine these two and have ATR data selectable from a pull-down menu. Should be able to zoom the image within the Target ID Lens – Zoom Timeline (Temporal Zoom) and not change the lens size. AA: Useful to have timeline capability. Still need all available dates to be viewable, perhaps in a side bar. Merge functionality where you can, such as target ATR info "on/off."
Target ID Lens – Detection	JM: Good if it can rule out non-targets (i.e., minimize false alarms). Skeptical (it can do so accurately). Would be useful if it could categorize: Tanks, PACs, Artillery, Sam … AA: Very smooth. Prefer to have zooming presets (2X, 4X, 8X) – a zoomable magnifying glass.
Target ID Lens – Best ID	JM: False readings/report could lead you down the wrong path – If the system is really accurate then it would be great to have. PW: Redundant with target ID – Zoom. Fonts get too small at far out zoom levels. Would like to see text remain a fixed size. Would be better to have a [textual] list of items with hyperlinks to targets.
Target ID Lens – ID List	JM: It would be really neat if you could click on the guess (e.g. T72) and get a model. AA: Liked better as zoom lens (slow).
Target ID Lens – Change ID	JM: Designate capability would be helpful/useful. Need to link to Annotation. Maybe okay for 2nd/3rd phase report. Reports only have identification (not guesses) PW: Would save an analyst the time of typing or writing on a tally sheet. Don't like the lenses because they are restricting/cumbersome to maneuver. Set levels of magnification are definitely needed (i.e. pixels in image to pixels on screen where 1:1 is optimal. AA: Have it linked on annotation so the name gets annotated with the analyst's description.
Target Report Lens – Graph	JM: Okay, but you really want to report the Analyst's designation – need a human interface for validation PW: There's got to be a better way than putting the graph inside a lens. EH: Keep the display with green boxes for when the operator is zoomed out. Should display full report initially; it started off too small to be useful. Need to consider adding more user preference capabilities. AA: Tied to ATR. Should be kept separate; don't like to see reports generated from the ATR.

Target Report Lens – Table	JM: Like tabular format better [than graph] – more like how actual reports are formatted. PW: Poorest implementation of lenses so far. Hyperlink to document or icons, etc would be better. EH: Display started off too small. AA: If there were large numbers of targets, then the table would be better than the graph. Can directly compare with Order of Battle report.
Target Report Lens – Detail	JM: Not much use in reporting, Needs to be confirmed by analyst EH: Not something used very often. Need to change initial display size to be more easily readable. AA: Not very useful.
Ground Truth Lens	JM: Great to incorporate such information however, doing so is manpower intensive and time consuming. Useful but probably not practical. PW: Extraordinarily useful. EH: Not useful for moving targets. AA: Would rather see Ground Truth on side bar along with meta-data. (line drawings on photographs, etc.). Would like a hyperlink to Jane's Guide. Don't really expect to have much Ground Truth data.
Target Model Lens	JM: Softcopy modeling would be very useful. PW: Nice to have, interface is cumbersome EH: It would be nice to overlay target model on the actual target, with the ability to change target zoom level, orientation, etc. AA: Very good for identifying radar cross sections (high reflectivity, etc.).
Site Model Lens	JM: Need to be annotated graphic overlay AA: Very useful to determine desired area and targets.
Reference Point Lens	PW: Good for describing location of target objects. Implementation is useless because you can't center things and there is no way to control the exact location of the reference. EH: Should erase full name to start typing on far left – currently, leaves "Reference Point.xxx" on typing line. Should appear where the cursor is placed. Should be able to resize and change colors. AA: Very important. Would like to be able to place (drag/drop) the reference point.
Annotation Ink Lens	PW: Mission critical, can't do job without [annotation]. Need to interact directly with shapes/icons. Sloppy to do freehand – useless EH: Don't need freehand drawing capability. Would like user selectable shapes for each separate target/area. Where is the eraser? Should be able to save the annotation whenever the operator wants to. AA: Would rather have a palette of annotations to choose from.
Annotation Shape Lens	JM: Annotation of text, lines and shapes (esp. squares) is important in P1, 2 and 3. Important that it is easy to do. Save

	and print capabilities are needed PW: It is awkward because your annotation cannot directly control shapes. WN: Need the ability to create multiple shapes. AA: Suggest combining INK and Shape lenses. Put on single palette of shapes than user can choose from.
Image Layer View Lens	JM: Toggle on/off rather than using a lens would be more useful. PW: Inability to zoom/pan inside of lenses is very bad. Can't tell which image you are looking at because there is no labeling of images. Not much value. EH: May not be necessary. Why not just have the images displayed all the time? WN: Not sure what this lens is supposed to do. AA: Should bring up image meta-data. Put in side bar.
Image View Lens – Single SAR	PW: It is mission critical to compare different images side by side or overlaid for change detection. No feedback as to which image you are looking at. Extremely awkward. AA: Best way to select images is to select then click it.
Image View Lens – Temporal	AA: Would like to see image data-data on side bar.
Hyperlink	PW: very convenient. Fonts disappear at large zoom settings. Need to remember where you put them. Perhaps a separate list of hyperlinks would be useful. Awkward to have them on the map. WN: Should also zoom in addition to changing the geographic area. Should also display data about the image (e.g., date created, etc.)
Layer Controls Lens	JM: Not much need to use it PW: Very useful for typical imagery analysis – Not so much for S&T. Toolbar would be better – took lens off of image and worked with it as if it was a toolbar. AA: Good for trafficability analysis. Should consider capability to select all images and look at them locally or globally.
Vector Map Lenses	JM: Usefulness depends on task: roads would be useful, hydro and land cover are not essential PW: need legend for color codes. No un-merge capability. Redundant with Image Layer control lens. EH: Don't need the separate lenses; just one lens with pull-down menu on individual vector maps. AA: Easy to operate.
Friendly/Enemy Units Battlespace Lenses	JM: Demarcation lines are too dynamic to have friendly battlespace lines. Enemy units lens is much more useful than friendlies PW: Dangerous. Could miss enemy sites if you don't make it global. Using the lens gives you a tunnel vision view of the image and hides data beyond the bounds of the lens. Font size is too small at far out zooms – should rather have text stay a constant size at any magnification. Like the ability to zoom in where the cursor is. Should be an option to keep them as separate lenses. EH: Might be quite useful to other types of analysts. Would like

	to see just one lens with a pull-down menu for the various display options. AA: Very important in a dynamic battlefield situation.
Symbology Editing Lens	JM: Need drag and drop capability. PW: Name on lens gets too small at far out zooms. Why move all symbology to put down one. Symbology on lens blocks image as you move over it. No grab/move capability. Drag/drop would be better. No ability to update. EH: Need to be able to change the text and to move objects. WN: Need the ability to change identifier names and to change display size. Suggest having a whole toolbox of drag and drop items for symbology editing. AA: Need drag & drop capability to place symbols.
Image Control Lens	JM: Definitely need. PW: Brightness and contrast are relatively crude enhancements-need more. Image control is mission essential. Minimally need brightness, contrast, darkness, and sharpness control. EH: Need more controls (e.g., sharpness, rotation, angle of view, etc.). WN: Need a full toolkit for image control (e.g., rotate, etc.) like ELT700 or DIEPS. AA: Very important.
Navigation Portal	JM: Need to know where you are. Want to also know where you have already been. PW: Invaluable to getting the big picture/overview. Would be nice to be able to move around using the navigation teleportal and have the main screen slaved to the portal. Shouldn't have a portal inside a portal. One of the more useful lenses in the whole program – serves as a good overview. WN: What is the difference between the Teleportal Lens and the Navigation Portal. Need to rethink what is really needed and the best way to display it. AA: Cursor point to location.... Too cumbersome.
Teleportal Lens	PW: Change detection is mission critical. Capability to put teleportal and main screen side by side would be nice for change detection. Good to do chronological comparisons – crude first step to having a change detection program.
Surface Portal Lens	PW: Why have a surface portal if its functions are encompassed in a teleportal? Portals should not show themselves – it blocks data within the portal. EH: Do not show this within itself. WN: Should not display itself within itself.
Raster Map Layer View Lens	PW: Some usefulness to see map underneath image. Should be able to quickly toggle lenses on and off. EH: It might be nice to see image data through the raster map data (i.e., to see both at the same time). WN: Background "clear/fill" didn't do anything. AA: Very powerful for looking at ground features. Rather have one fade to the other (raster → imagery, or toggle).

Image View Lens - Single Rastermap	PW: Lets you look through several layers of data. Simpler just to toggle raster maps. Awkward to use. EH: Not useful to me, but might be to another analyst. WN: Should identify type of map --- more descriptive information than just "top, 2nd from top, 3rd from top", etc. AA: Not intuitive what resolution you are going to get.
Image View Lens - Single EO	JM: Concept of multiple Images/EO Radar etc. presented together is new – may be useful to single out specific images PW: I see no function in this whatsoever. Toggle rastermap off would be a little more useful as a wide area indicator of where EO imagery is, Would be better if it showed all EO images, not just one. WN: Could not display most of the image squares. Why only one square at a time? Difference between large image squares and smaller green (layered) squares?
Reference Point Lens	PW: Can't control where reference point is placed, so what good is it? Need drag/drop to place reference point. AA: Allows you to reorient large sites. Need to be able to drag and drop. Need to tie in with mensuration (distance).