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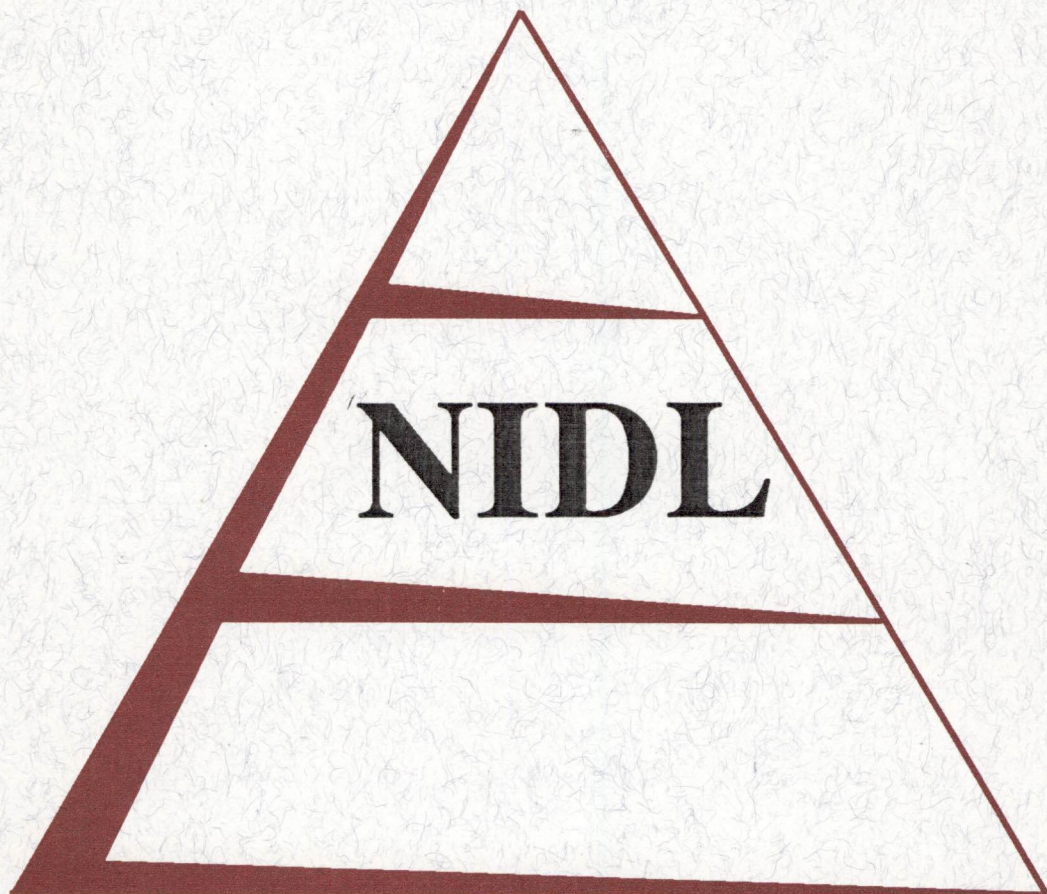
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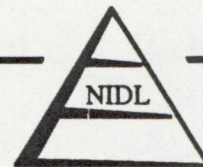
National Information Display Laboratory



SOFTCOPY REVIEW

January 22-23, 1992

Princeton, New Jersey



**The National Information Display Laboratory
Softcopy Review**

Welcome/Administrative Items

Curt Carlson

January 22, 1992



WELCOME

to the

National Information Display Laboratory

Softcopy Review

Dr. Curtis R. Carlson
Director, NIDL

January 22, 1992

E1



The National Information Display Laboratory

Softcopy Review Agenda

January 22, 1992

7:30 AM	Registration/Refreshments	
8:30 AM	Welcome/Administrative Items	Curt Carlson
8:45 AM	National Laboratory Concept/Partnering	Sam Grant/Curt Shaffer
9:00 AM	NIDL Introduction	Curt Carlson
9:30 AM	Keynote: R&D in the Intelligence World	Bob Herd, Director, ORD
10:00 AM	Break	
10:15 AM	The Future: What We Could Do; What We Should Do	Vic Leonard, Boeing Space Research
10:45 AM	Tactical Command & Control Requirements	David Usechak, JSTARS
11:15 AM	JNIDS Methodology and NIDL Initiatives	Lt. Kevin Williams, JNIDS
11:45 AM	Lunch - Poster/Demo Sessions	

E2



The National Information Display Laboratory Softcopy Review Agenda

January 22, 1992 (Con't.)

12:45 PM	Information Processing, User Support	Norm Winarsky
1:20 PM	Image Change Detection	Padmanabhan Anandan
1:50 PM	The Importance of Imaging Standards	Mike Isnardi
2:20 PM	Break	
2:30 PM	Analyzing Local Structure in Images	Prof. Edward (Ted) Adelson, MIT
3:00 PM	Algorithm Understanding Laboratory	Curt Carlson
3:30 PM	Interactive 3D Data Visualization	Herb Taylor
4:00 PM	Implications of Virtual Reality	H. Taylor/A. Firester/ N. Winarsky
5:00 PM	Demonstrations (5:00 - 6:50 PM)	
7:00 PM	Reception and Dinner - Ramada Hotel	

E3



The National Information Display Laboratory Softcopy Review Agenda

January 23, 1992

8:00 AM	Registration	
8:20 AM	Welcome	Curt Carlson
8:30 AM	The National Exploitation Laboratory - NEL	Art Cobb, NEL
9:00 AM	Display Technology and User Support	Art Firester
9:30 AM	Display Evaluation and Certification	Phil Heyman
10:00 AM	Application of Visual Models to Display Eval.	Bob Amantea
10:30 AM	Break	
10:45 AM	Softcopy Quality Control	Dave Patterson
11:15 AM	EL Displays	P. Niel Yocom
11:45 AM	Lunch - Poster/Demo Sessions	
12:45 PM	Seamless Tiling for Large Panel Displays	Gerry Alphonse
1:15 PM	Future Directions for EL Displays	Chris King, Planar
1:45 PM	Applications of High Performance Monitors	Thomas Goliash, Stan Kriz, AVP/MegaScan
2:15 PM	Conclusion	Curt Carlson
2:30 PM	Open Sessions (2:30 PM - 4:00 PM)	
2:30 PM	Demonstrations (2:30 PM - 4:25 PM)	

E4



The National Information Display Laboratory Softcopy Review

ADMINISTRATIVE INFORMATION

- Security
- Badges
- Telephones
- Message Center
- Address Card
- Evaluation Form
- Technology Demonstrations
- Reception and Entertainment

E5



August Review Evaluations

DSRC TALKS:	Quality of Presentation (1 to 4)	Matched Your Interest (0 or 1)
NIDL Introduction	3.00	0.96
Invited Talk: HDTV	3.18	0.89
NIDL Tasks	2.96	1.00
Softcopy Technology	3.00	0.97
Navy User Support	2.70	0.79
Softcopy Keys & Guides: Interactive Search	2.72	0.86
Multispectral and Subpixel Processing on the PE	2.78	0.83
Extraction of Signal from Noise	3.07	0.68
Display Technology	3.31	0.96
Display Evaluation and Certification	3.12	0.97
Open Discussion on Government/Industry Needs	2.80	0.96
Display System Simulator	3.19	0.88
High Brightness CRT Monitor	3.52	0.85
Novel Displays	2.44	0.88
CRT Monitor Standards	2.55	0.90
AVERAGE	2.96	0.89

E6



August Review Evaluations

	Quality of Presentation	Matched Your Interest
GOVERNMENT TALKS:		
National Laboratory Concept/Partnering	2.96	1.00
Imagery Support to Naval Strike Operations	3.38	0.90
Global Change and EOS Processing Requirements/USGS	2.85	0.66
Need for Standards in Intelligence Comm. Workstations	2.73	0.87
AVERAGE	2.98	0.86

OTHER OUTSIDE SPEAKERS:

Computerized Medical Imaging	3.33	0.74
Architecture & Tech. in the 90's	3.18	0.91
Volumetric Rendering	2.95	0.59
AVERAGE	3.16	0.75

DEMONSTRATIONS:

Princeton Engine	3.07	0.93
Multispectral Data Browsing/Compression	3.13	0.82
Communications	2.71	0.82
Display System Simulator	3.29	0.88
Display Evaluation/Certification Facility	2.86	0.81
Zero Spot Growth CRT System	3.11	0.60
AVERAGE	3.03	0.81

E7

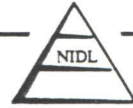


August Review Evaluations

... we listen to and appreciate your comments ...

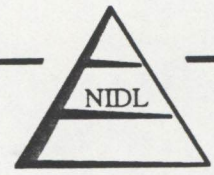
- User needs
- Partners
- NIDL and Sarnoff
- Technology
- Strategic direction
- Conference process

E8



National Information Display Laboratory Softcopy Review

- **The next NIDL Softcopy Review will be on the 12th and 13th of August 1992**
- **The NML Review will be on the 29th and 30th of January in Boulder, Colorado**
- **We look forward to seeing you**



**The National Information Display Laboratory
Softcopy Review**

Partnerships
... making the National Lab concept work for you ...

Curt Shaffer

January 22, 1992



Partnerships

... making the National Lab concept work for you ...

Curt Shaffer

January 22, 1992

H1



Selecting a Technology

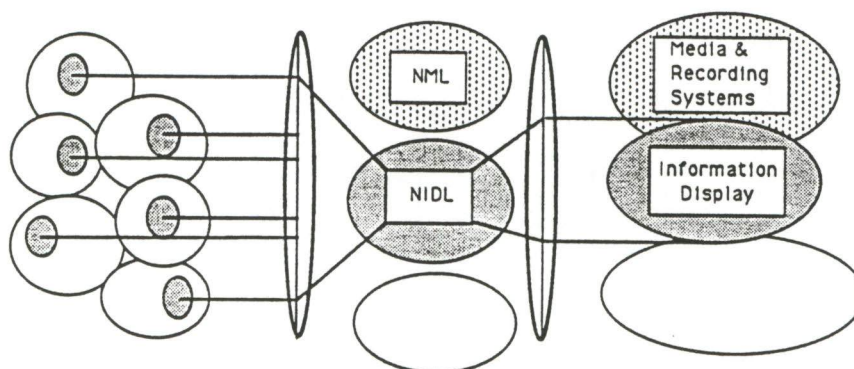
- Broad critical government application/need
- Large industry and commercial base, also universities
- Government requirements ahead of commercial product performance
- Emphasis on new science

H2



The Center of Excellence Concept

... focusing the resources of Industry onto User's needs ...



Government Users

- Users & Developers of Technology
 - Program Offices
 - R&D Groups
- Core technologies, essential to success of program

Centers of Excellence

- Focus
- Leverage
- Standards
- Continuity
- User Support

Industry

- Commercial Manufacturers
- R&D Centers
- System Developers
- Universities

H3



National Lab Business Strategy

... developing programs with overwhelming value ...

- Work with users to determine needs
- Begin "seed" program
- Seek partners with world leading capabilities
 - Government, Industry and Universities
- Develop programs that provide:
 - User satisfaction
 - Revolutionary Improvements
 - Path to commercialization

H4



Selecting a Lab Host

- Broad resource base
- Industry leader (capital invested, record of quality, projected IR&D, manufacturing technology)
- Management philosophy -- independent, innovative
- Pro-active team leader
- National and/or world recognition of excellence
- Government and commercial base established

H5



Partner

- Common technology interest (current or planned)
- User or user representative
- Joint investment (dollars or resources)
- Help establish government requirements
- Part "ownership"
- Part control
- Long term relationship

H6



User

- Government or industry
- Common technology interest
- Application level of technological research
- Base for OPS analysis
- Requirement source
- Test and evaluation participation

H7

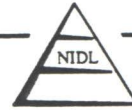


Getting Started with Industry

... how we can begin to build new partnerships ...

- Express interest and make contact
- Review and assess government requirements
- Compare current and future product lines
- Identify desirable research plan
- Define value added to/from National Lab
- Establish agreement with government sponsors
- Develop detailed joint agreements among industry partners

H8

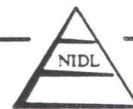


Getting Started with Government

... how we can begin to build new partnerships ...

- Express interest and make contact
- Compare strategic directions and issues
- Participate in joint program/project level discussions
- Identify any immediate OPS support needs
- Joint on-going research
- Create broadly based new programs
- Extend the partnership

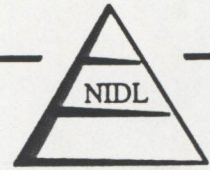
H9



Advantages for Partners

- Joint communication forum (Government and Industry)
- Improved ROI/leverage
- Best in the industry
- Diversity of technical views/approaches
- Consolidated access to requirements
- Sustained services
- Focused industry/academic research

H10



The National Information Display Laboratory Softcopy Review

Introduction

Curt Carlson

January 22, 1992



INTRODUCTION

to the

National Information Display Laboratory

Dr. Curtis R. Carlson
Director, NIDL

January 22, 1992

E10



Outline

- **Government needs**
- **NIDL concept**
- **World technology trends**
- **NIDL strategic technologies**
- **NIDL highlights**
- **Conclusion**

E11



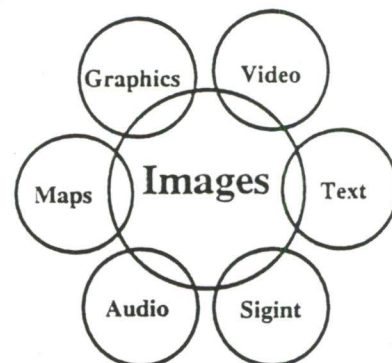
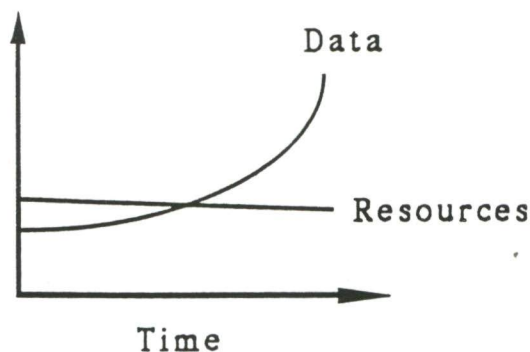
Government Needs and the NIDL Concept

E12



Government Information Needs

*... rapidly exploiting and
disseminating all critical information ...*



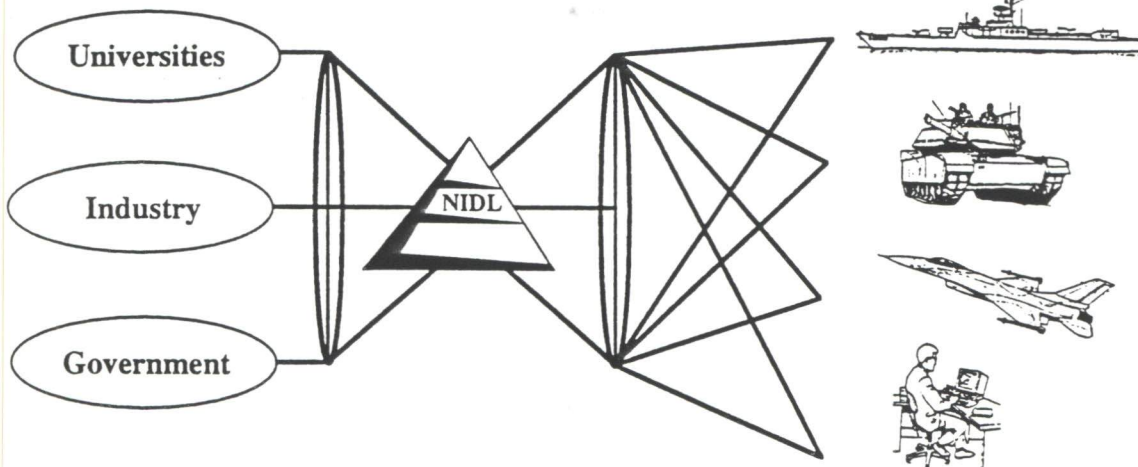
- Rapidly changing roles and responsibilities
- Increasingly diverse users
- Increasing data types

E13



The Concept

*... focusing the resources of
Government, Industry and Academia onto User's needs ...*

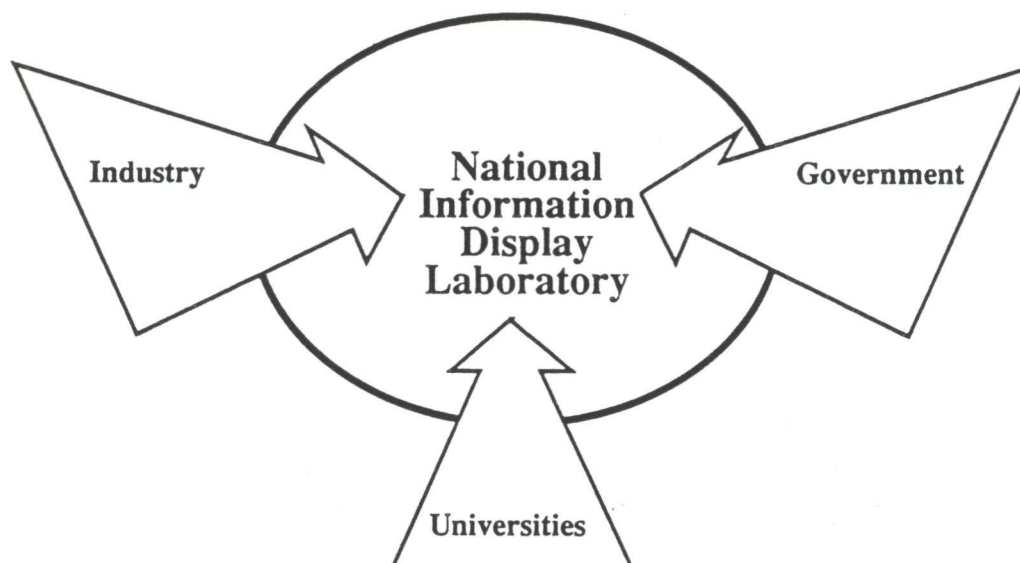


E14



NIDL "Distribute" Laboratory

... combining resources of Government, Industry, and Academia ...



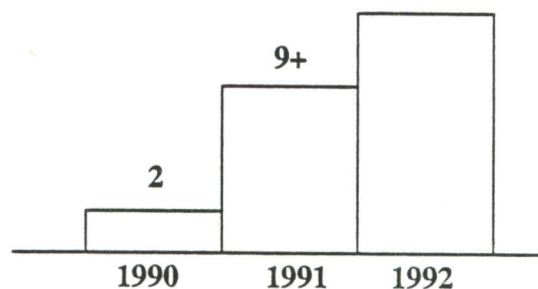
E15



Partners and Users

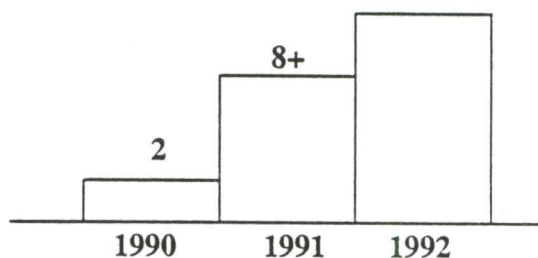
- **Government Partners and Users**

- Air Force
- Navy OP 94
- USGS
- JNIDS
- OSTP
- NEL



- **Industry & Academia Partners**

- Princeton University
- MIT
- Texas Tech
- Planar
- RCA/TCE
- DTI -AVP/MegaScan

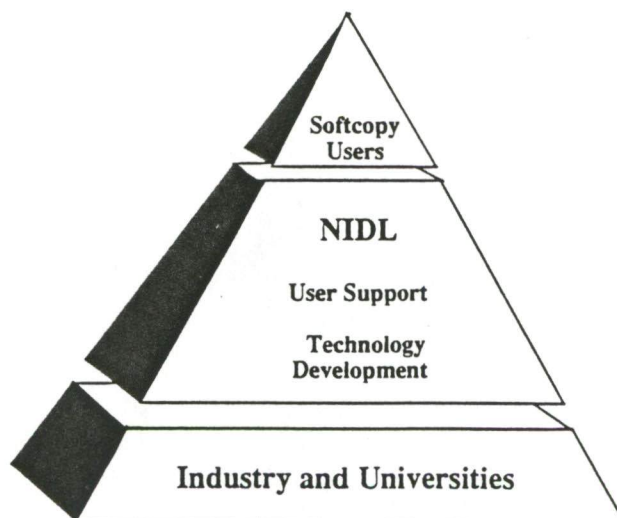


E16



National Information Display Laboratory

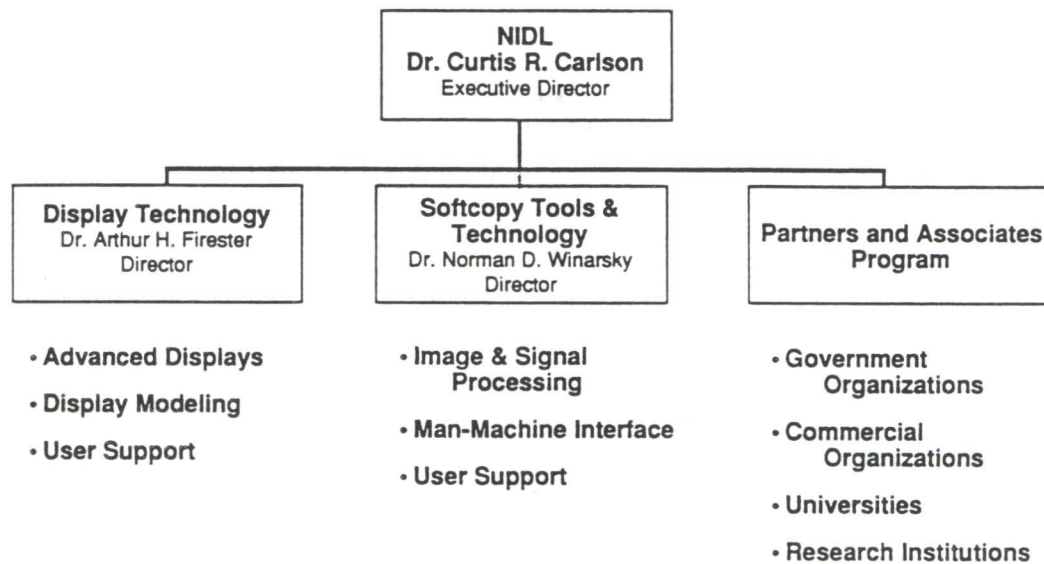
... a Center of Excellence for Softcopy technology ...



E17



NIDL Organization



E18



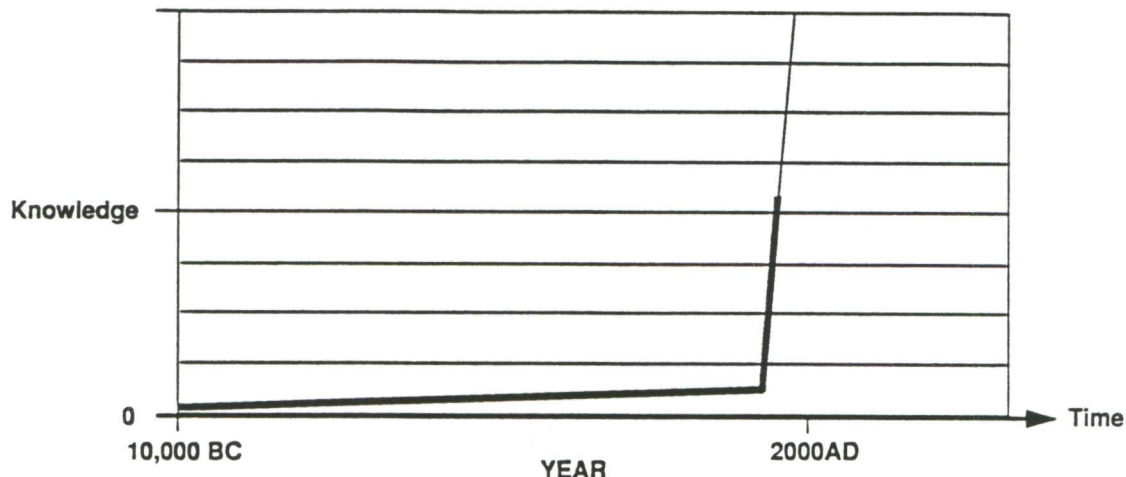
World Technology Trends

E19



The Information Explosion

*... approximately 90% of all knowledge
was generated in the past 35 years:
It will double again in the next 10 - 15 years ...*



Source D.B. Merrifield: U.S. Department of Commerce

E20



The Importance of Images

*... one of the keys for managing
the information explosion ...*

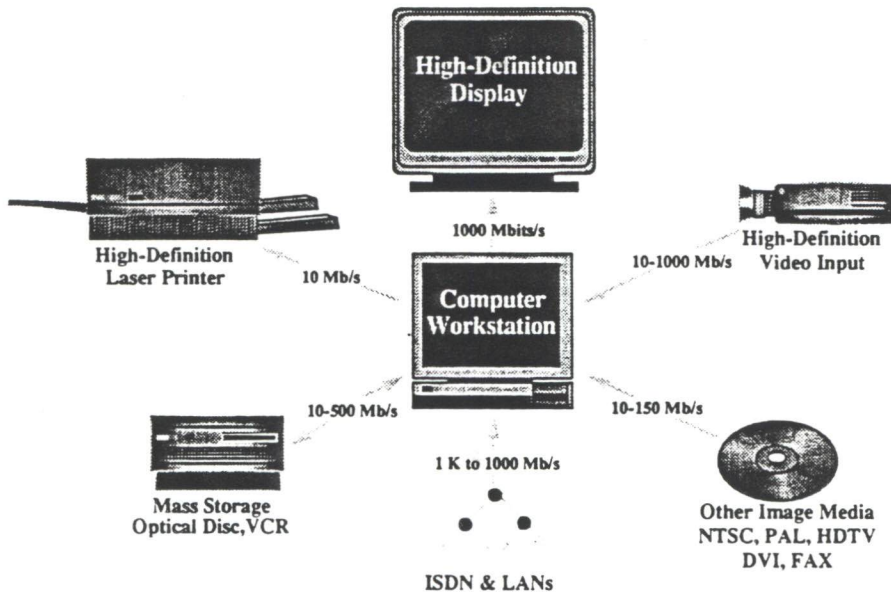
- Our most important sense
 - 10^9 bits/sec for vision
 - 10^5 bits/sec for hearing
- Often the best (only) means of analyzing complex data
- Images are “interesting” and “compelling”
- But
 - Resolution must match the eye
 - Moving images contain 10-100 times more information
- Requires
 - Communication rates that match the human visual system
 - Computer power that rivals the human brain

E21



Office Environment of the Late 1990's

... the office will heavily exploit HDTV technology ...

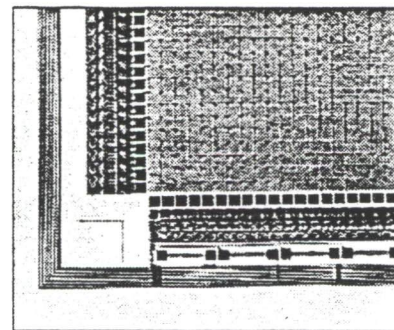
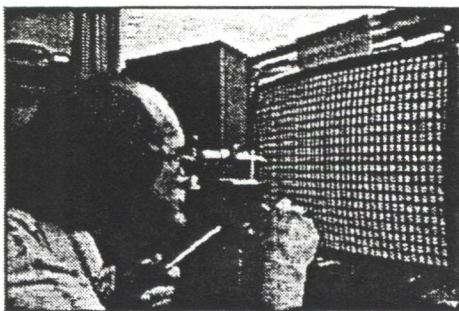


E22



Display Technologies

... large, uniform, high-resolution, bright displays ...



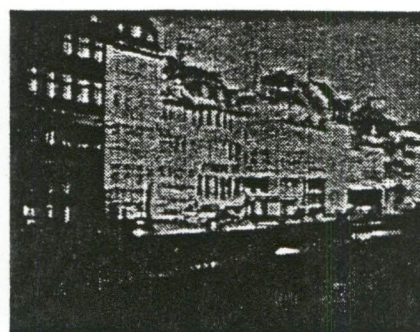
E23

HDTV

*... the key is extremely high-performance
image compression ...*



HDTV

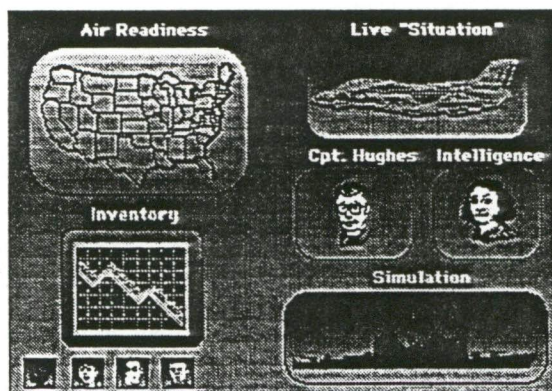


NTSC

E24

High-Resolution Video Workstations

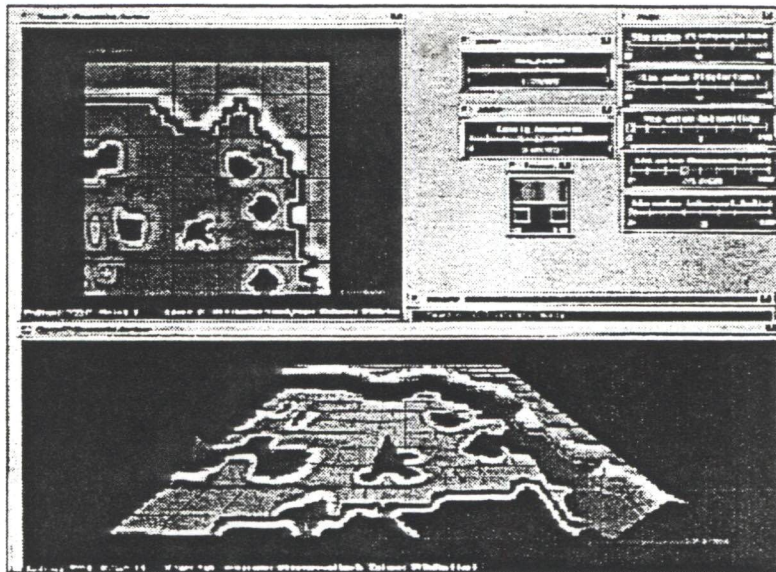
... will have multiple video and graphics windows ...



E25

Data Visualization

... presenting data to users in their visual language ...

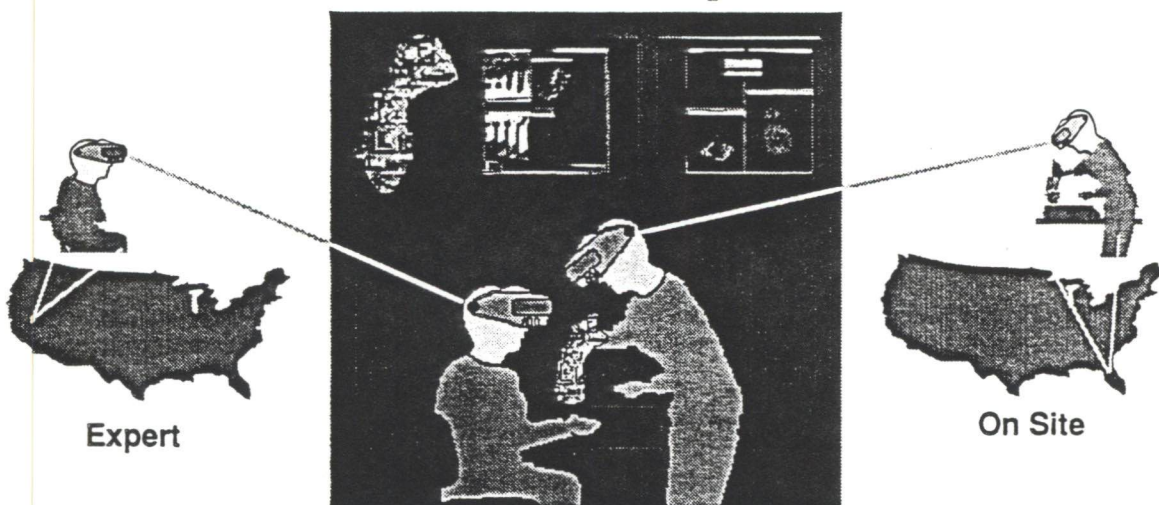


E26

Virtual Reality

... creating real-time, high-resolution, 3D synthetic environments ...

Collaborative Workplace



E27

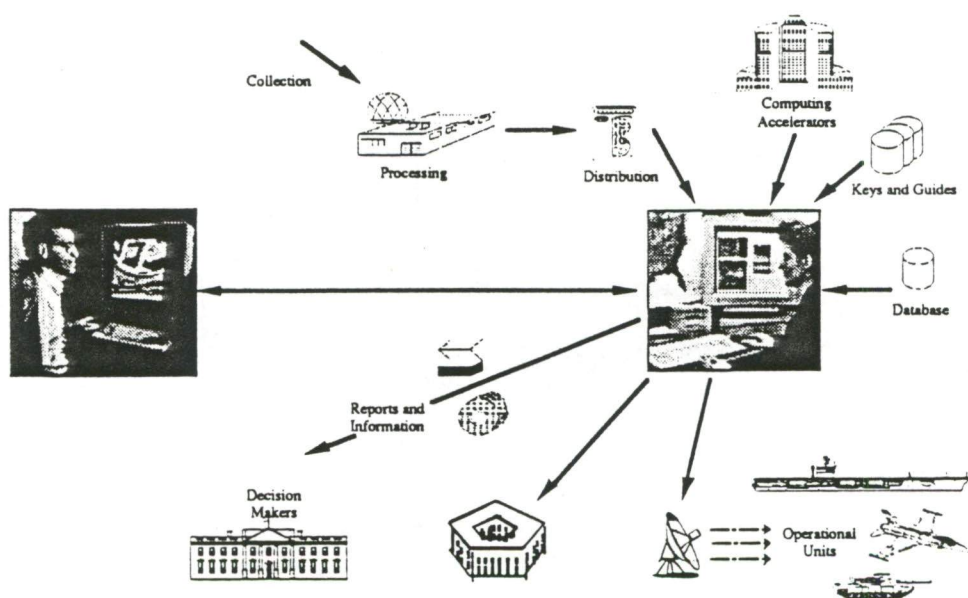


NIDL Strategic Technologies

E28



The User's Softcopy Environment *... putting the User in control ...*

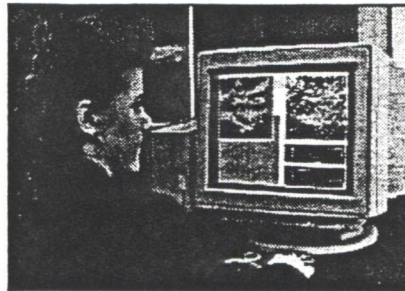


E29



NIDL Strategic Thrusts

... changing the way the user makes decisions ...



Information Processing

- Providing the analyst and tactical decision maker with the benefits of breakthrough Softcopy information processing technology

Display

- Providing the analyst with Softcopy display developments that create a visual paradigm surpassing film and a light table

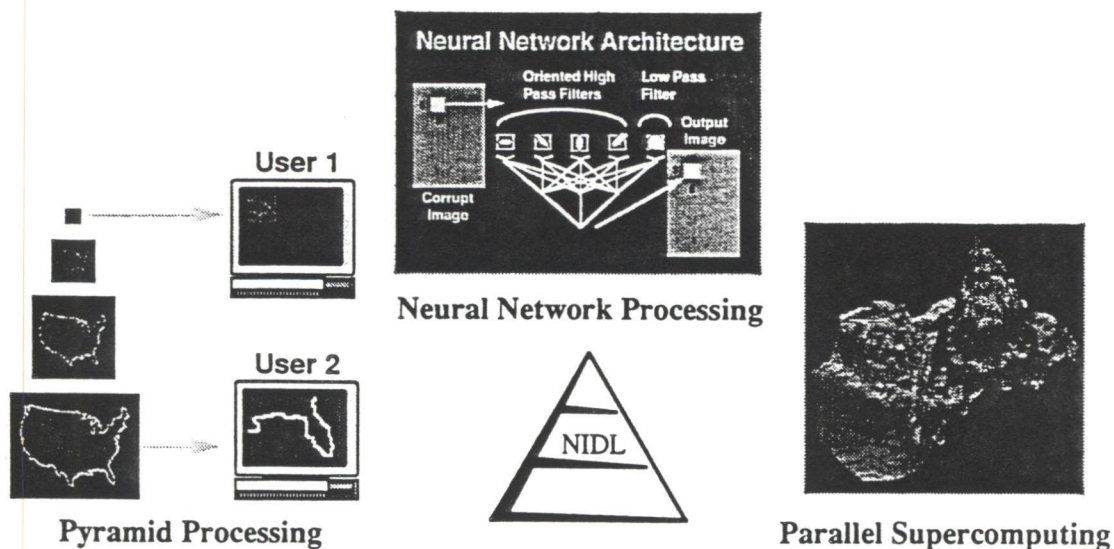
****UTILIZING THE STRENGTHS OF THE COMMERCIAL MARKETPLACE****

E30



Strategic Technologies

... focus of NIDL Softcopy Tools & Technology ...



E31



Strategic Technologies

... focus of NIDL Softcopy Tools & Technology ...

Neural Network Processing

- Neural Network Tools and Applications
- Real-time Training
- Signals from Noise



Pyramid Processing

- Change Detection
- Keys & Guides: Interactive Search
- Efficient Multispectral Data Access
- Analysis & Visualization of Collateral Data
- Interactive Performance Visualization

Parallel Super Computing

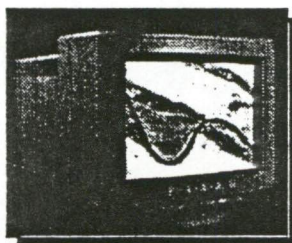
- Massively Parallel Production Front End
- Algorithm Understanding Lab
- Realistic Rendering

E32

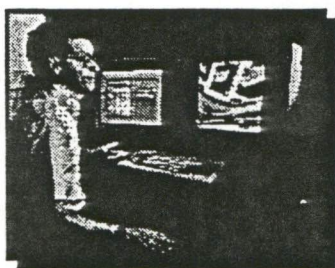


Strategic Technologies

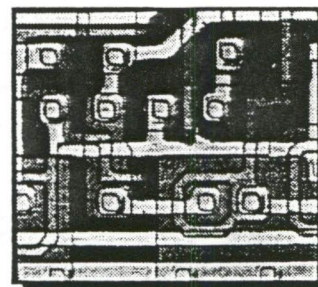
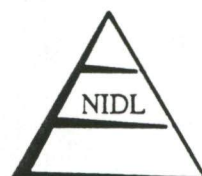
... focus of NIDL Display Technology ...



Display Systems



Display Systems Simulation



Integrated Circuit Technology

E33



Strategic Technologies

... focus of NIDL Display Technology ...

Display Systems

- High-Resolution High-Brightness CRT Monitor
- Tiling for Wall-sized Flat Displays
- Display Evaluation & Certification
- Softcopy Quality Control



Display Systems Simulation

- Display System Simulator
- Visual Modeling
- LCD/EL/CRT/Tiling/Paper-like
- Display Evaluation & Certification

Integrated Circuit Technology

- LCD
- EL
- Paper-like Displays

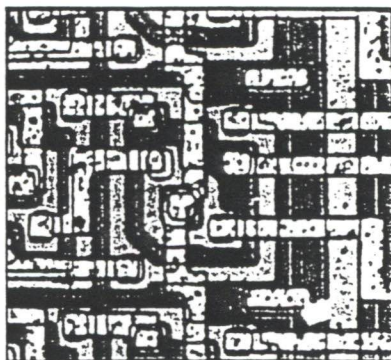
E34



What's the Difference? - Not Much

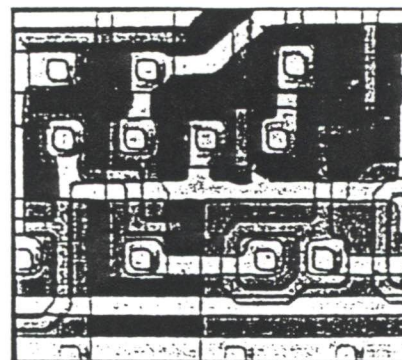
... future displays will include massively parallel computation capabilities ...

RCA 1802 Microprocessor
(5 μ m IC Technology)



CMOS Microprocessor
on Si (circa 1972)

Sarnoff's 6" x 8" LCD Display
(5 μ m IC Technology)



Si LCD Driving Circuitry
on Glass (circa 1991)

E35



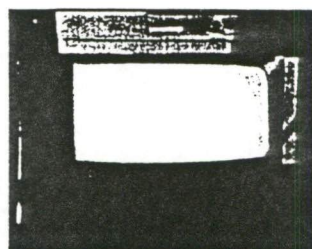
NIDL Highlights

E36

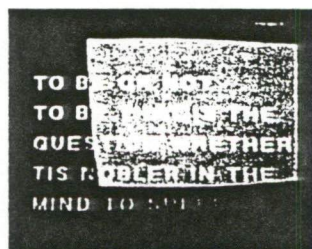
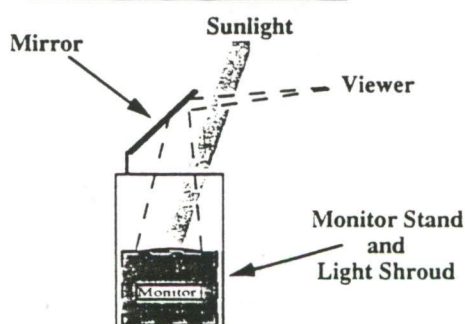


User Support

*... President's teleprompter:
timely response to a user's need ...*



Old



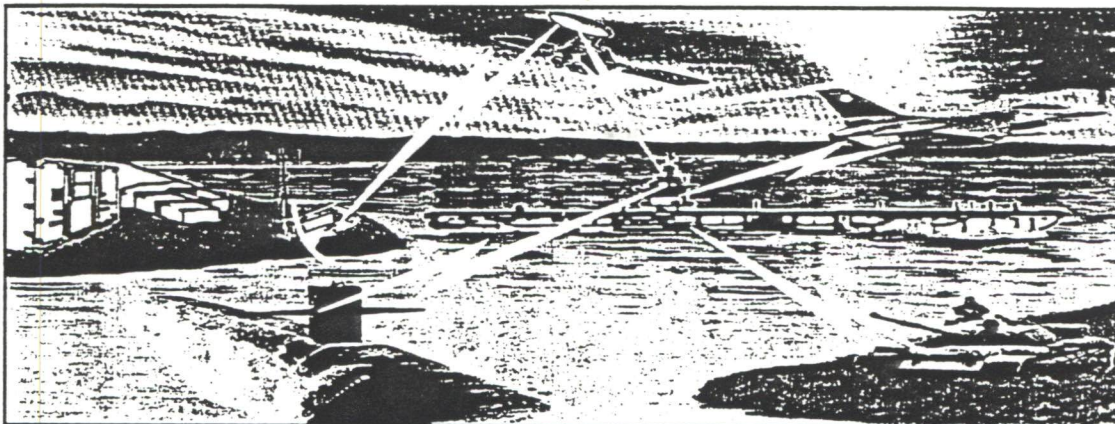
NIDL
Improved

E37



User Support

... providing Navy support for the Copernicus program ...



"We began our work together last fall and since then both labs have provided valuable services including user support at operational sites, pre-procurement consulting on large system acquisitions, and some very compelling advanced technology research. The Navy has realized substantial cost savings, as well as improved operational performance as a direct result of these labs."

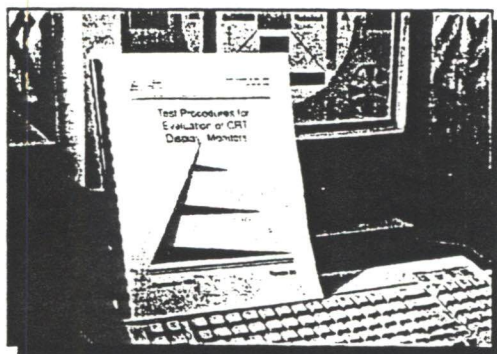
Vice Admiral Jerry O. Tuttle, U.S. Navy

E38



Standards

... establishing industry display and imaging standards that represent the government's viewpoint ...



Measurement Procedures

Luminance Step Response

Objective

Equipment

Test pattern

Procedure

Data

Analysis

Luminance Step Response (Continued, also see full figure)

Objective: Characterize luminance and contrast response of the video camera of the CRT display.

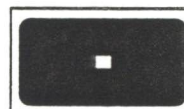
Equipment: Quantum Data 4700S-1, Measurement SUPERSPOT 100, OM-1 Output, Photometer, Oscilloscope.

Test pattern: Use the CIBYTE SQUARE 170-screen test at screen center using uniform frames and video at input rates of 30, 60, 120, 240 and 255 or frames in the Figure. Document contrast and input rates to test 0. For contrast and luminance use 10% and 100% luminance levels. Also generate the inverse pattern.

Procedure: Use Response 100 with CCD input camera with In-View to capture luminance profile of right and left side edges of the CIBYTE SQUARE 170-screen test film.

Data: Photograph and/or trace of generator output to identify values of luminance. Compare the luminance output to the SUPERSPOT 100 display of screen test output. Adjust luminance to the screen and then repeat the test for the entire screen.

Analysis: Quantify amount of luminance or contrast and 10% to 100% rise and fall times.



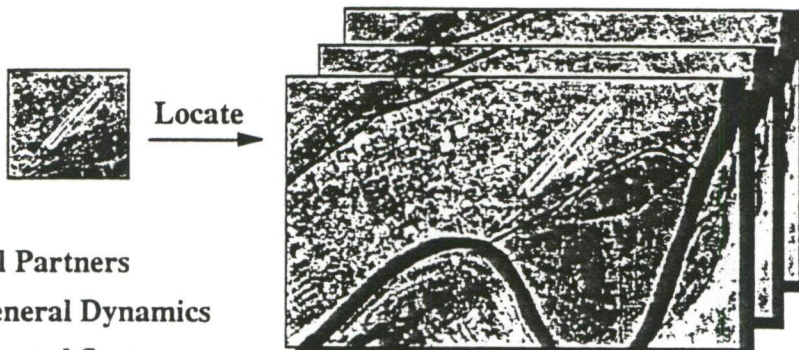
E39



New Partner

... JNIDS: an NIDL partner with a common strategic vision ...

- JNIDS IMPRINT initiative
- User need: assistance in the processing of aerial imagery
 - Tasks include content based search
 - Based on fundamental approaches to image processing (pyramids and fractals)



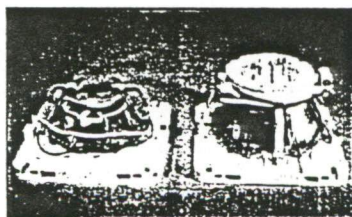
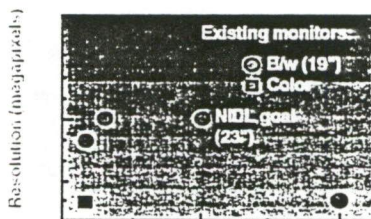
- Commercial Partners
 - General Dynamics
 - Iterated Systems

E40

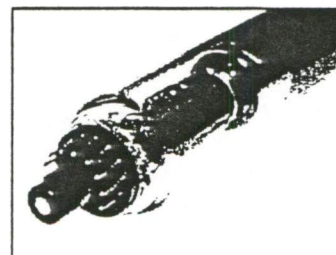


Technology

... working closely with an NIDL Partner to develop a new high-brightness, high-resolution CRT monitor ...



Yoke



Electron Gun

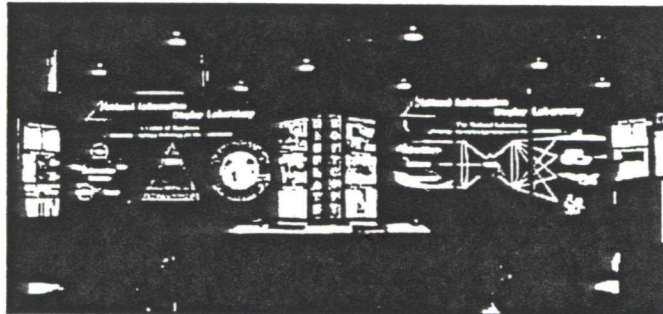
E41



Communications

... reaching out to both the Government and Industry ...

- Government
 - IPWG
 - NASA
 - JNIDS
 - NEL
 - DNI
 - DARPA
- ORD
- OSTP
- FAA
- IRDC
- DCA staff
- Navy Op 94
- Industry
 - Int'l. Display Conference Keynote
 - SID Plenary Presentation
 - SID Standards activities
 - SID Display Booth
 - JTEC
 - Many other individual companies



E42



Conclusions

... a new model for Government/Industry collaboration ...

- NIDL is a Center of Excellence in Softcopy Technology
- Goal: develop bold new way to satisfy the needs of Government Users through both:
 - Aggressive User support
 - Advanced technology
- Focus key softcopy and display technology on the interface to Users, to make them much more productive
- NIDL is a "Distributed Laboratory" with world-leading partners
- For additional information, call NIDL at 609-951-0150

E43



NIDL TASKS

National Information Display Laboratory Softcopy Review

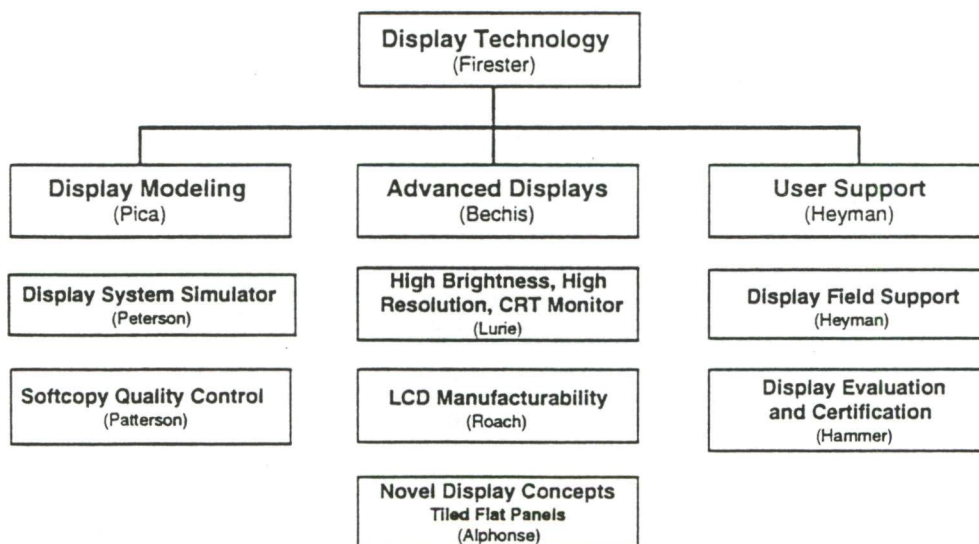
Dr. Curtis R. Carlson
Director, NIDL

January 22, 1992

E44



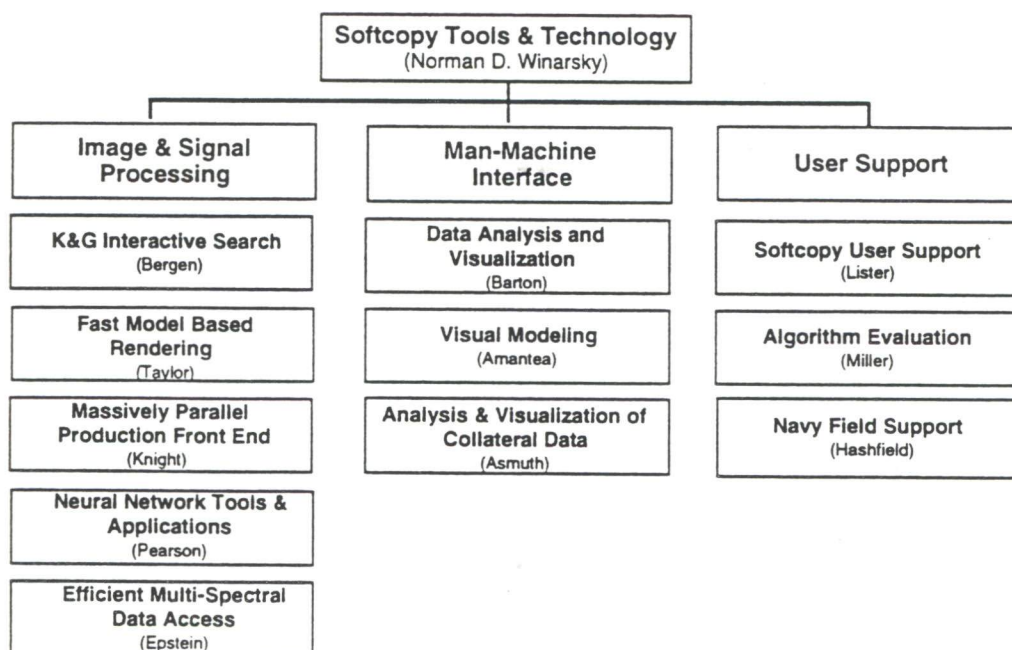
NIDL Display Technology Programs

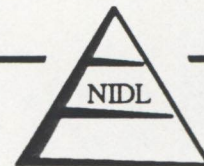


E45



NIDL Softcopy Technology Programs



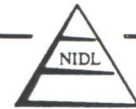


**The National Information Display Laboratory
Softcopy Review**

Information Processing and User Support

**Dr. Norman D. Winarsky
Director, Information Processing**

January 22, 1992



**The National Information Display Laboratory
Softcopy Review**

Information Processing and User Support

**Dr. Norman D. Winarsky
Director, Information Processing**

January 22, 1992

F1



Introduction

... developing NIDL partnerships ...

- Overview of Softcopy projects
- NIDL strategy
- Prototypical example of NIDL strategy
 - Softcopy Keys & Guides
 - IMPRINT
 - Infobases
- Summary

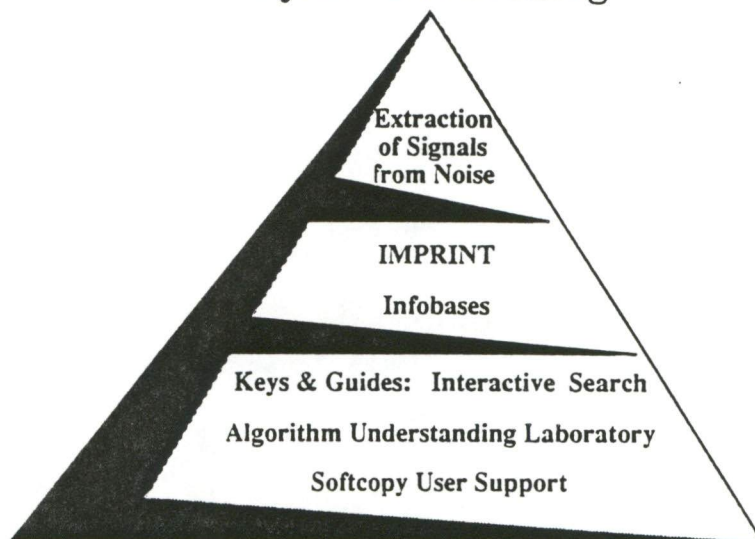
F2

Image and Signal Processing



... applying unique and powerful tools to support the analyst ...

Pyramid Processing



Neural Network Processing

Parallel Supercomputing

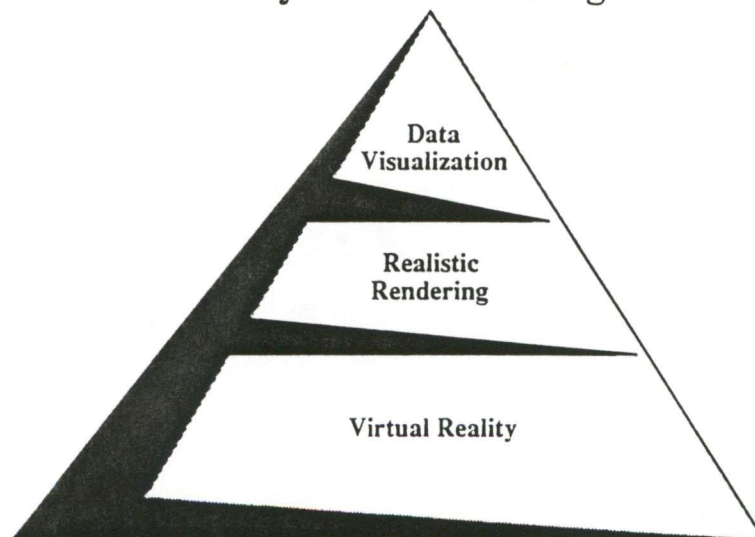
F3

Man-Machine Interface



... presenting complex information to the User's most powerful sense ...

Pyramid Processing



Neural Network Processing

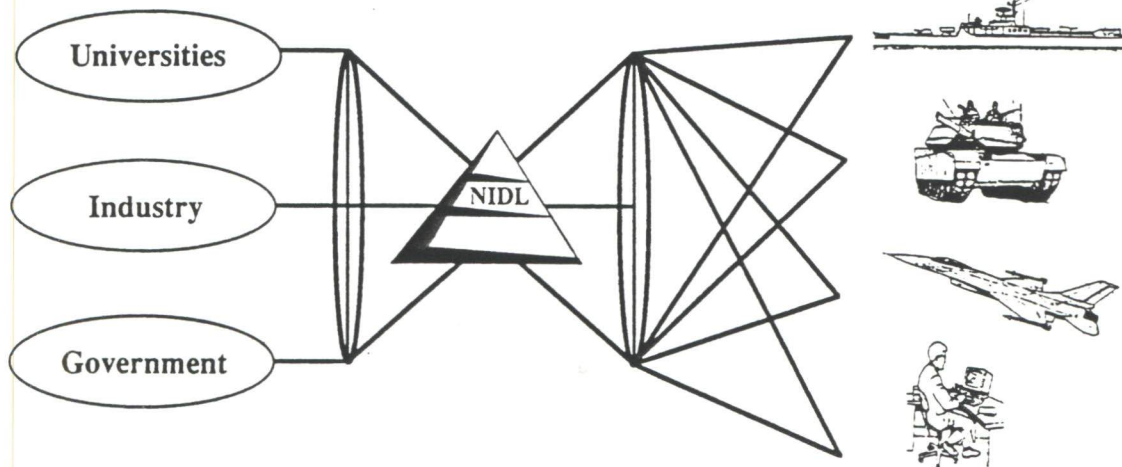
Parallel Supercomputing

F4



The National Labs Concept

*... focusing the resources of Government,
Industry and Academia onto Users' needs ...*



F5



NIDL Strategy

... developing programs with overwhelming value ...

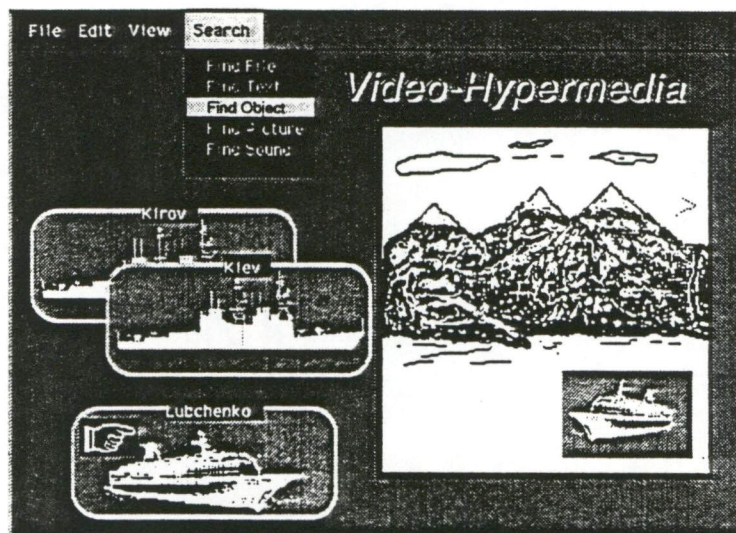
- Work with Users to determine needs
- Begin seed program
- Seek program partners with world-leading capabilities
 - Government
 - Industry
 - Academia
- Develop program that provides
 - User support
 - Revolutionary improvements
 - Path to commercialization

F6



An Example: Softcopy Keys & Guides Program

... increasing the scope and power of what can be done ...

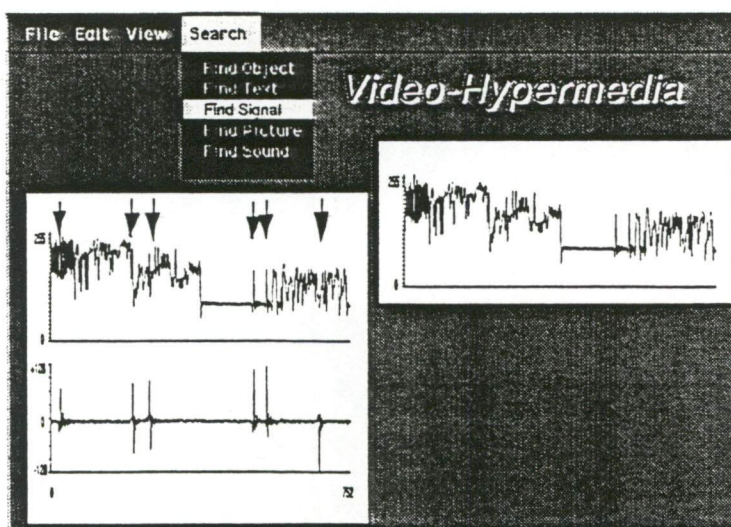


F7



An Example: Softcopy Keys & Guides Program

... increasing the scope and power of what can be done ...

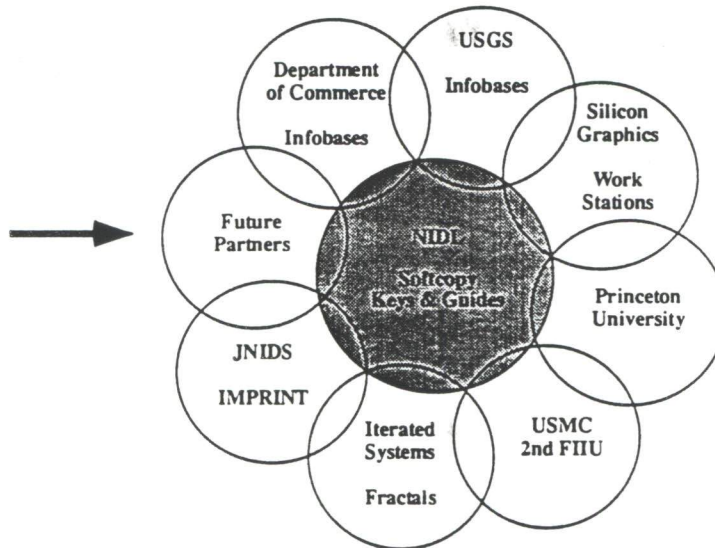


F8



Softcopy Keys & Guides

... providing leverage with government, industry and academic partnerships ...



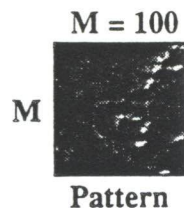
F9



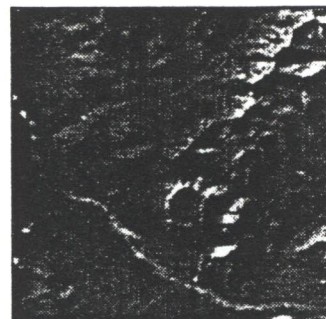
Content Based Search: Why is it a Problem?

... it can be computationally costly ...

$N = 10$



N



- For translation, rotation and scale: computational cost on the order of 10^{16} (proportional to N^2M^4)
- Conclusion: need a very computationally efficient approach

F10



Achieving Computational Efficiency

... pyramid representation -- a necessary ingredient for success ...

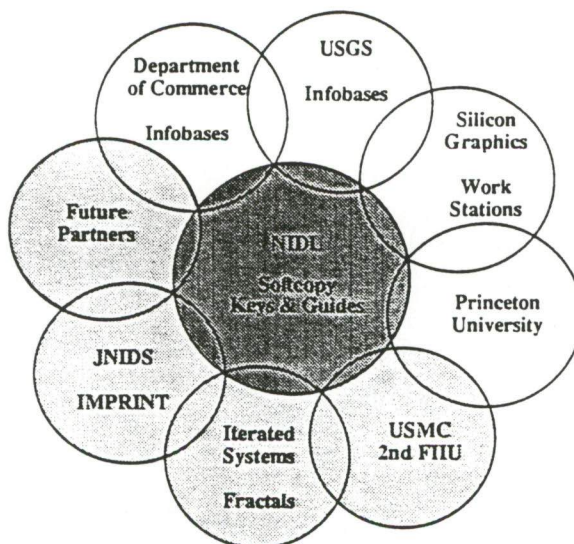
- Search efficiency
 - Work at the lowest resolution possible
 - Restrict areas of search
 - Match simple image features
- Provides computer savings of two orders of magnitude per pyramid level

F11



JNIDS/NIDL IMPRINT

... providing leverage with government, industry and academic partnerships ...



F12



JNIDS/NIDL IMPRINT

... an IMagery PRototyping INiTiative ...

- JNIDS Charter
 - Accelerate, extend and deepen the intelligence analyst's cognitive abilities through rapid application of advanced technology
- USMC 2nd FIIU Mission
 - Derive intelligence information from aerial imagery produced from thermal infra-red (IR) sensors, side looking airborne radar (SLAR), and conventional photography
- Fundamental User Need
 - Assistance in the process of exploiting aerial imagery

F13



IMPRINT - Key Objectives

... rapid development of advanced interactive exploitation tools ...

- Search for reference images by content
- Fuse images to extract maximum information from all sensors
- Construct and visualize 3D views of terrain
- Detect and visualize motion and change

F14



Core Technological Issues

... developing representations of image information ...

- Efficient handling of scale, orientation and other symmetries
 - quasi viewpoint invariance
 - rapid searching and matching
- Consistent representation of image information across tasks
- Flexible description of image information

F15

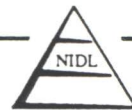


Key Elements of Solution

... user interaction with fundamental representations of image information ...

- Pyramids/Wavelets
 - extensional representation of scale and orientation
 - rapid searching
- Fractals
 - recursive representation of symmetries
 - extremely compact representation
- Intelligent user interaction

F16

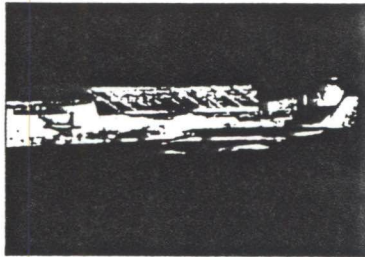


Sensor Fusion

... gaining maximal information from all sensors ...

Multiresolution approach:

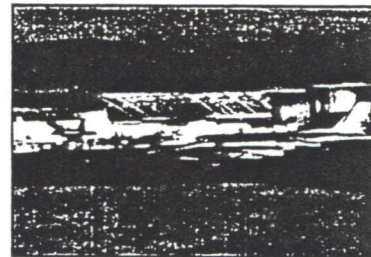
- Preserve essential image information
- Interactively select important structure
- Automatically select salient structure from each image



Visible Image



Infrared Image



Automatically
Fused Image

F17



Content Based Search

... efficient search through volumes of image data ...

- Interactive querying by reference to image data
- Pyramid/fractal-based fast pattern matching
- Simple hierarchical model generation

F18



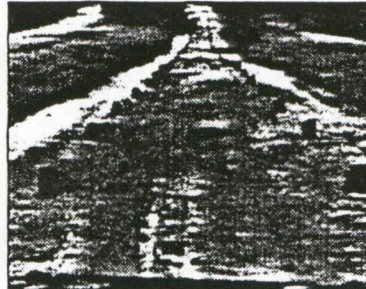
3-D Estimation and Visualization

... construction and visualization of 3D terrain views ...

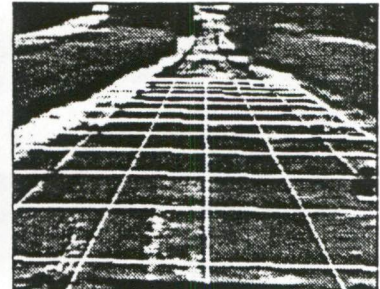
- Rapidly estimate 3-D structure from 2-D images using pyramid techniques
- Interactively analyze for obstacles, ground plane inclination



View 1



View 2



Height Map

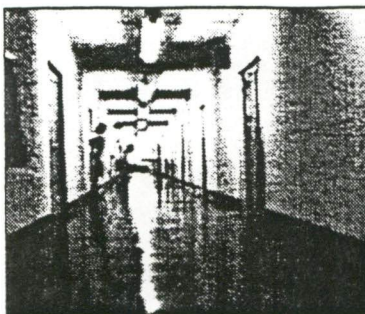
F19



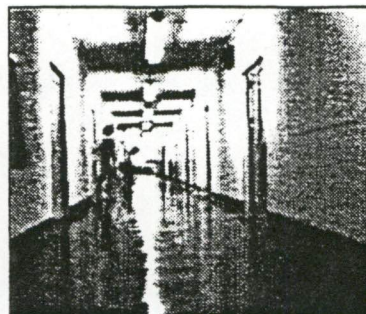
Motion Analysis

... detect and visualize motion and change ...

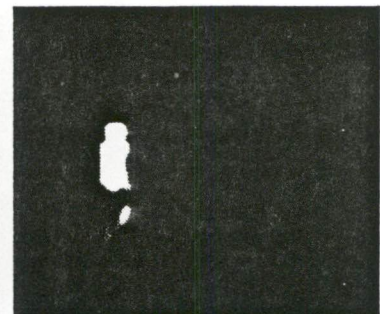
- Rapidly compute image motion due to camera motion
- Interactively analyze residual change to detect moving objects, compute speed, heading



View 1



View 2



Moving Objects

F20



Project Deliverables

... rapid prototyping ...

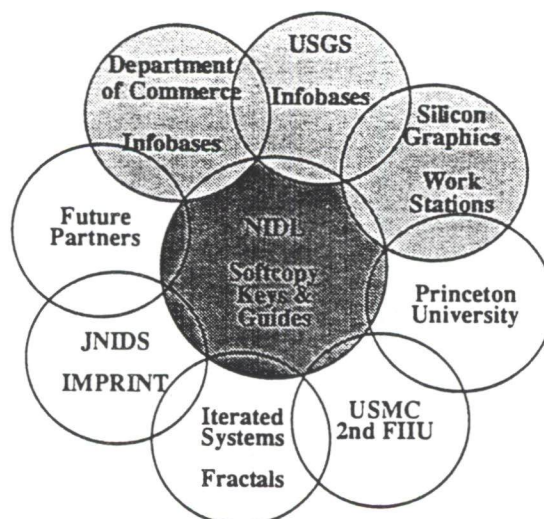
- Initial Toolset to 2-D FIIU: June 1992
 - runs on COTS platform
- Refined Toolset every 2 months for 2 years
 - iteration based on use by 2-D FIIU

F21



Feature Recognition Databases - Infobases

... *providing leverage with government, industry
and academic partnerships* ...



F22



Feature Recognition Databases - Infobases

... rapidly exploiting and disseminating critical information ...

- User Need
 - Environmental Impact Programs require:
 - ★ Improved management and access for huge volumes of data
 - ★ Real-time analysis of current and historical data
- Approach
 - Develop content based search capabilities to find, access, process and visualize the data
 - Based on pyramid (and wavelet) image processing

F23



Feature Recognition Databases - Infobases

... rapidly exploiting and disseminating critical information ...

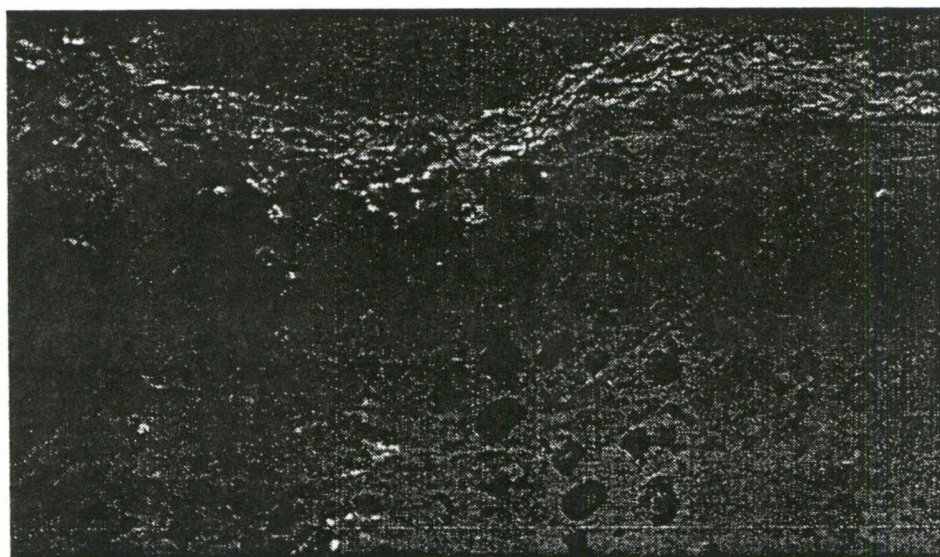


Image of Prudhoe Bay - July 25, 1977

F24



Feature Recognition Databases - Infobases

... rapidly exploiting and disseminating critical information ...

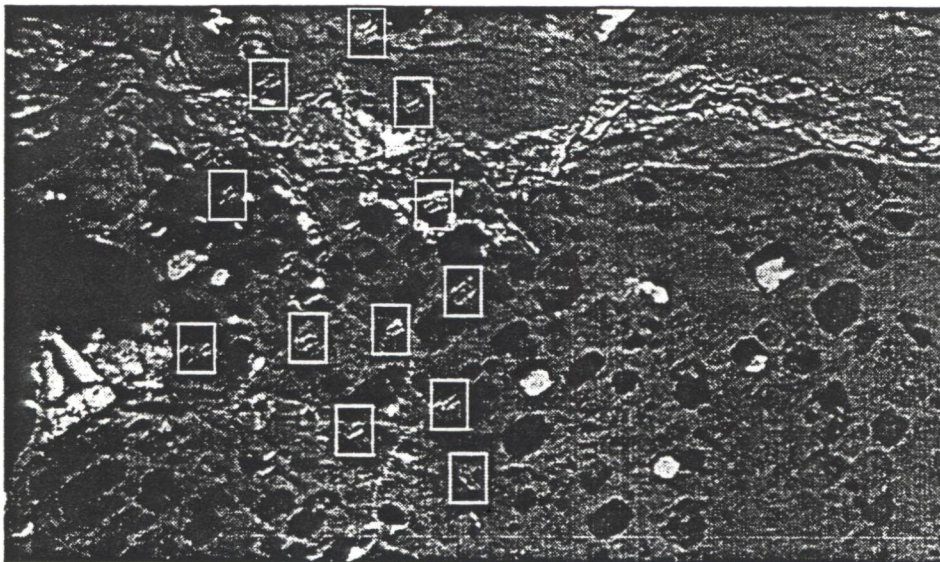


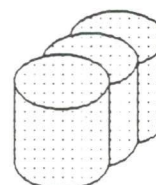
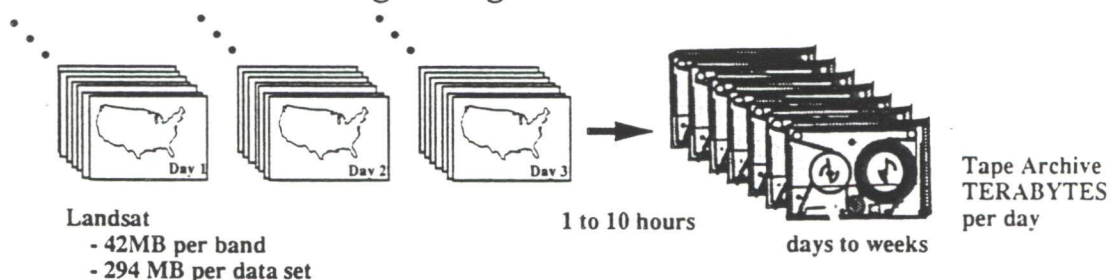
Image of Prudhoe Bay Showing New Construction - July 6, 1986

F25



USGS Operational Environment

... large imagebase search ...



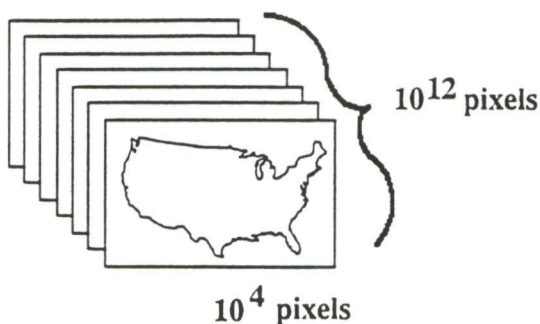
- Critical data not easily accessible. Scattered in:
 - time
 - space
 - multiple spectral bands

F26

Example

... finding data scattered in space, time and spectra ...

Environmental Change Detection: Deforestation Near Urban Areas



- Just to get to the point where we can ask the question, we must find:

- Urban Areas
- Forests
- Visible images every month over the last 10 years

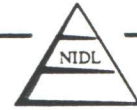
F27

Infobase - Key Objectives

... rapidly exploiting and disseminating critical information ...

- Software for:
 - Data management
 - Interactive content based access
- Access to a massively parallel real-time image processor for interactive visualization and analysis for
 - Multispectral
 - Multitemporal data
- Examples of use:
 - Find longest cloud-free sequence of tropical forest images
 - Select images from multisensor data (AVHRR, Landsat, etc.) showing evidence of deforestation
 - Visualize time sequences in these areas to verify and classify deforestation patterns

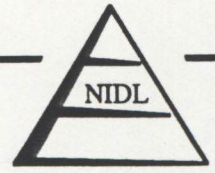
F28



Summary

... the model is working ...

- The programs evolving from Softcopy Keys & Guides are positioned to provide overwhelming value to:
 - DoD
 - Civilian Agencies
 - Commercial Industry
 - Universities
- All NIDL programs follow the model
- NIDL is actively seeking partners



**The National Information Display Laboratory
Softcopy Review**

Image Change Detection

**P. Anandon
Member, Technical Staff**

January 22, 1992



**The National Information Display Laboratory
Softcopy Review**

Image Change Detection

**P. Anandan
Member, Technical Staff**

January 22, 1992

11



Talk Overview

Needs

Image change detection for a wide variety of applications

Goal

Model-based multi-frame image alignment and temporal trend extraction

Approach

Using multi-scale representation and analysis of spatial and temporal information

Project Focus

Environmental impact of Oil Development in Prudhoe Bay, Alaska (for USGS)

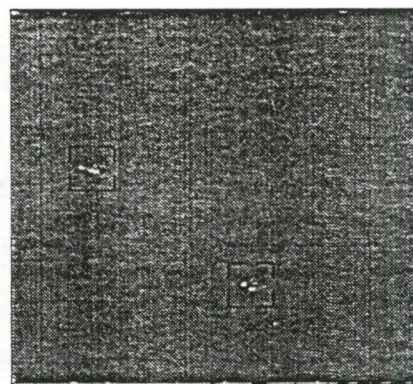
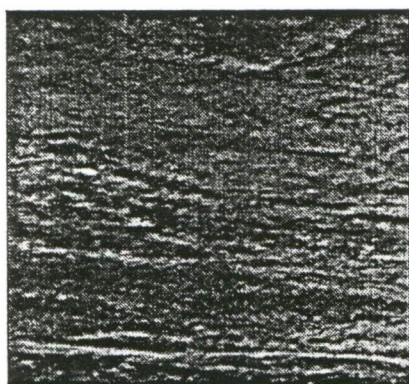
12

User Needs

... change detection in aerial and remote sensing imagery ...

- **Examples**
 - **Moving Target Detection**
 - **Military Installation Monitoring**
 - **Deforestation Studies**
 - **Environmental Impact of Oil Development**

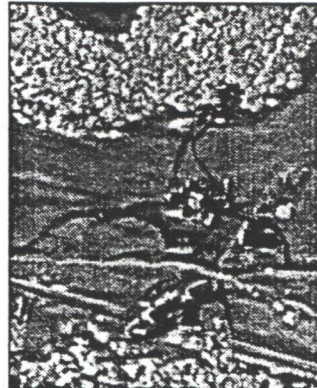
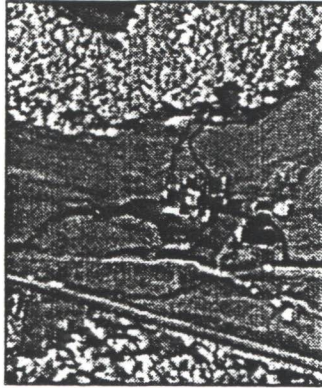
Moving Target Detection



- **Timescale of few seconds**
- **Small objects, highly localized (few pixels)**
- **Registration needed**
- **Limited variation in illumination and other factors**

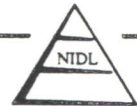


Military Installation Monitoring



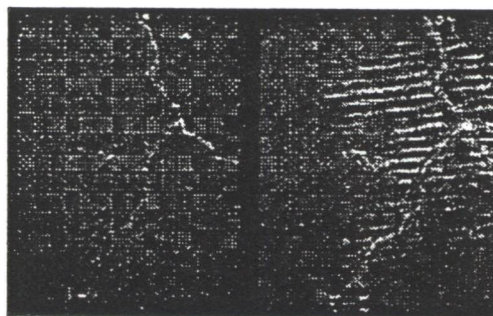
- Time scale of weeks to months
- Localized change (few tens of pixels)
- Registration needed
- Illumination and environmental conditions vary

15



Deforestation Studies

Brazilian Rainforest



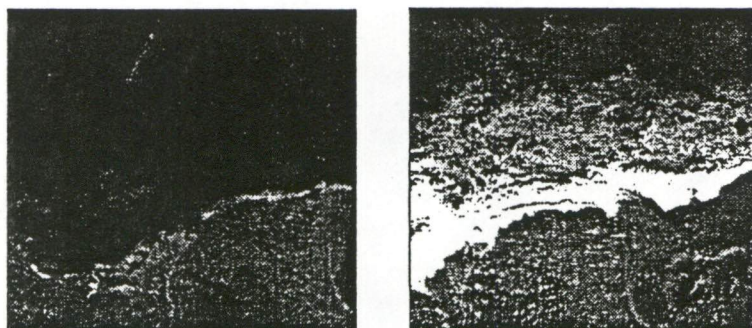
Landsat MSS Image
June 19, 1975

Landsat MSS Image
August 1, 1986

- Timescale of years
- Changes somewhat localized
- Registration needed
- Other changes significant--e.g., illumination, ground cover

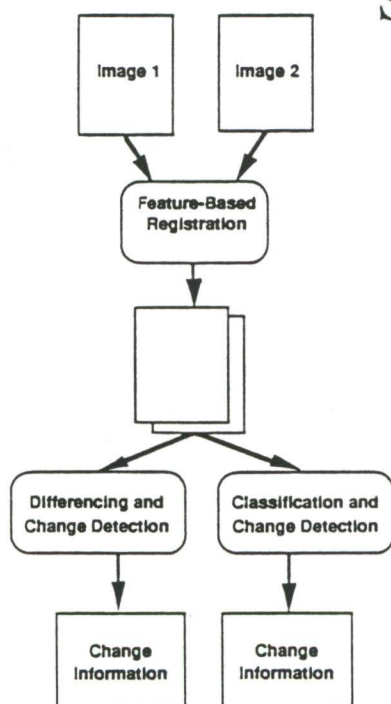
16

Environmental Impact of Oil Development



- Timescale of years
- Changes not localized, multiple types of changes
- Registration needed
- Other changes significant--e.g., illumination, ground cover

State of the Art



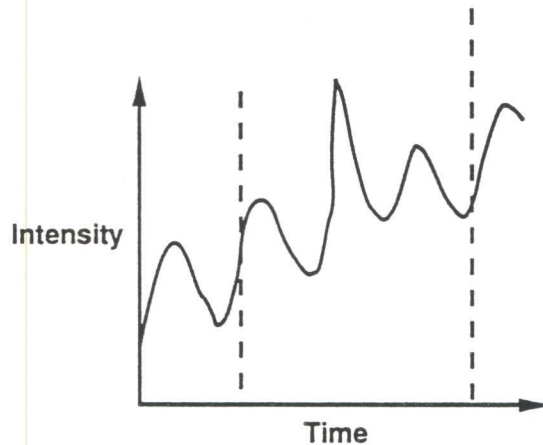
Basic Approach:

Registration of two images followed
by change analysis

Critical Problems:

- Techniques specific to different image classes
- Too much manual interaction needed
- No use of temporal patterns and trends
- Brittle techniques

Detecting Temporal Variation

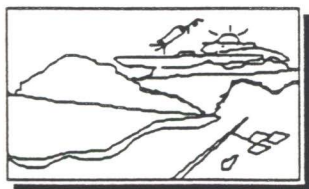
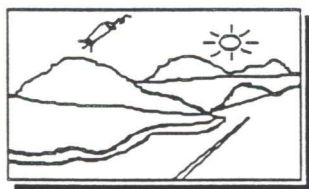
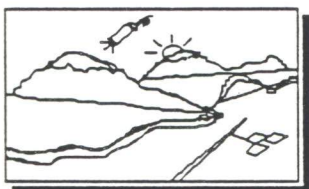


- Temporal image variation is due to multiple factors
- Changes occur at multiple time scales
- Two frame techniques fail to exploit temporal patterns

19

The Basic Problem

... changes are due to multiple phenomena ...



Types of Changes

- Changes to compensate for
- Changes of interest
- Spurious effects

Available Constraints

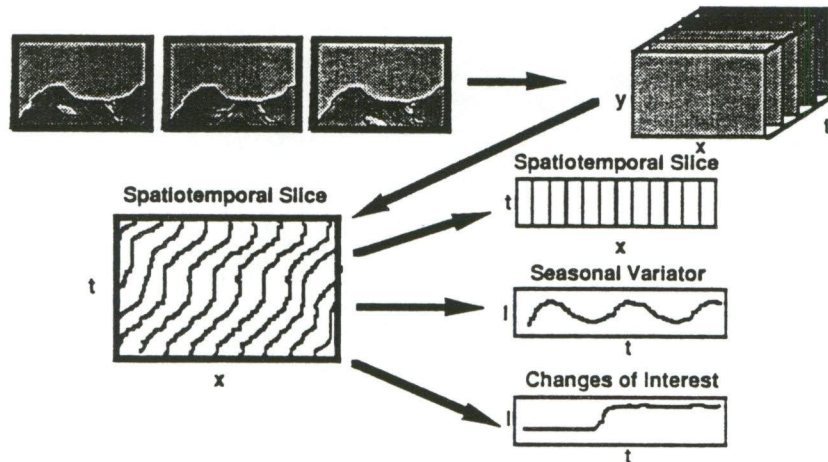
- Image formation models
- Terrain shape and reflectance models
- Change hypotheses

110

Project Goals

... image sequence alignment and decomposition ...

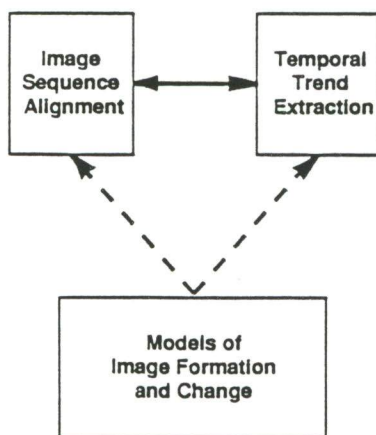
- Align long multi-spectral image sequences
- Extract and separate important trends



111

Approach

... multi-frame alignment and representation ...



- Simultaneous multi-frame alignment
- Interleave alignment and trend extraction
- Process information at multiple scales
- Wavelet (pyramid) representation
- Use image formation and change models to constrain alignment

112



Program Plan

... proven technology as a good starting point ...

- Use existing hierarchical registration techniques
- Extend these to handle illumination and other changes
- Incorporate image formation and change models
- Maintain close contact with customer (USGS EROS data center)

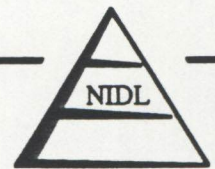
113



Conclusion

- A new approach to change detection based on long temporal sequences
- Automatic alignment and trend extraction allows the user to concentrate on high-level issues
- Approach applicable to a wide class of imagery; hence, to a wide range of problems
 - Moving Target Detection
 - Military Installation Monitoring
 - Deforestation Studies
 - Environmental Impact of Oil Development

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**The National Information Display Laboratory
Softcopy Review**

The Importance of Imaging Standards

**Michael A. Isnardi
Head, Systems Research Group**

January 22, 1992



The National Information Display Laboratory
Softcopy Review

The Importance of Imaging Standards

Michael A. Isnardi
Head, Systems Research Group

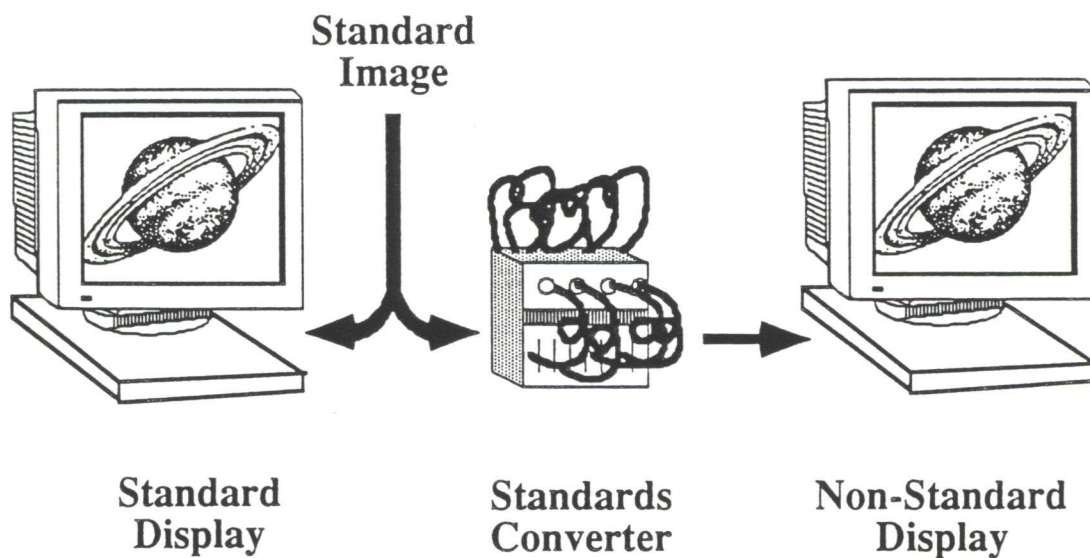
January 22, 1992

G1



Why Imaging Standards?

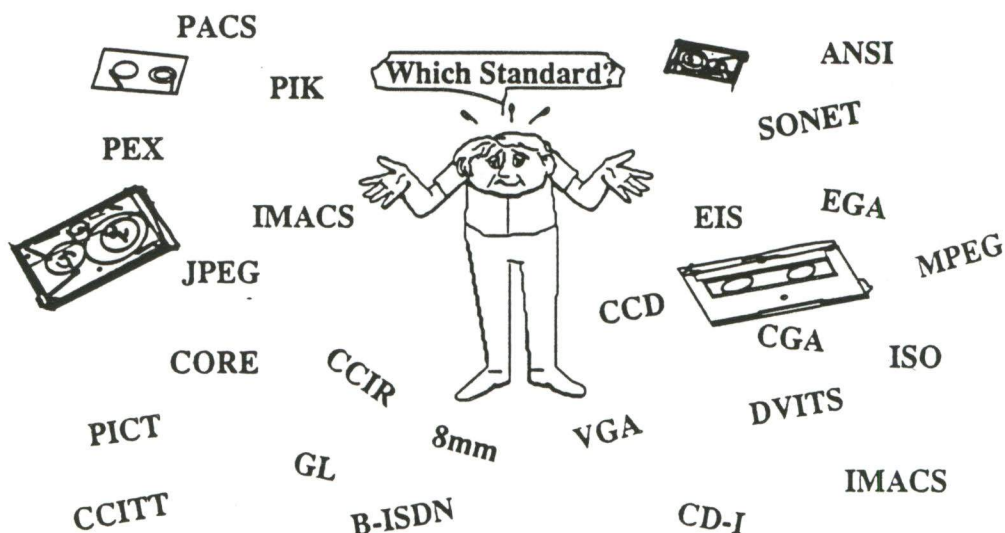
... they reduce cost and increase efficiency ...



G2

Which Imaging Standards?

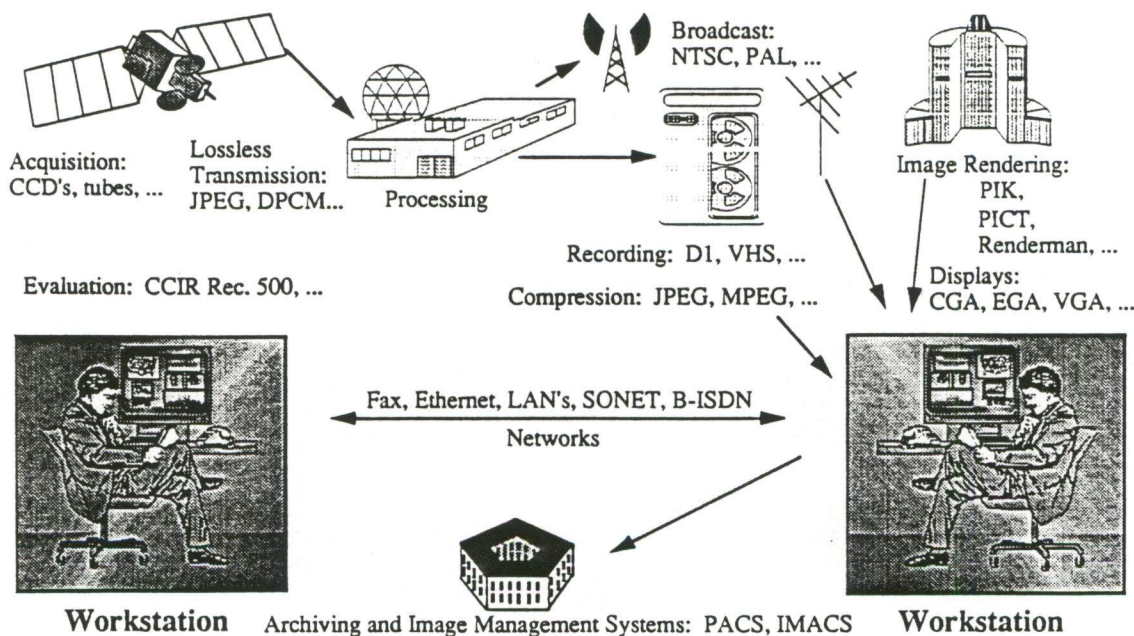
... we'll look at ways to avoid drowning in the alphabet soup of imaging standards ...



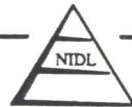
G3

The World of Imaging Standards

... standards are needed wherever image data is used ...

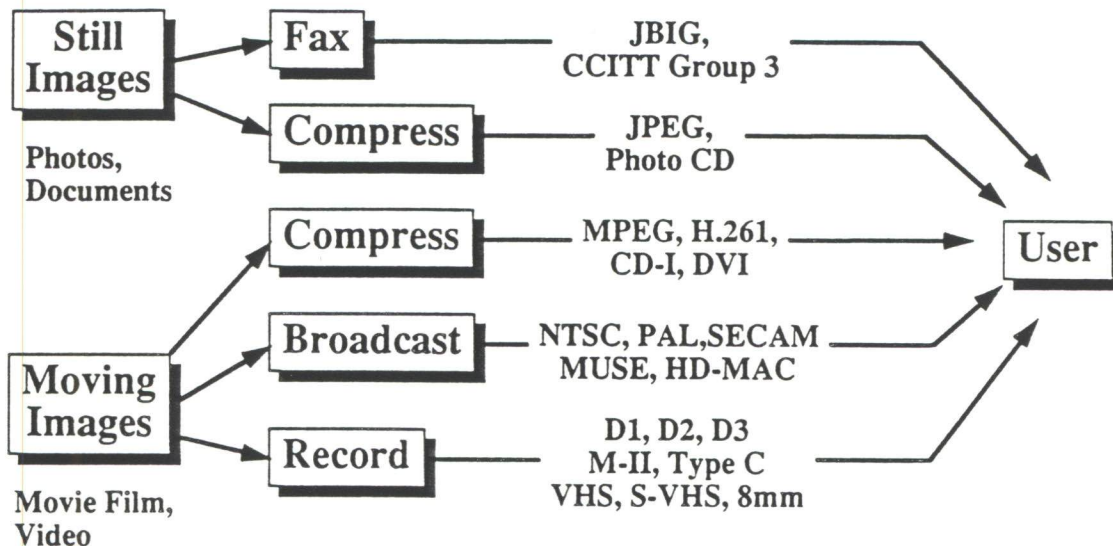


G4

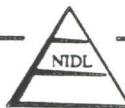


The World of Imaging Standards

... transmission and compression ...



G5



The World of Imaging Standards

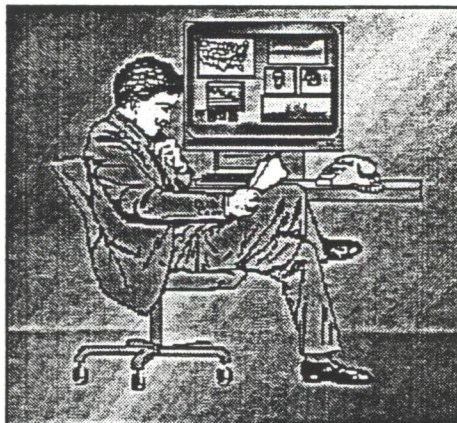
... image programming, generation and display ...

Programming

- PIK
- QuickDraw
- CORE
- GKS
- PHIGS
- PEX
- PostScript
- GL

Graphics File Formats

- PICT
- TIFF
- Postscript
- Renderman



Display

- CGA
- EGA
- VGA
- Super VGA

Multimedia

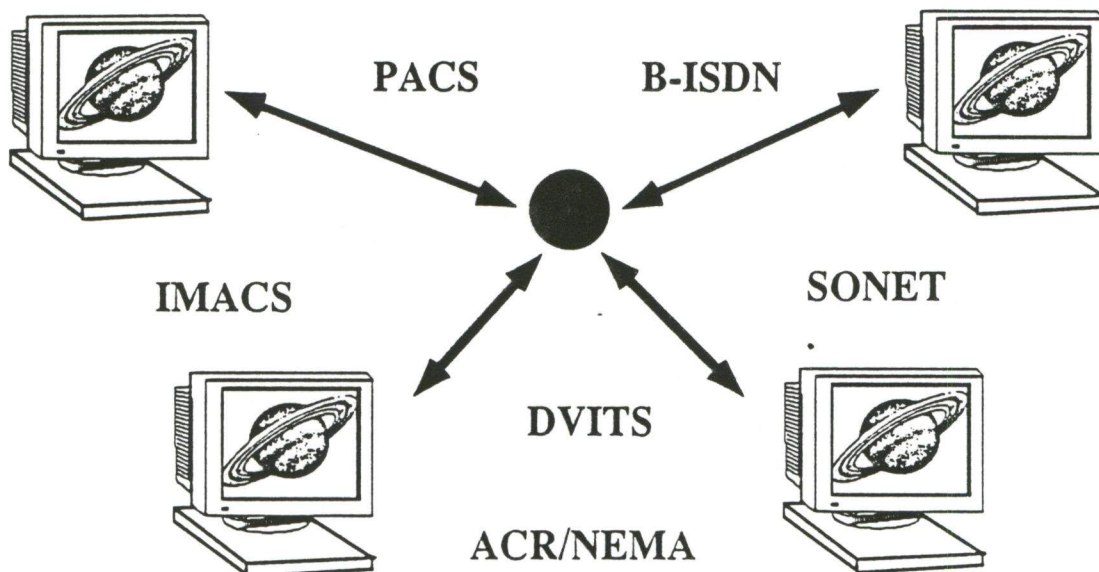
- Photo CD
- CD-I
- DVI
- QuickTime

G6



The World of Imaging Standards

... networks and archiving/management systems ...

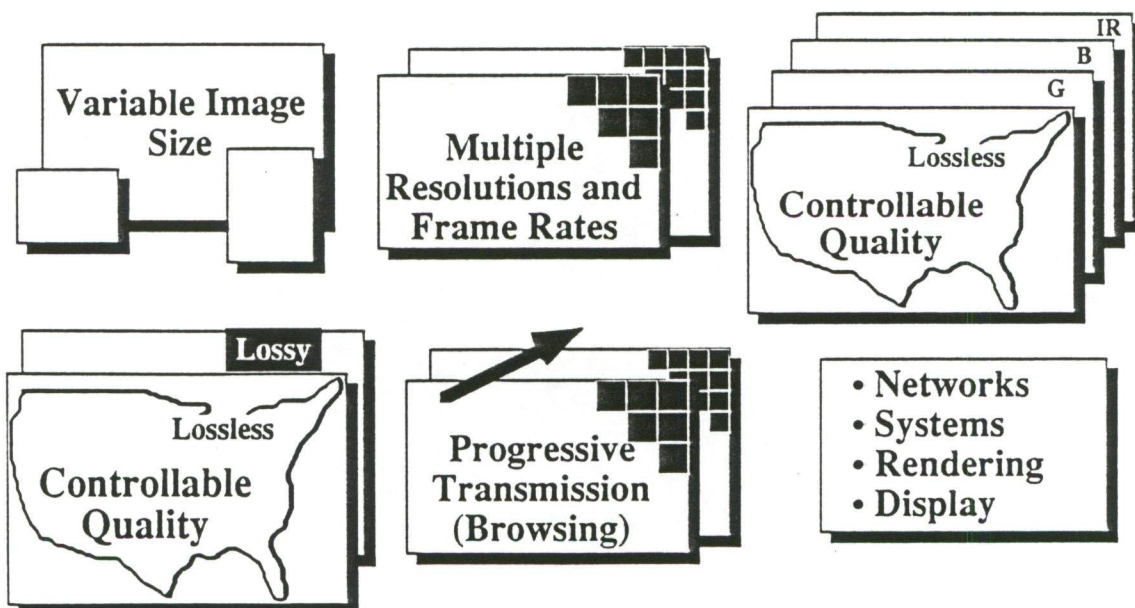


G7



Important Issues in Imaging Standards

... we must look for standards in all areas of concern ...



G8



A Single Imaging Standard?

*... probably not, but here's where NIDL
can make an impact ...*

- Participate in standards organizations
- For example, we can propose enhancements to a proven compression standard, such as:
 - multiple scanning formats
 - multiple layers
 - multiple transmission modes
 - variable quality
 - network-friendly protocols
 - ability to incorporate new image representations, such as objects, objects with behavior, sub-bands, pyramids, wavelets and fractals.

G9



Standards Setting Organizations

*... NIDL must be active in these organizations
in order to understand, use and propose imaging standards ...*

SMPTE

...electrical and physical film and video formats...

SID

...display formats...

IEEE

...signal interface formats...

ISO

...international standards for
photography and graphic arts...

Imaging Standards

EIA

...video interface formats...

CCITT

...compression formats...

CCIR

...electrical and physical video formats,
video quality metrics...

ANSI

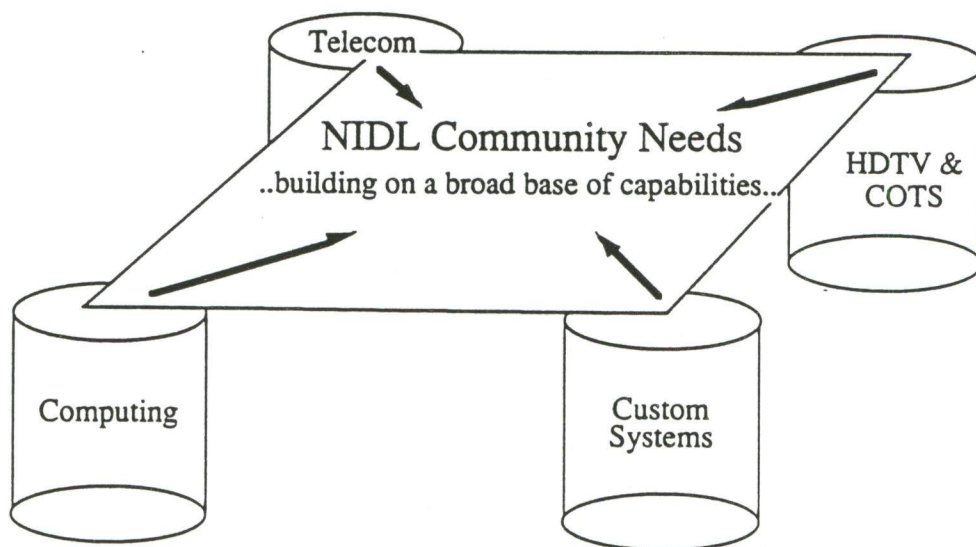
...Image Technology Standards Board...
...ensures industry-wide standards...

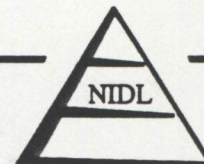
G10



Commercial Leverage

*... COTS will be an important component of
future imaging systems ...*





**The National Information Display Laboratory
Softcopy Review**

Algorithm Understanding Laboratory (AUL)
... developing in-depth understanding of algorithms ...

Curt Carlson and Steve Miller

January 22, 1992



The National Information Display Laboratory Softcopy Review

Algorithm Understanding Laboratory (AUL)

Curt Carlson and Steve Miller

January 22, 1991

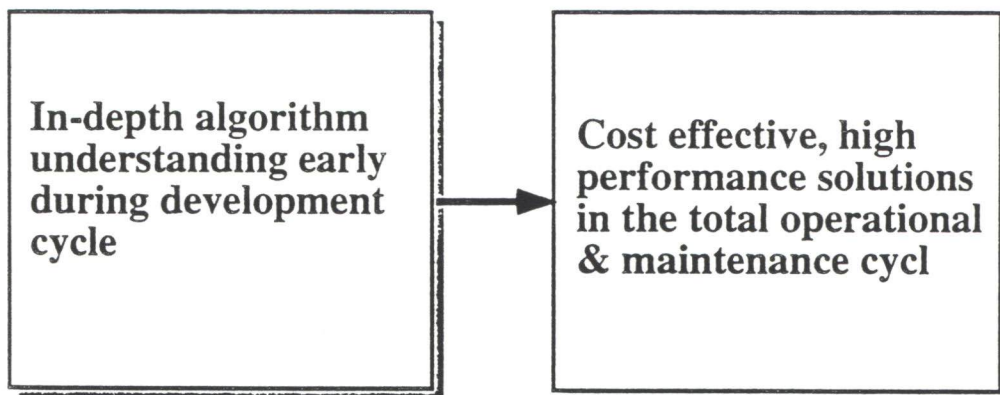
**Team Members: Ben Epstein, John SantaPietro, Leslie Dias,
Martin Czigler, and Bob Browne**

K1



The Hypothesis

... algorithm understanding is key ...



K2



An Example of the Need

... a conclusion from DARPA's Executive Study Group ...

"automatic target recognition (ATR) is the major enabling technology (from surveillance to BDA)"

However,

"substantial investment has been made to date with limited results ... "

What is needed is,

*"Disciplined investigation of algorithms and phenomenology"
"Data sources, widely accessible data base"
"Objective evaluation of performance"*

K3



Spatio-Temporal Processing

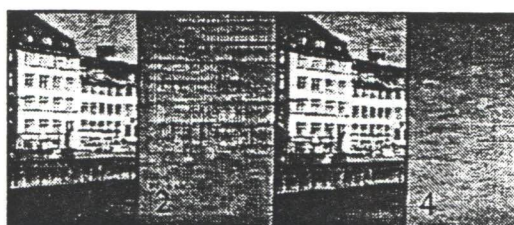
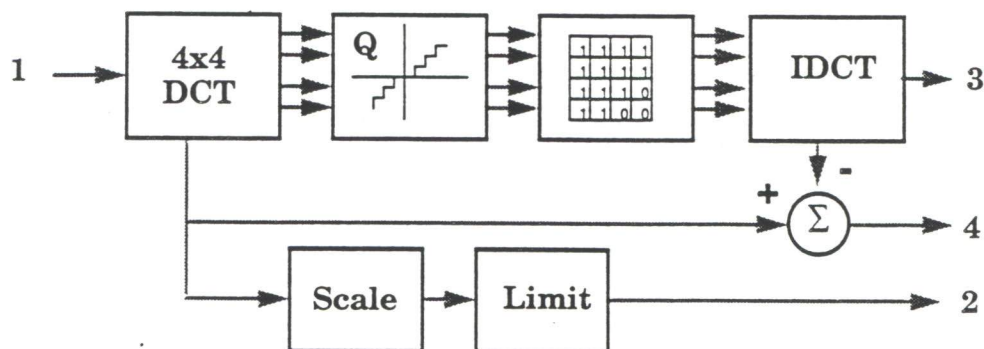
... an indication of the future ...

Algorithm Comparison Evaluation Sheet									
1 - A Little Better 5 - Excellent Improvement									
Algorithm	Static Diagonal	Static Test 1	Static Flicker	Motion Diag	Motion Test 1	Motion Errors	Motion Flicker	Sum	Relative Gates
Repeat	0	0	0	0	0	0	0	0	1
Average	1	0	-1	1	0	0	1	2	1
Diag-3	2.5	-1	-0.5	2.5	0	0	1	4.5	2
Diag-4	3	-1	-0.5	3	0	0	0	4.5	2
Mid 1	0.5	1	2.5	3	-1	-2	3	7	2.5
Mid 2	-0.5	1	4.5	1.5	1	0	1	8.5	2.5
Mid 3	3.5	2	5	2.5	0	0	1	14	3.5
Bernard	4	2	5	2	0	0	1	14	3.5

K4

Algorithm Visualization

... assessing the effects of parameter changes ...



K5

Side-by-Side Comparisons

... analyzing different algorithms on the same data ...

	Image 1	Image 2	...	Image N
Algorithm 1			...	
Algorithm 2			...	
...				
...			...	
...				
Algorithm K			...	

K6



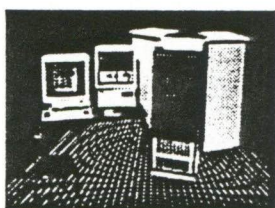
Elements of the Solution

... interactively visualizing parametric changes ...

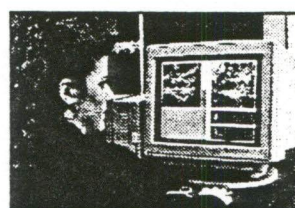
Visualization



Computational Power



Interactivity



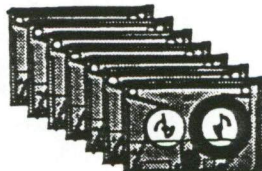
K7



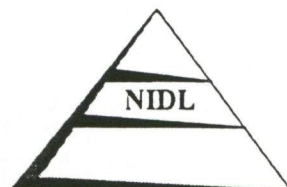
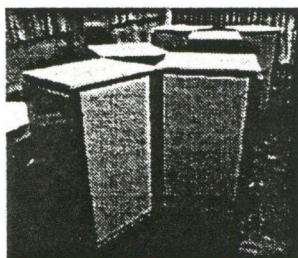
Resources

... additional ingredients of the solution ...

Databases



Facilities



Team

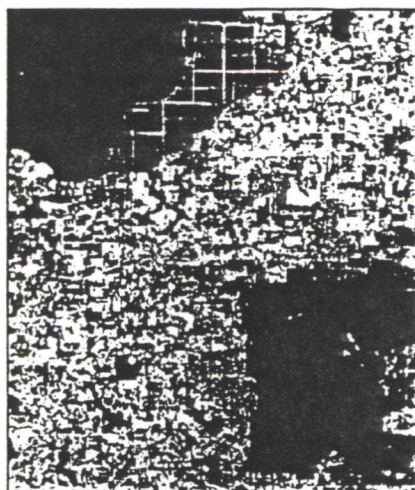
- domain experts
- phenomenologists
- algorithm experts

K8

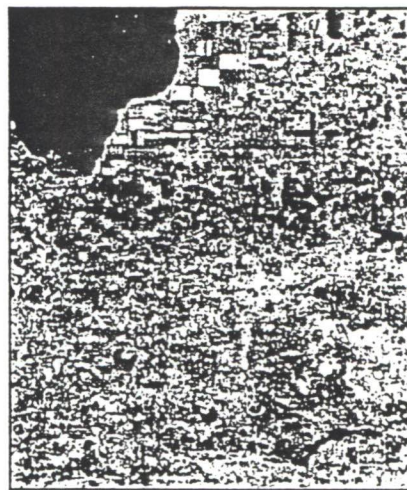


Multispectral

... sponsors use it ...



Original Image



Terrain Characterized Image

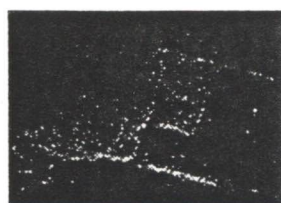
Interactivity aids algorithm understanding

K9

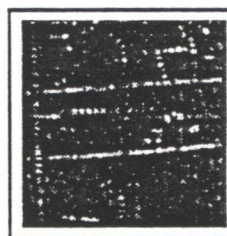


SAR

... contractors use it ...



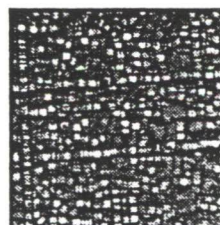
Original Image



Feature 1



Feature 2



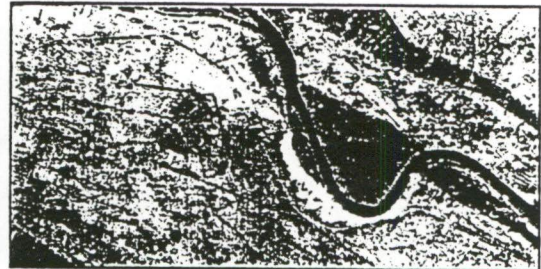
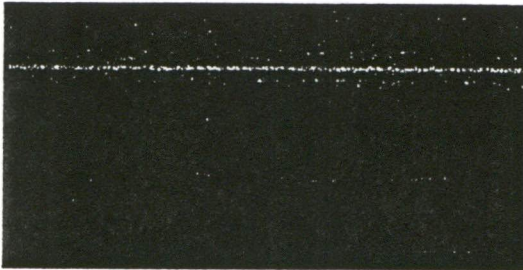
Feature 3

Visualization aids algorithm understanding

K10

Neural Networks

... we use it ...



Computational power aids algorithm understanding

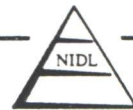
K11

AUL Roles

... helping to accelerate algorithm development ...

- Enhance communication within the government and industrial communities
- Facilitate collaboration
- Develop and promote benchmarks and standards

K12



Next Steps

... we want to work with you ...

- “Brainstorming” session Thursday afternoon
 - Sign-up sheets available at registration table
- Leave business card or note in drop-box at front desk
- Indicate interest on Evaluation Form
- Call Vic Korsun at (609) 734-2064 or Steve Miller at (609) 734-3245

K13

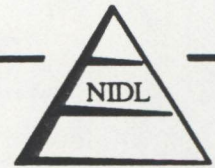


Conclusions

... developing in-depth understanding of algorithms ...

- The AUL exists today
- In-depth understanding through
 - computational power
 - visualization
 - interactivity
- We invite you to participate

K14



**The National Information Display Laboratory
Softcopy Review**

Interactive 3D Data Visualization
... Towards Real-time Mission Planning ...

Herb Taylor
Member, Technical Staff

January 22, 1992

Partner: Pat Hanrahan, Princeton University

Team Member: Jim Matey, Jim Kaba, Gordon Stoll, and Dave Kalokitis



The National Information Display Laboratory
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Interactive 3D Data Visualization

...Towards Real-time Mission Planning ...

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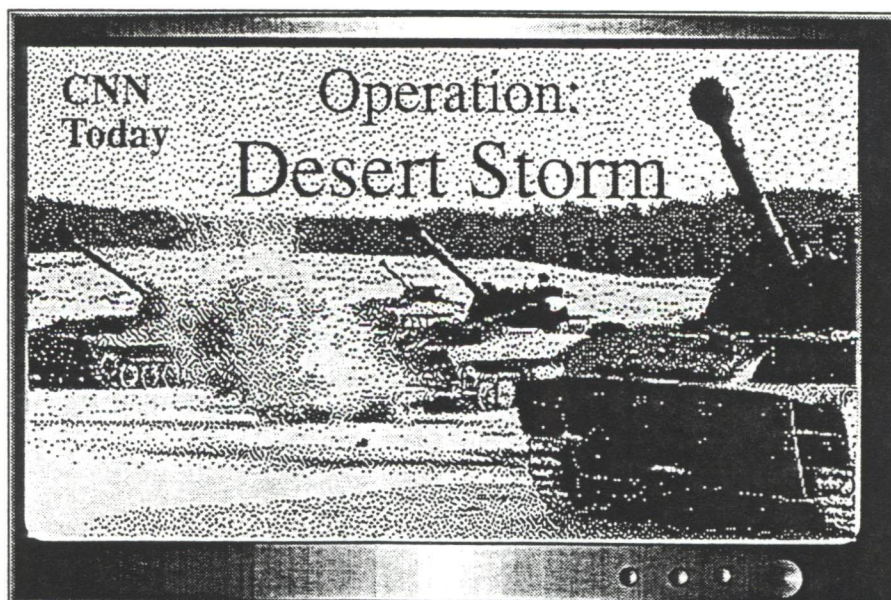
Team Members: Jim Matey, Jim Kaba, Gordon Stoll, and Dave Kalokitis

J1



The Mission Planning Bottleneck

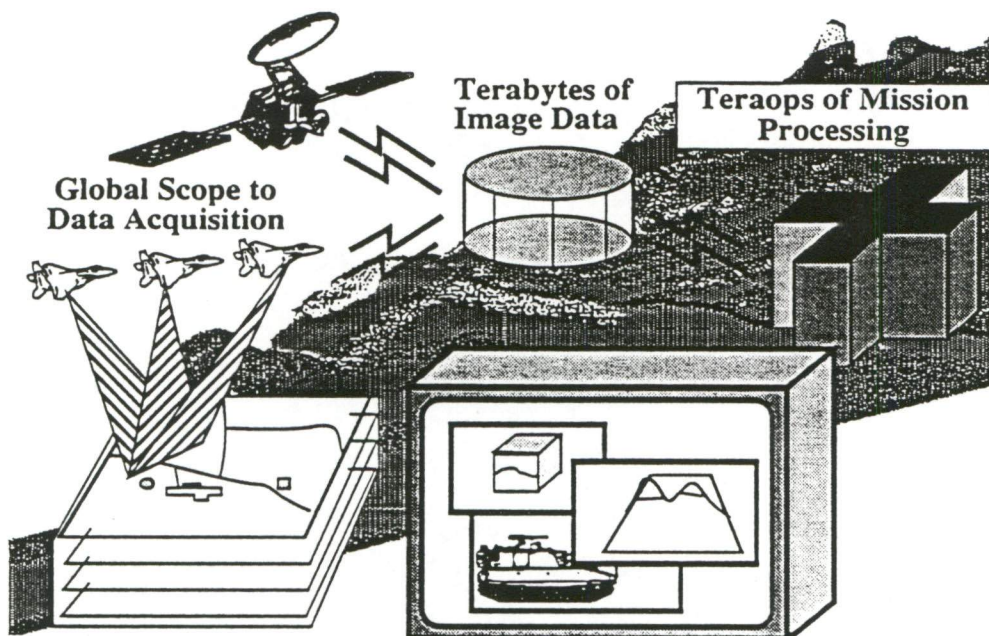
- Critical events develop rapidly on a global scale



J2

The Mission Planning Bottleneck

- Massive accumulation of diverse types of data
- Mission plan only useful NOW, not tomorrow



J3

Mission Planners Objective

... achieve a unified view of the Battlefield ...

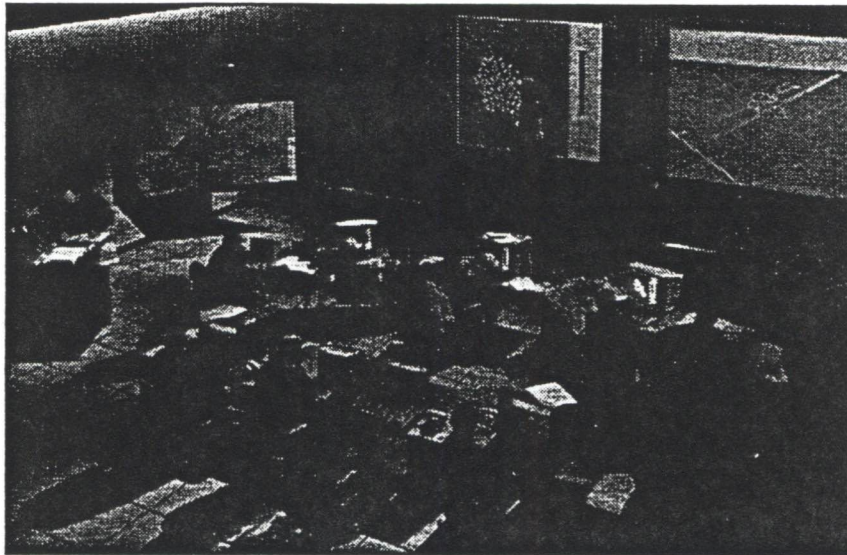
• Motivation

- Mission Planners *must* be able to keep pace with the rapidly developing Global battlefield
- They *must* have the ability to plan a mission *anywhere* in the world *while* critical events are unfolding
- They must be able to *combine* within a single computational framework diverse data types synthesizing where necessary entire new views of the theatre of operation

J4

Mission Planning Today

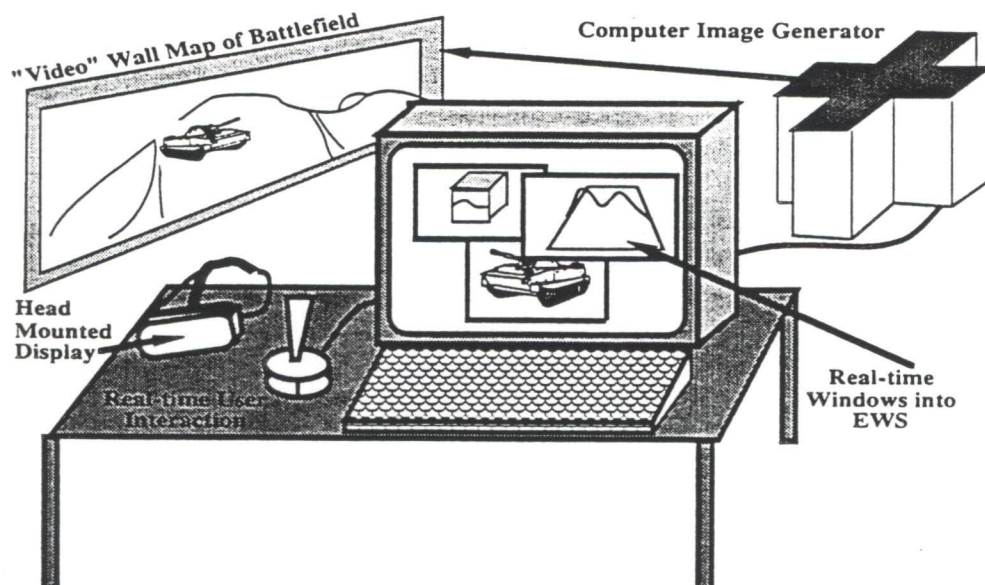
... modeled after AFOT , Sembach, Germany ...



J5

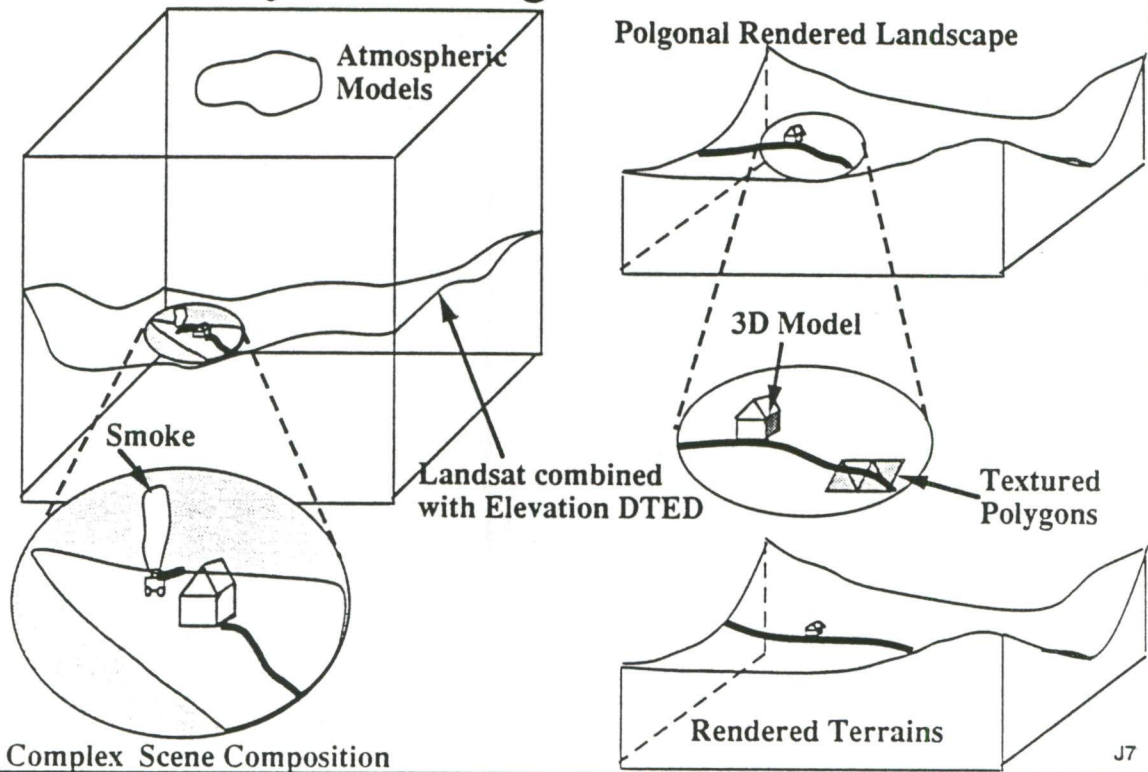
Mission Planning Tomorrow

... the Virtual Battlefield of the Future ...



J6

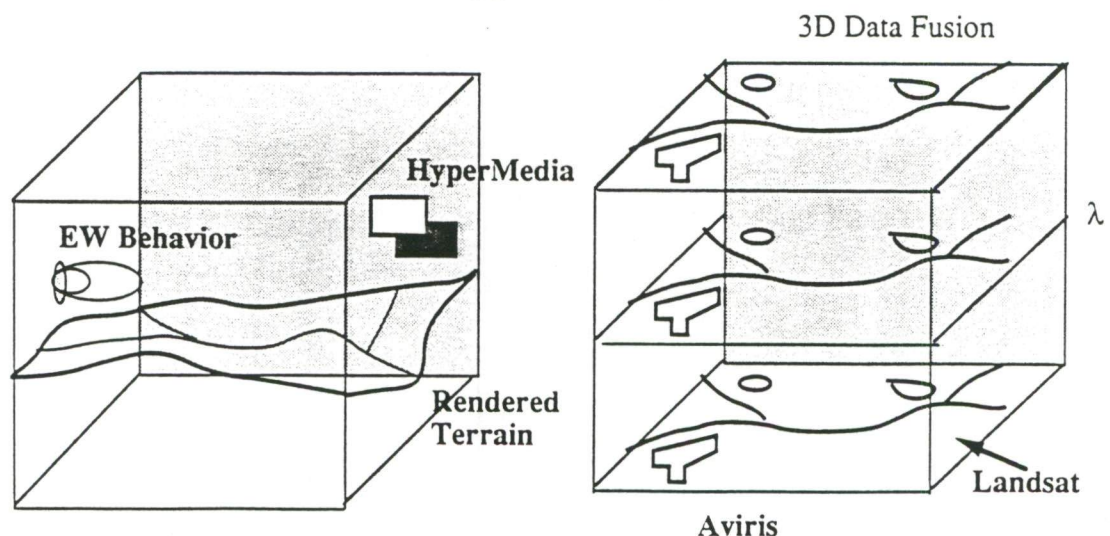
Synthesizing Mission Data



Synthesizing Mission Data

... 3D Display of colateral data ...

- 3D Data sets abound
 - Aviris, Statistical, Hypermedia, etc





The COTS Computer of the Year 2000 Will Be Capable of:

**1 GigaFlop
1 Gigabit I/O
1 Gigabyte Memory**

J9



Real-time Mission Planning

... requires new algorithms and architectures ...

- Overall Approach
 - *Combine* massively parallel architecture *with* algorithms to achieve near real-time 3D rendered scenes
 - Algorithms complement existing rendering methods and allow complex scenes to combine both polygonally and non-polygonally rendered data
 - Exploit Landsat and Digital Elevation
 - Exploit this image generation ability to demonstrate effective mission planning scenarios

J10

Rendering Algorithms

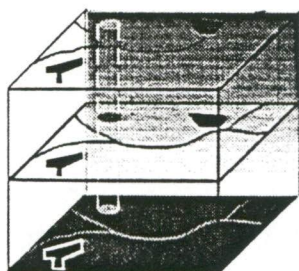
... summary of rendering algorithms ...

- Real-time terrain rendering at 30Hz
 - Combine Digital Elevation and Landsat
- Volume Rendering
 - Real-time at 4Hz for 256x256x256
 - 1 Second Rendering with real-time playback for 1Kx1Kx1K
- Complex Scene Composition
 - Fuse Heterogeneous Data - Polygonal and Non-polygonal

J11

Voxels, Polygons and Images

... matching algorithms with data structures ...



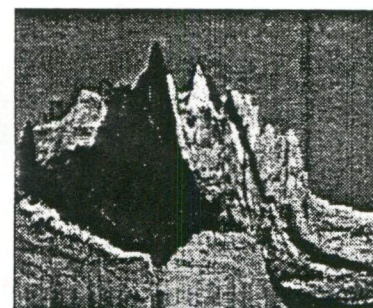
Key Idea - Volumes are generated directly from 3D Data

- Sampled Data remains in its original form without loss
- 3D Simulations cast directly into volumetric visualization



Key Idea - Scenes are represented by Geometry and movement by geometric transforms

- Scenes built from models
- Polygonal models reduce total amount of data



Key Idea - By exploiting 2D Transformations Terrain can be rendered very Fast

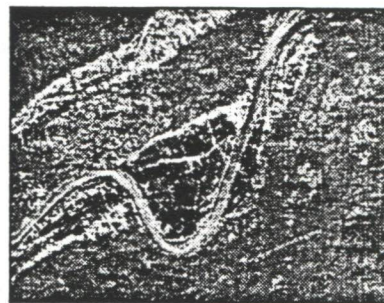
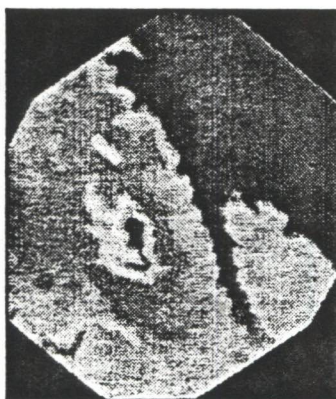
- Elevation Data is 2D
- Use Real-time 2D Rotation capability

J12



Terrain Rendering

- Construct 3D view from 2D DTED + 2D Landsat
- Real-time terrain rotation technique uses 3 pass shear algorithm.

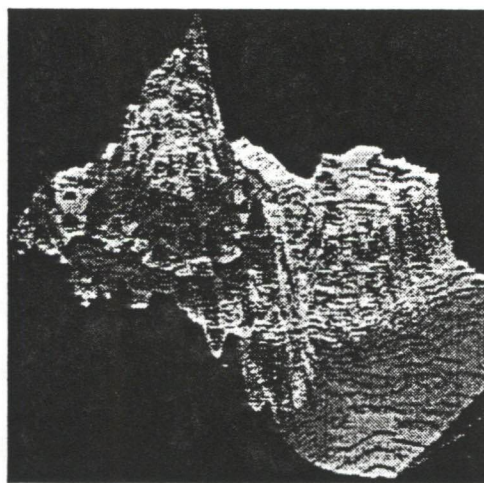
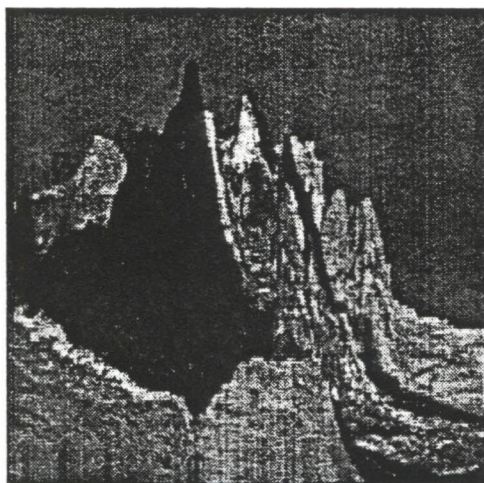


J13



Parallel Terrain Rendering

... future directions in Realistic Scene Rendering ...

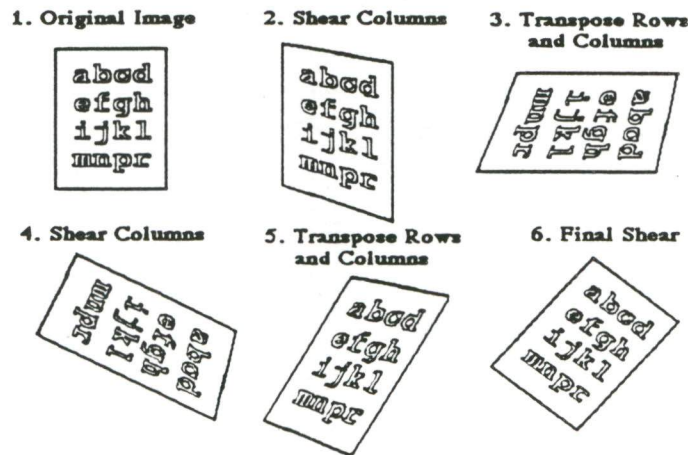


J14

Real-time 2D Rotate

... simple horizontal and vertical shears ...

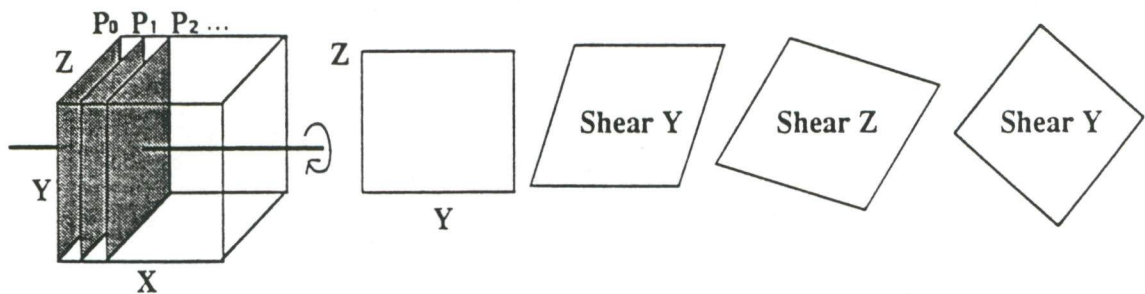
- Rotations are built from X and Y shears
- Princeton Engine real-time transpose facility turns X shears into "transpose + Y shears"



J15

Parallel Volume Rendering

... single axis volume rotation (about X) ...

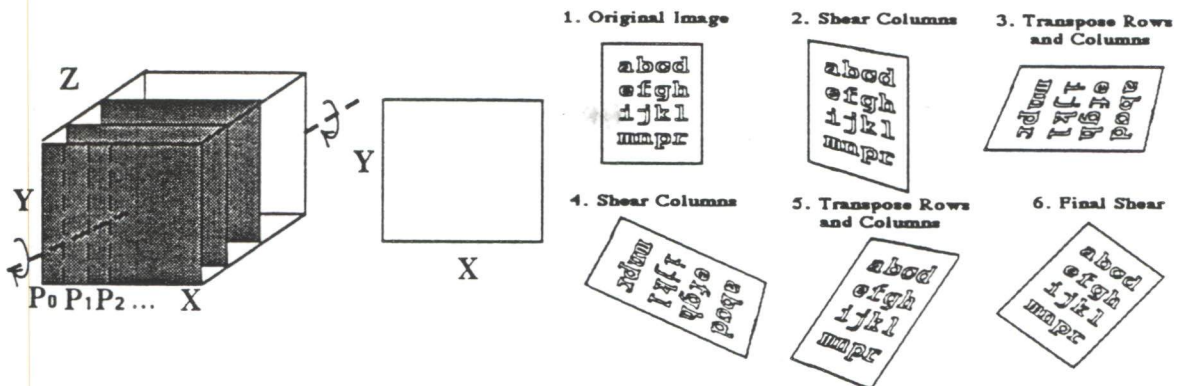


- Rotate Volume About the X axis
 - Give one Y-Z slice to each processor P₀, P₁ ... P_{n-1}
 - Use 2D algorithm on each "slice" in the Y-Z plane
 - Rotate each slice by three shears in Y, Z and Y

J16

Parallel Volume Rendering

... single axis Volume rotation (about Z) ...

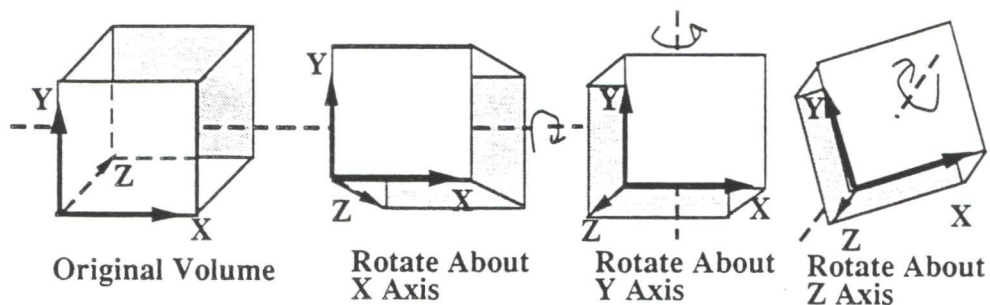


- Rotate Volume About the Z axis (X-Y plane)
 - Same as 2D rotate algorithm

J17

Parallel Volume Rendering

- General Rotation
 - Combine Single Axis and 2D rotation Algorithms



J18



"Re-Animator"

... interactive visualization real-time playback system ...

- **PROBLEM:**

How to create an on time Mission Plan when the ammount of image data far exceeds the processing power available

- Current COTS Systems are CPU, Memory and I/O Bound

- **SOLUTION:**

Develop a System which enables real-time animations to be created in seconds that would otherwise take *hours* or *days*

- Render and Visualize Extremely Large Data Sets
- Permits significant user control over display parameters
- While the Volume is rotating user can interact with data

J19



"Re-Animator"

... provides real-time visualization of large data sets ...

- **"Batch" Process Volume Rotation**

- Create animation by "slicing" each successive step of the rotation to form a smooth continuous motion sequence
- Rotate about X, Y or Z axis

J20

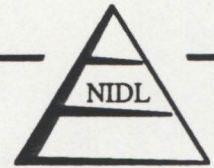


Towards Real-time Mission Planning

... future directions in Realistic Scene Rendering ...

- **Summary**

- The next generation of mission planners will require increasing interactivity in rendering - enabling near real-time turn around for critical missions.
- To accomplish this tools must be developed which combine architectures with new algorithms.
- Rendering Algorithms Must Match Data - need to merge "polygonal" scenes with "voxel" scenes to form single visualization framework



**The National Information Display Laboratory
Softcopy Review**

Display Technology and User Support

**Arthur H. Firester
Director, Display Technology**

January 23, 1992



The National Information Display Laboratory Softcopy Review

Display Technology and User Support

Arthur H. Firester
Director, Display Technology

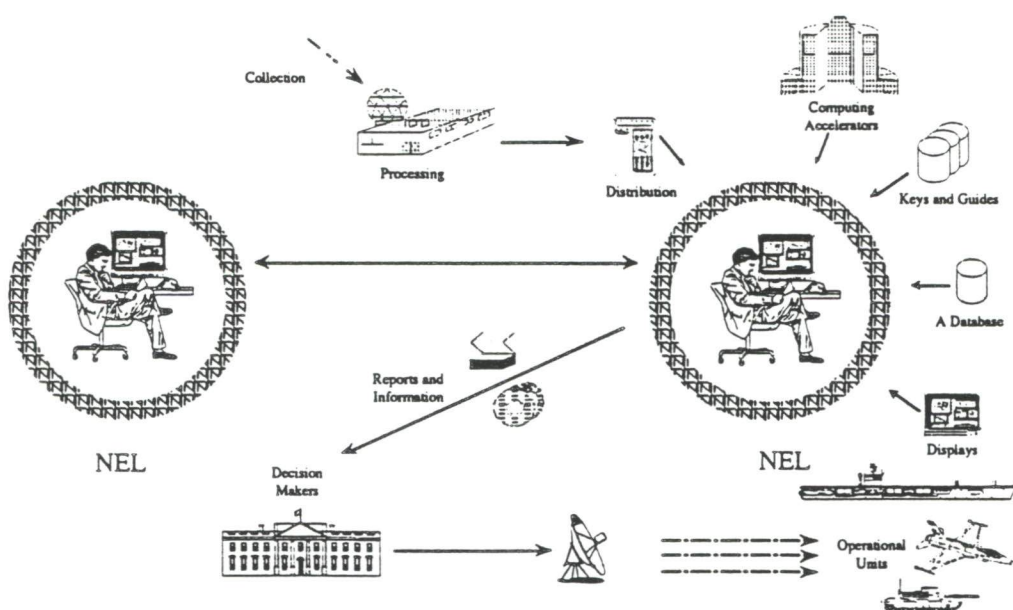
January 23, 1992

L1



The Analyst's Softcopy Environment

... putting the Analyst in control ...

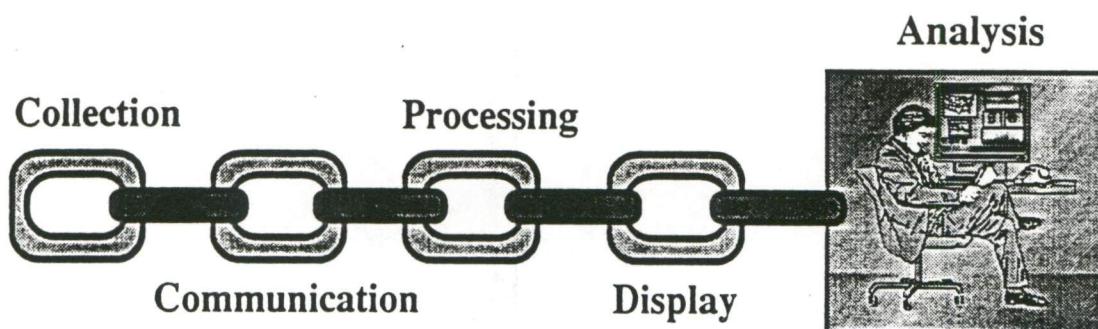


L2



The Display

*... the last link in the information chain
to the Analyst ...*

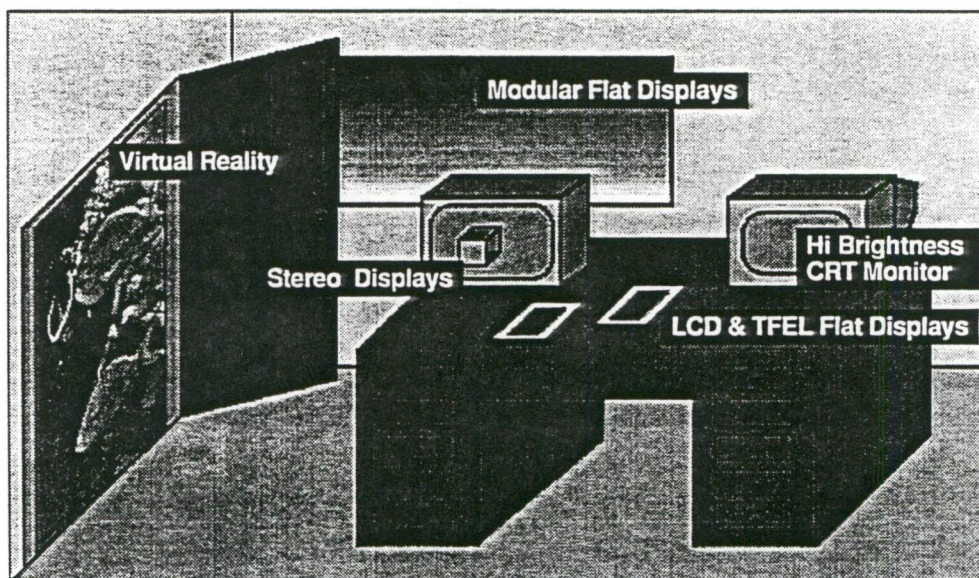


L3



Advanced Displays

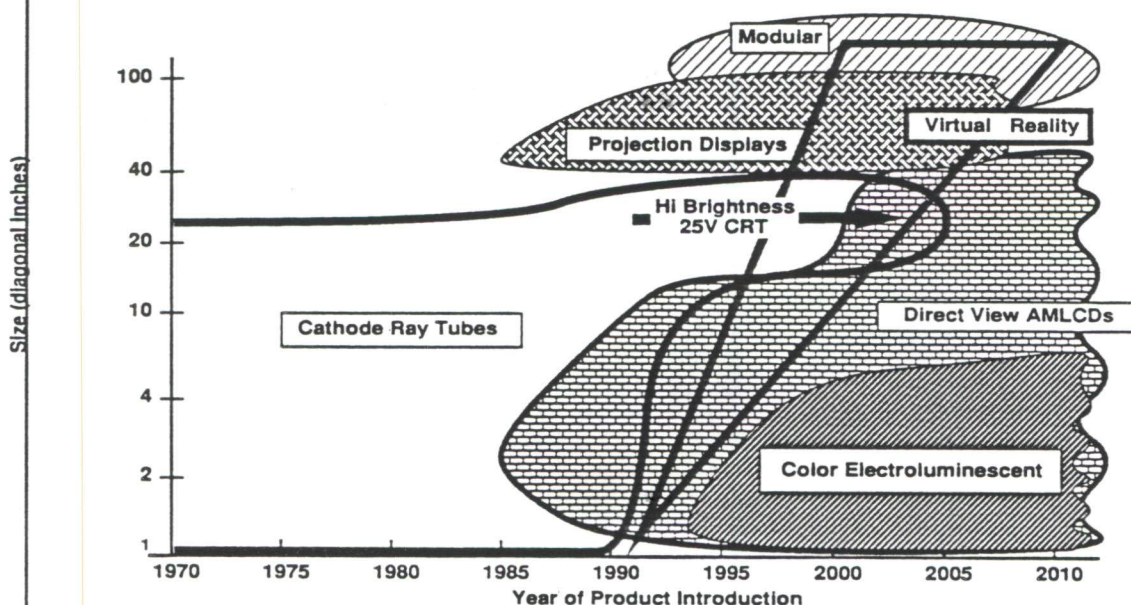
*... breadth of user needs drives a multiplicity of
display technologies ...*



L4

Technology Trends

... medium size CRTs will remain dominant for at least 10 more years ...



L5

Display Issues

... differing display needs drive simultaneous development of many display technologies ...

CRT

- Resolution vs. Brightness vs. Color compromise driven by basic physics

LCD

- Manufacturability
- Size and resolution
- System Reliability/Integration

EL

- Color
- Brightness

Tiling

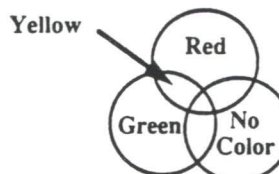
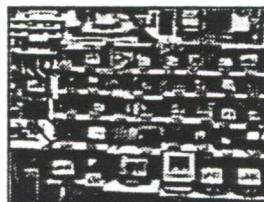
- Invisible Seams

Electronic Paper

- Basic electrically addressed display phenomena
- Reflected brightness and angular viewability

Virtual Reality

- Resolution matched to human eye
- Display goggles

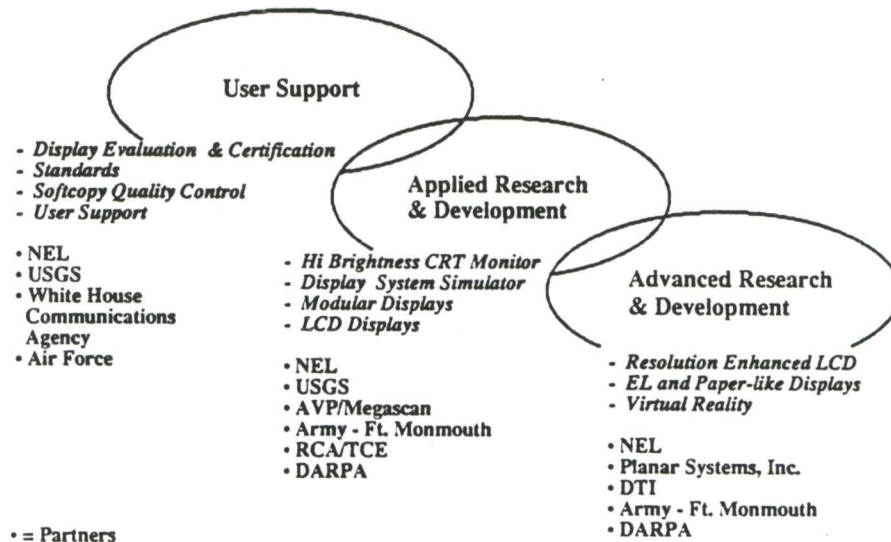


L6



NIDL Display Programs

... a technology spectrum supporting user's current and future needs ...



L7



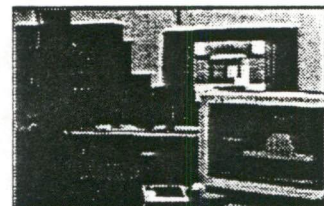
Display Evaluation and Certification

... helping the government user make the right monitor selection ...

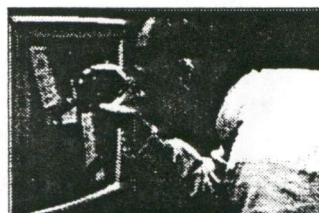
Measurement Procedures



Measurement Laboratory



Task Dependent Evaluations



Reports



L8



Display Measurement Standards

... to enable leveraging of technology, markets, and to broaden involvement ...

- Version 1.0 and 2.0 disseminated to users, manufacturers, and technical communities
- Version 3.0 in preparation for review by SID-EIA



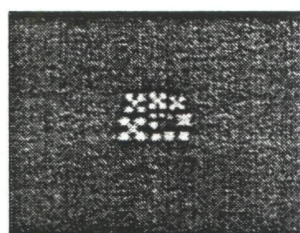
Measurement Procedures

L9

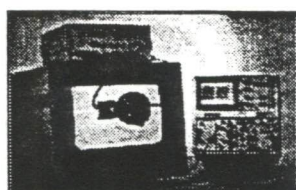


Softcopy Quality Control

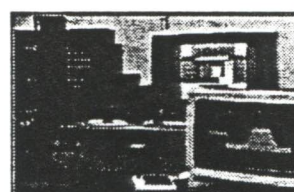
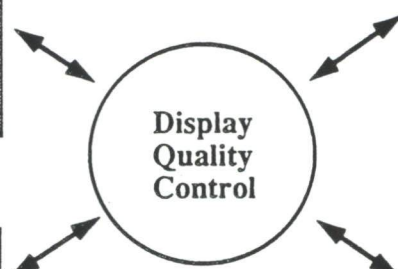
... on-site display performance evaluation to ensure user-specific softcopy quality control ...



User Test Software



User Test Hardware



Display Evaluation & Certification



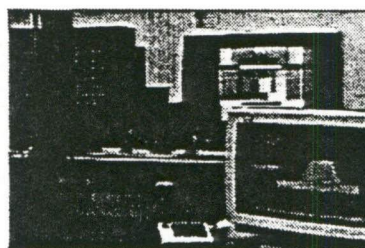
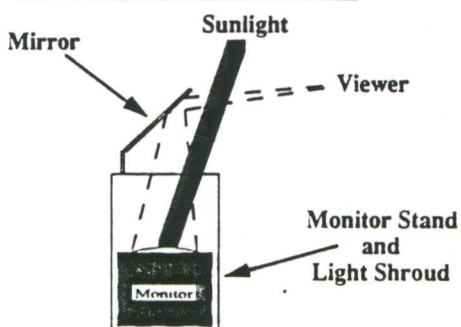
Display Simulator

L10



User Support

... timely response to user needs ...

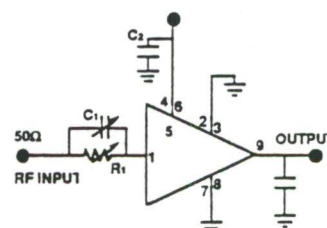
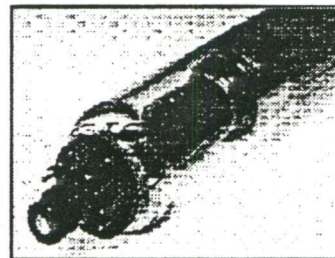
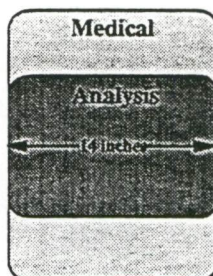
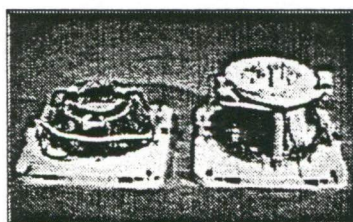
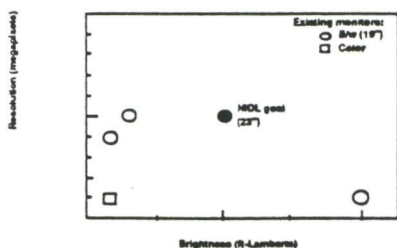


L11



High Brightness, High Resolution CRT Monitor

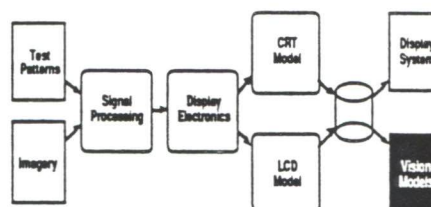
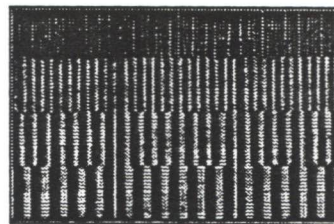
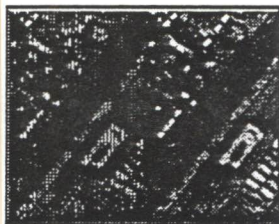
... high brightness, uniform resolution, large screen COTS monitors are needed but not available ...



L12

Display System Simulation

*... simulation enables rapid display system specification
and eliminates extensive, costly, slow prototyping ...*



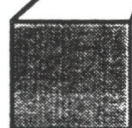
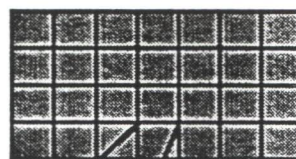
Data Flow Design Paradigm

L13

Modular Displays

*... wall displays built cost effectively by seamless
tiling of individual units ...*

- Determine psychophysical requirements for invisible seams
- Evaluate tiling concepts through modeling and simulation
- Evaluate and prioritize technologies
- Develop approach satisfying requirements



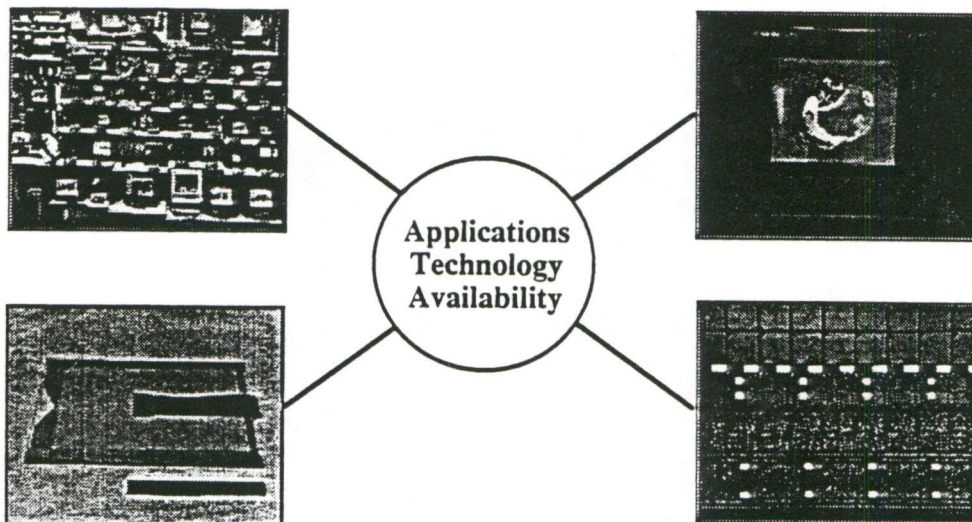
Example
14-inch diagonal
1024 x 768 pixels
0.28 mm/pixel



L14

Active Matrix LCDs

... active matrix liquid crystal displays are becoming the dominant display technology ...



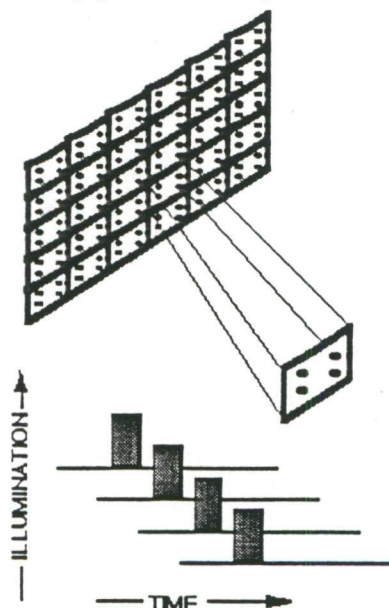
L15

Resolution Enhanced LCDs

... multiplying resolution without reducing production yields ...

Dimension Technologies Inc.

- Demonstrate 4X enhanced resolution through subpixel sequential illumination
- Explore engineering issues
- January '92 contract start

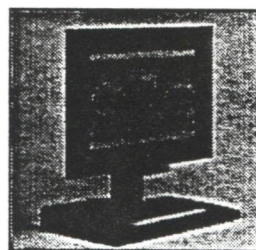
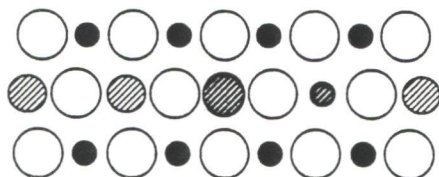
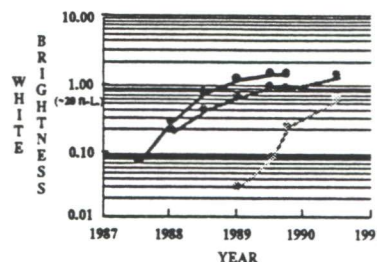
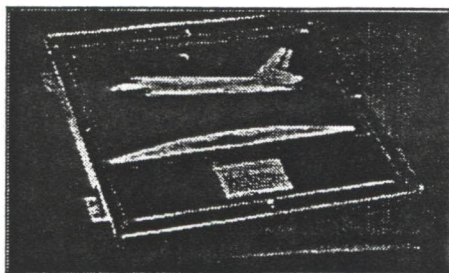


L16



Color EL Display Development

... lack of an efficient blue phosphor is technology bottleneck ...



A full partnership program with Planar Systems, Inc.

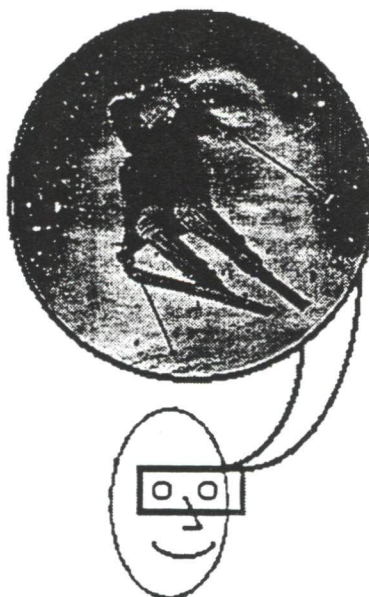
L17



Virtual Reality

... head-mounted displays demonstrate the most promise for near-term development ...

- Active Matrix LCD
 - 1500 lines/inch
 - integrated drivers
 - full color now
- Active Matrix EL
 - 1000 lines/inch
 - integrated drivers
 - full color soon
 - fully solid state
- Deformable Mirror Device
 - 1500 lines/inch
 - integrated drivers
 - full color now
 - very accurate grayscale

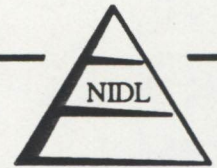


L18



Summary

- **Display technology is undergoing simultaneous evolution and revolution**
- **NIDL technology and user support programs are in place to address government user needs of today and the future**
- **NIDL seeks more users and partners to steer and implement our programs**



**The National Information Display Laboratory
Softcopy Review**

**Display Evaluation
and Certification**

**Phil Heyman
Head, Advanced Technology**

January 23, 1992

**Team Member: Peter Wojtowicz, Larry Hammer, Mike Polak,
Mike Grote, and Jim Beherrell**



The National Information Display Laboratory
Softcopy Review

Display Evaluation and Certification

Phil Heyman
Head, Advanced Technology

January 23, 1992

M1

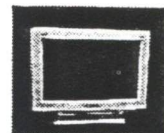
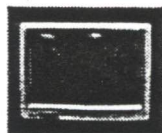
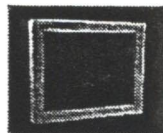
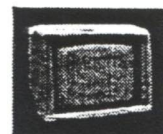
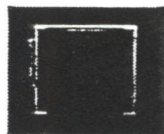
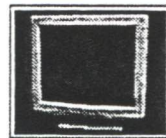


Need for Display Evaluation

*... helping the government user make
the right monitor selection ...*

To find the right monitor within budget

- New applications
- Wasteful multiple searches
- Incomplete specifications



M2



Display Evaluation Status

*... providing timely information to
government display users ...*

Company/Model	Addressability	Size	Mode	Requester
Sony GDM1950	1280x1024	19V	Color	Navy
Hitachi HM5219	1280x1024	19V	Color	Navy
Tektronics GMA201	2048x1536	19V	Mono	Navy
Megascan UHR4820	2560x2048	19V	Mono	NEL
Sony GDM1936	1280x1024	19V	Color	Navy
Hitachi HM4320	1280x1024	19V	Color	Navy
Tektronix GMA203	1024x1024	19V	Mono	NEL
Conrac 7550	1600x1280	19V	Color	E Systems
UBEX 2019	1600x1280	19V	Color	E Systems
Image Systems C2ILMAX	1600x1280	19V	Color	E Systems

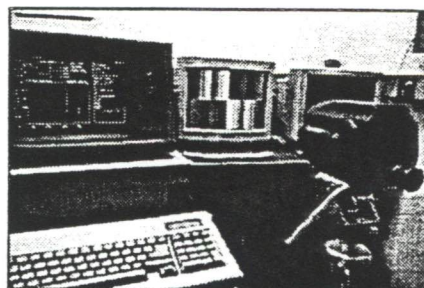
M5



Display Evaluation Status

*... COTS equipment and universal standards facilitate
monitor evaluation and selection ...*

- Continued to drive for monitor measurement standardization
 - Working through SID/EIA
 - Version 3.0 for 5/92
- New evaluations and measurements
 - Color monitor linewidth
 - Convergence
 - Spectroradiometry

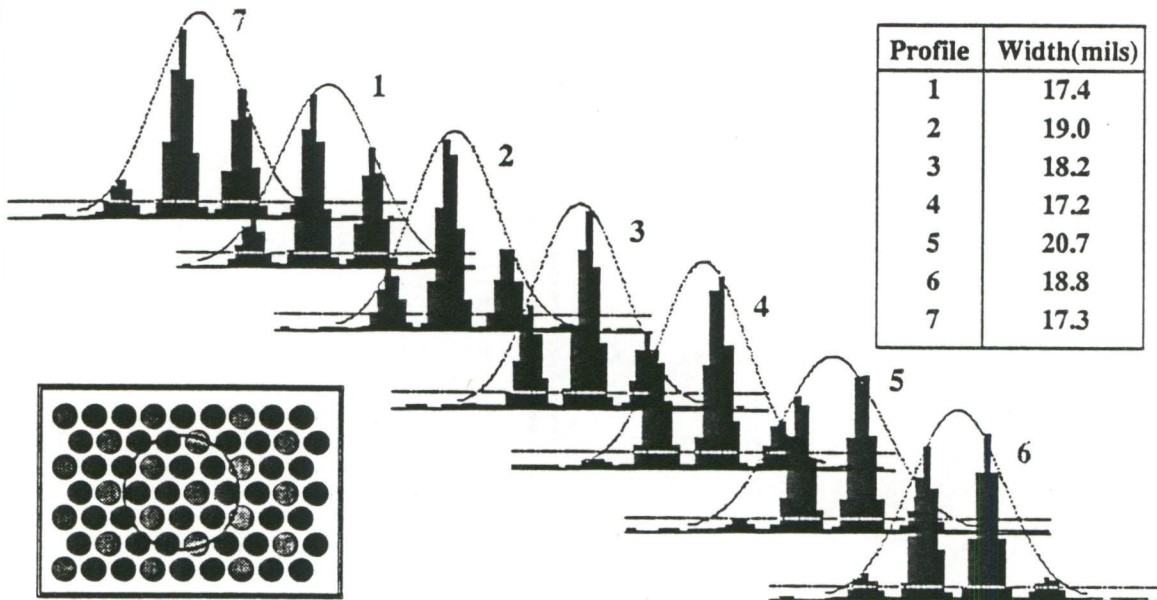


M6



Color Monitor Linewidth Measurement

... making measurements on sampled data ...

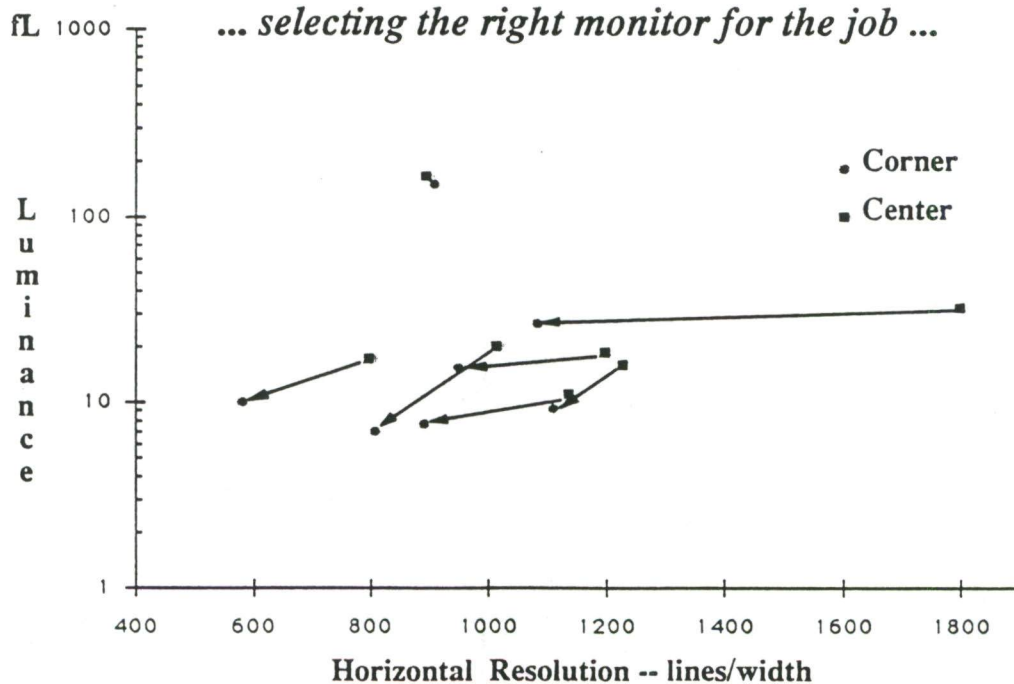


M7



Monitor Summary

... selecting the right monitor for the job ...

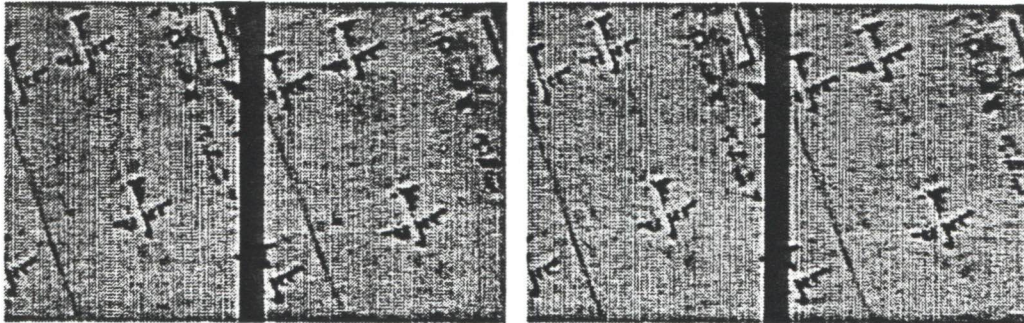


M8



Center-to-Corner Rolloff

... what it really means ...



Center
1230 l/w

Corner
1100 l/w

Center
1200 l/w

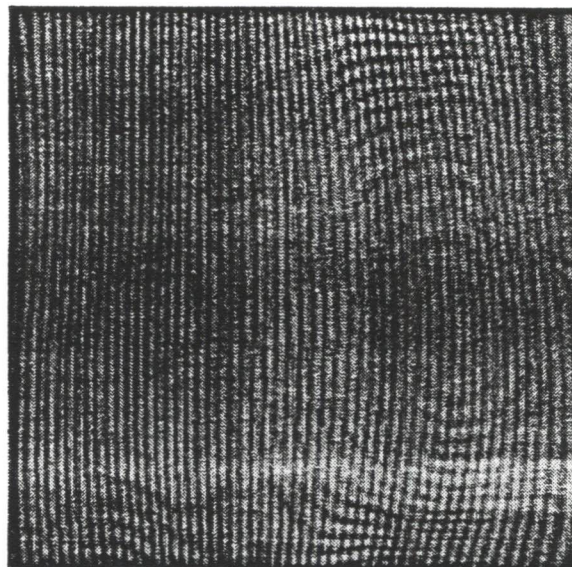
Corner
950 l/w

M9



Moire

... what you see may not be there ...



M10



Display Evaluation Plans

... continued service to the community ...

Near term

- Monitor Measurements
- Move standards toward acceptance
- Circulate "Monitor Reference Library"
- Establish monitor viewing room



Longer range

- Projection
- Flat Panel

M11



Upcoming Measurements

*... quantifying the important monitors
for the community ...*

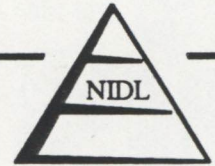
- Typical COTS workstation monitors
- Imp. Tektronix GMA 201 2048x1536 19V Mono
- Imp. Megascan UHR4820 2500x2000 19V Mono
- Sony DDM2801 2048x2048 28V Color
- Chromatics 2500 2500x2000 27V Color
- Orwin 1599 2048x2048 21V Mono
- Orwin C2900 1600x1200 27V Color

M12



Summary

- Color monitor resolution roughly half specified addressability
- No correlation between resolution and addressability
- Data is available on 10 monitors
- Standardization effort on schedule
- We want your input



**The National Information Display Laboratory
Softcopy Review**

**Application of Visual Models to
Display Evaluation**

**Robert Amantea
Program Manager**

January 23, 1992

Partner: NASA

Team Members: Jane Asmuth and Jeff Lubin



**The National Information Display Laboratory
Softcopy Review**

Application of Visual Models to Display Evaluation

**Robert Amantea
Program Manager**

January 23, 1991

Partners: NASA

Team Members: Jeff Lubin and Jane Asmuth

N1



Visual Modeling

... relating display performance to vision tasks ...

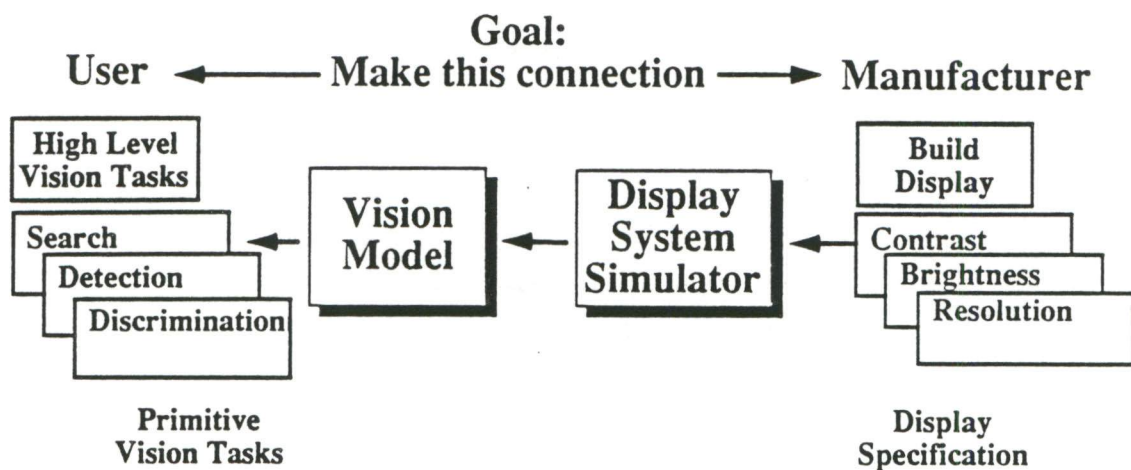
- **Need:**
 - Assist in developing display performance criteria for imagery exploitation tasks
- **Approach:**
 - Develop model of human visual task performance that uses real imagery
 - Use Display System Simulator to provide imagery
 - Calibrate and validate model with visual experiments
- **Benefit:**
 - Evaluates display using real visual interpretation tasks
 - Minimizes time spent on display evaluation

N2



The Visual Modeling Solution

... from visual task to display specification ...



- Integrates display and human vision model
- Connects high level vision task to display specification

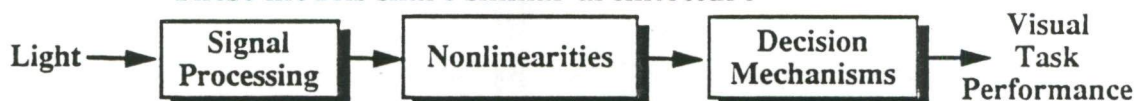
N3



Modeling Strategy

... build on established models ...

- Leverage vision models that already have been used in display evaluation
 - They are effective when applied to simple stimuli and tasks e.g., JND Model predicts visibility of 1D patterns
 - These models share similar architecture



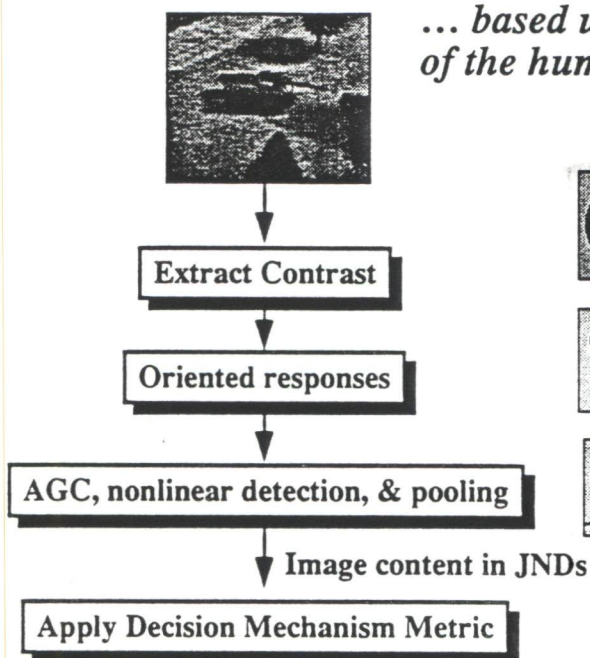
- Use real imagery
- Extend signal processing to higher dimension signals
 - 2 Spatial Dimensions
 - Time
 - Color
- Incorporate decision mechanisms for higher level tasks
 - e.g., Find the Tank!

N4

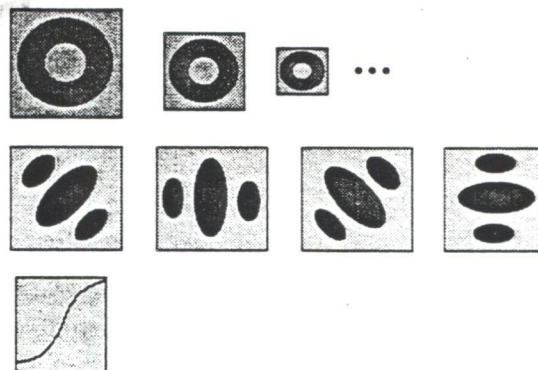


Vision Model Structure

*... based upon the physiology
of the human visual system ...*



pyramid technology

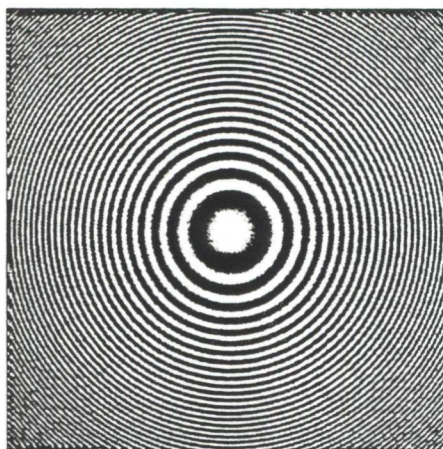


N5



A Visual Model Test Signal

... a useful tool to explain the model ...



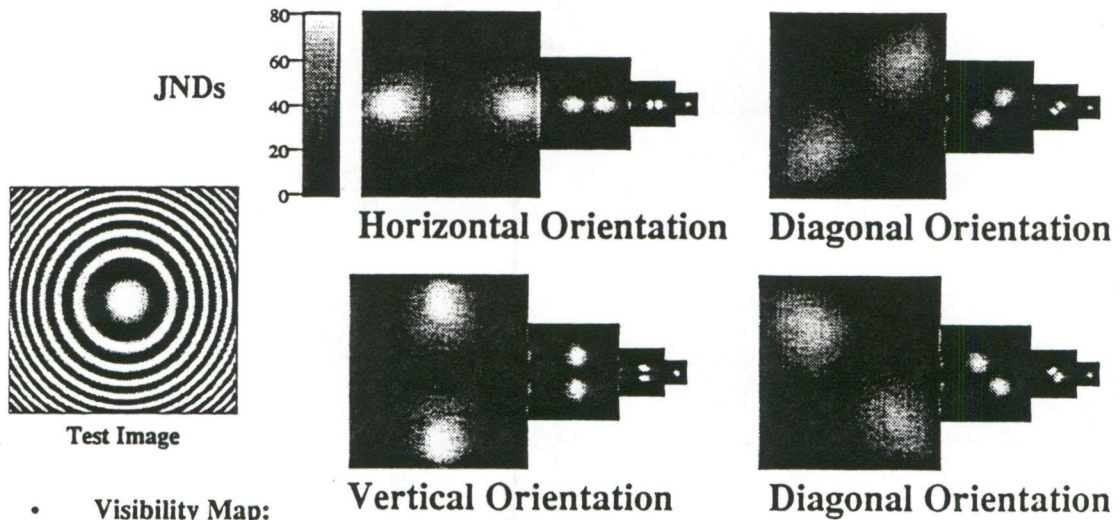
Test Image

- This test image contains all spatial frequencies
 - (2-24 cycles per degree)
- Circular geometry contains all spatial orientations

N6

Oriented Visibility Maps

... a 4 dimensional display of image information ...

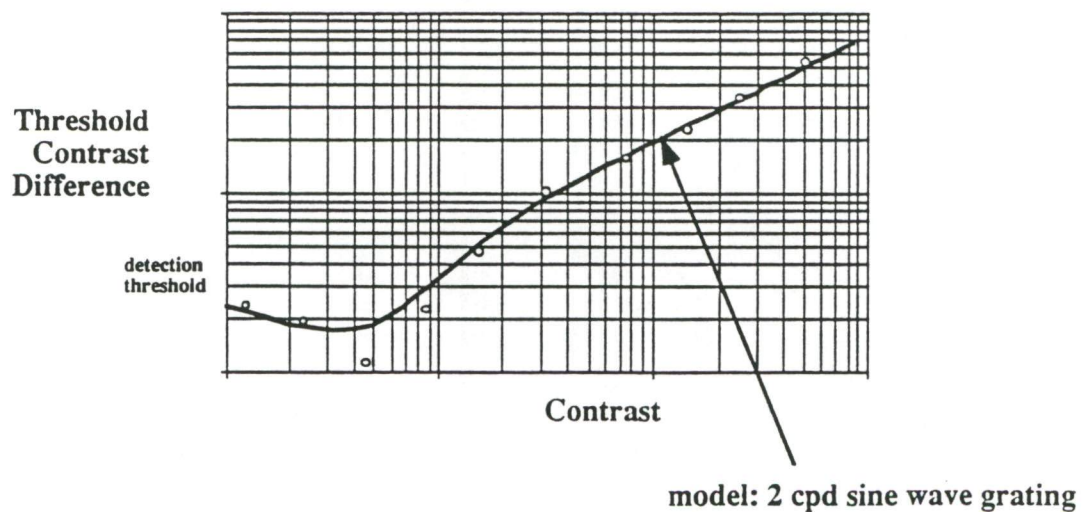


- Visibility Map:
 - Frequency dependent distribution of information in an image measured in JNDs
- Dimensions
 - x, y, spatial frequency, orientation

N7

Verification and Calibration

... comparing model to experimental data ...

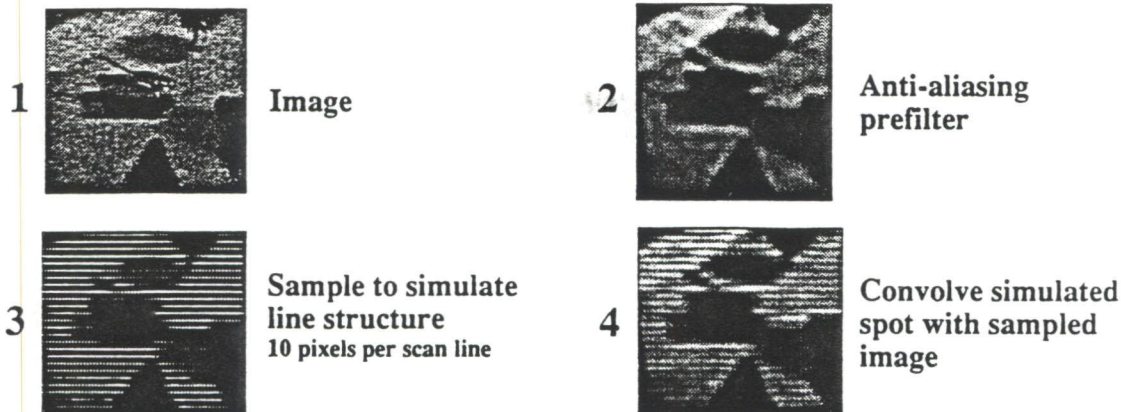


N8



Simulating a CRT Scanned Image

... creating imagery for the visual model ...



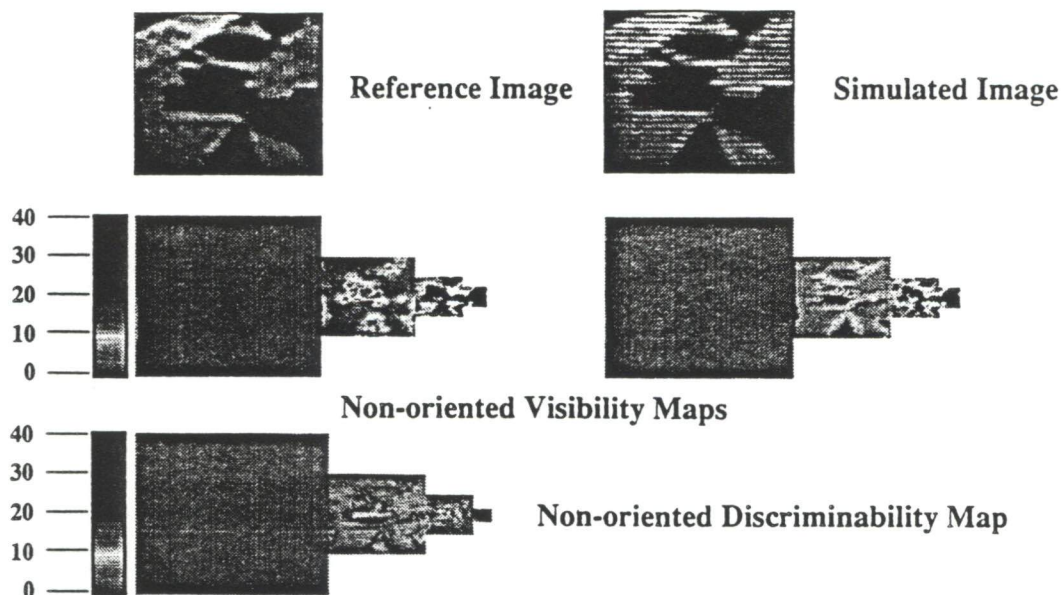
Scan line spacing: 12 mils
Screen size for 1000 lines: 12"
Image size: 0.3" (3.5°)
Viewing distance: ~10"

N9



Constructing a Discriminability Map

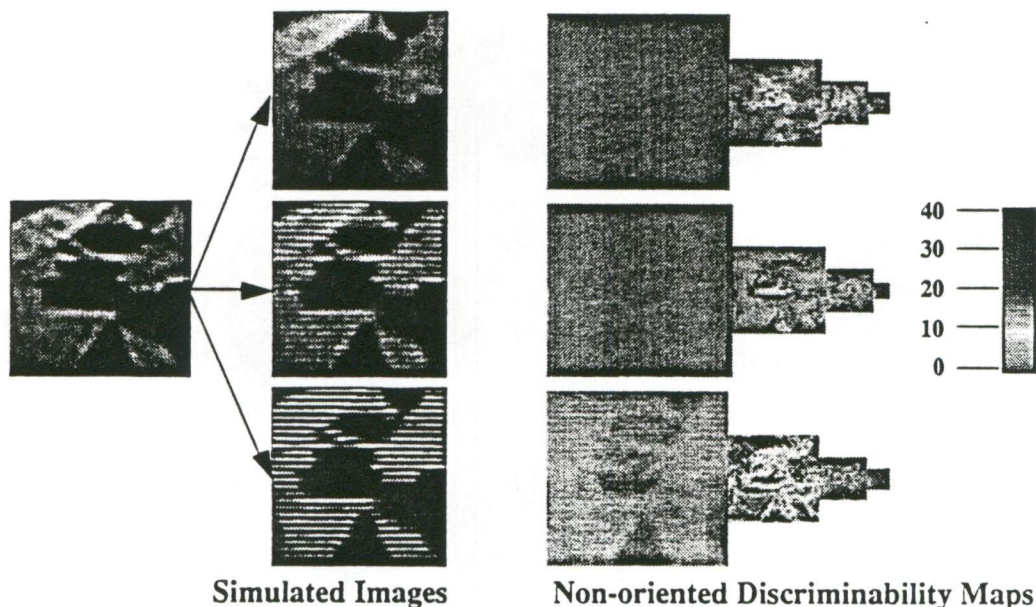
... identifying the visible changes in the image ...



N10

Images with Varying Spot Size

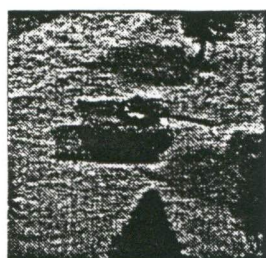
... identifying the best match to the reference image ...



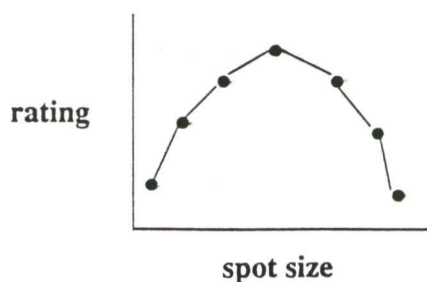
N11

Quantitative Experiments

... validating the visual model ...



- Simulate images with varying spot size
- Perform rating experiment
- Compare optimum spot size from rating to that from vision model



N12



Summary

... satisfying the user needs ...

- Psychophysics based model applicable to a wide variety of visual tasks
- Applied the model to display performance for real imagery
- Model is still under development, but...
 - Applicable to some problem areas today
 - We have experts
 - Let us help you with your application

N13

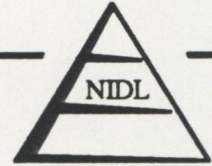


Future Work

... extending the range of applications ...

- Apply existing model to applications with real imagery
- Exercise model against wider set of CRT & LCD artifacts
 - e.g., pixel mosaic, jaggies
- Extend to more complex signals
 - e.g., color, time, stereo
- Extend to other tasks
 - e.g., search

N14



**The National Information Display Laboratory
Softcopy Review**

Softcopy Quality Control

**David R. Patterson
Project Leader**

January 23, 1992

**Team Member: Albert Pica, John Morrissey, Tom Marett, and
Bob Browne**



The National Information Display Laboratory
Softcopy Review

Softcopy Quality Control

David R. Patterson
Project Leader

January 23, 1992

Team Members: Al Pica, John Morrissey,
Tom Marett and Bob Browne

O1



Display Users Needs

... high performance over time to insure display quality ...

NEEDS:

- Accurate display of critical information
- Reproducible, dependable and COTS displays
- Display performance requirements related to users' visual tasks
- Measurements that are consistent with standards and application

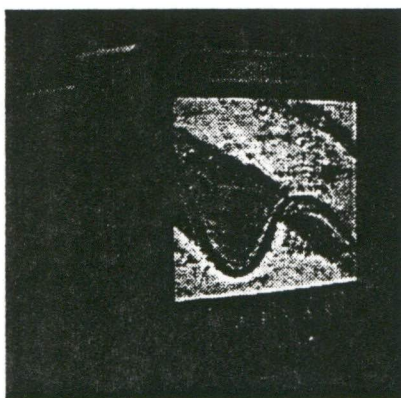
**"Is my display *still* good enough
to do the job ?"**

O2



Softcopy Quality Control

... broad range of users who require high performance ...



<u>Application</u>	<u>User</u>
Exploitation	NPIC, NEL
Image interpretation	USGS
Cockpit displays	NASA
Air traffic control	FAA
Filmless radiology	NIH

O3



Technical Approach

... leverage NIDL technology developments ...

- Use standardized measurements of COTS displays to define baseline performance
- Develop user self-test *software* for direct display characterization
- Develop user self-test, *hardware* for display characterization
- Provide *guidelines* for a quality program for softcopy displays
- Develop hardware vendor relationships for commercialization

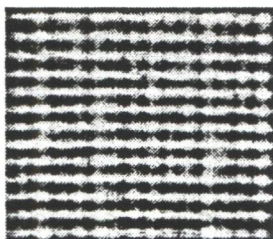
O4



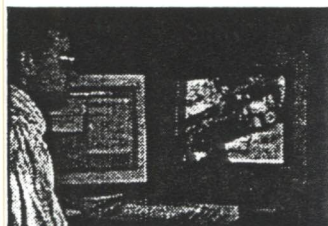
Synergy With NIDL Technology

... use of other NIDL resources to improve quality control ...

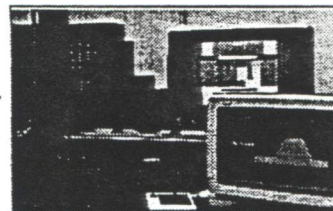
Field Support



Display Simulator

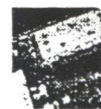


Display Evaluation & Certification



Visual Models

High
Resolution
Image



Lower
Resolution
Image



DISPLAY
QUALITY
CONTROL

05



Defining Quality

... control after defining quality ...

Geometric

Viewing Distance

Size

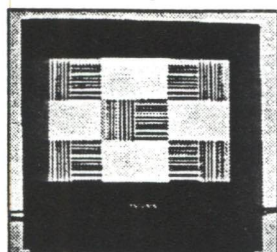
Aspect Ratio

Scanning Lines

Interlace/Progressive Scan

Scan Line Spacing

Linearity



Electrical

Bandwidth

Dynamic Range

Signal To Noise

Frame Rate

Field rate

Photometric

Brightness

Gray Scale

Contrast Ratio

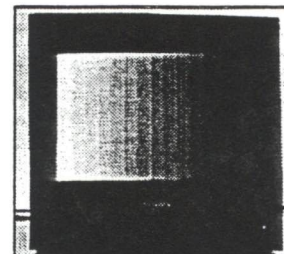
Color

Resolution

Spot Size

MTF

Uniformity



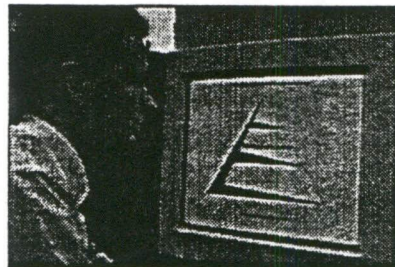
06

User Self Test Software

... self-test software for display evaluation ...

Concept: Fast check for users of COTS workstations without the need to disturb the normal display environment

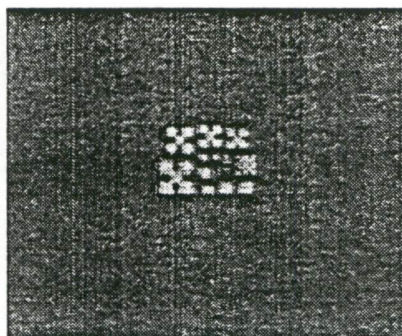
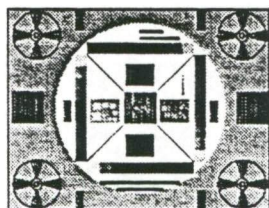
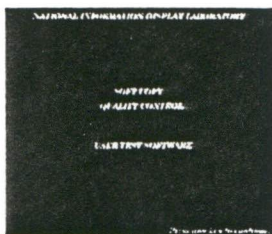
- Initial display adjustment of brightness and contrast
- Menu driven self evaluation with several patterns and a system for user rating
- Results scored and retained for future reference and evaluation



07

Status: Software Evaluation

... software program for direct display evaluation ...



Use User Workstation
Display Evaluation Software

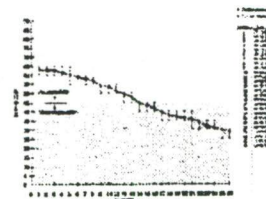
Operating Instructions

The user workstation displays a test pattern to be used to adjust your display. The display's brightness and contrast, settings to adjust the quality of your display, are displayed. Check settings, the instructions for full or more settings for your workstation.

Step 1:
The workstation will test the test of the display settings. The settings will be in different positions and brightness levels. For each setting, press the center and the monitor back with your right hand, and then press the left mouse button.

Step 2:
The workstation will test the test of the display settings. The settings will be in different positions and brightness levels. For each setting, press the center and the monitor back with your right hand, and then press the left mouse button.

Press any key to continue.



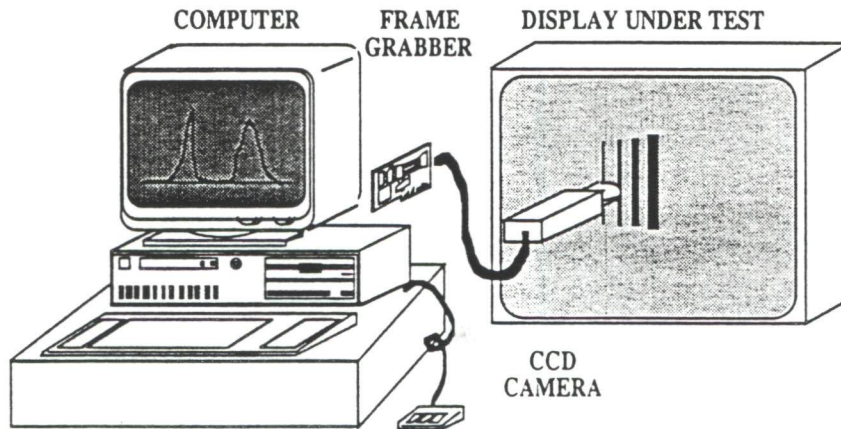
Software copies and applications material available next month.

08

On Site Hardware

... on-site system for comprehensive display evaluation ...

Concept: COTS, on-site, portable, test equipment for fast characterization of display performance

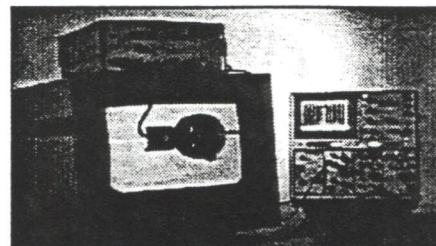
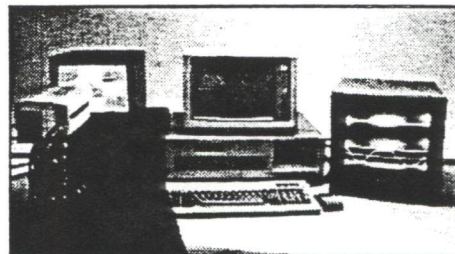


O9

Status: On-site Hardware

... in-house development to influence future COTS products ...

- Assembling in-house CCD/Frame grabber test system
- Identified COTS Equipment
- Survey of support software, hardware



O10



Guidelines

... procedures to ensure task specific display performance ...

Concept: Guidelines are the *glue* that hold together
quality control, on-site, software and hardware

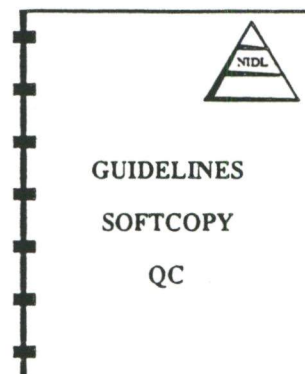
Version 1.0

How to:

- make display adjustments
- use on-site software
- use on-site hardware

Version 2.0

Task specific guidelines



O11



Status: Guidelines

... formal definitions of testable factors affecting quality ...

**Preliminary review of measurable characteristics
in a self-test, user system**

- Dynamic Range
- Linearity
- Brightness
- Contrast
- Gray Scale
- Uniformity

Intensity

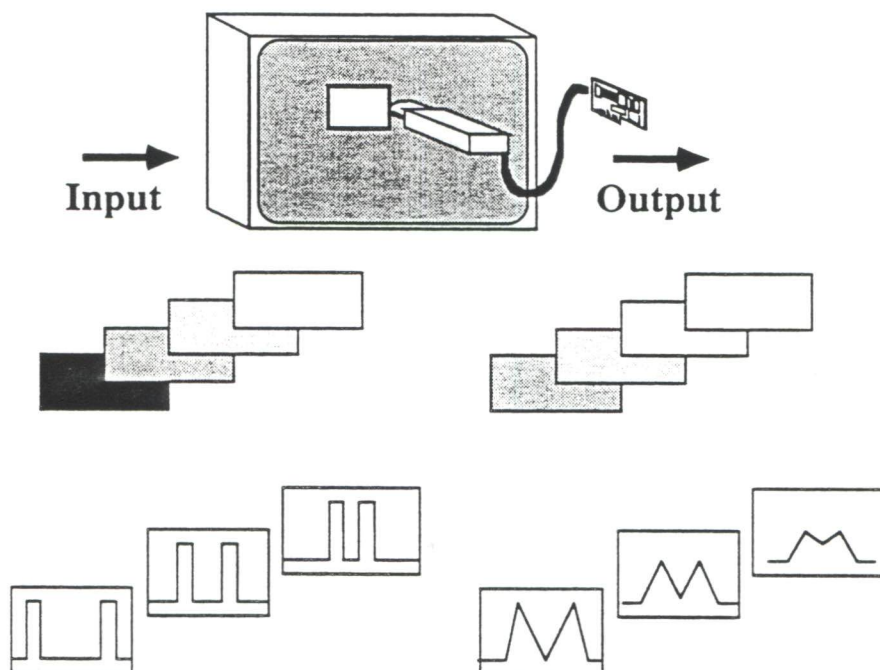
- Bandwidth
- On-Off Pixel Performance
- MTF

Resolution

O12

Intensity & Resolution

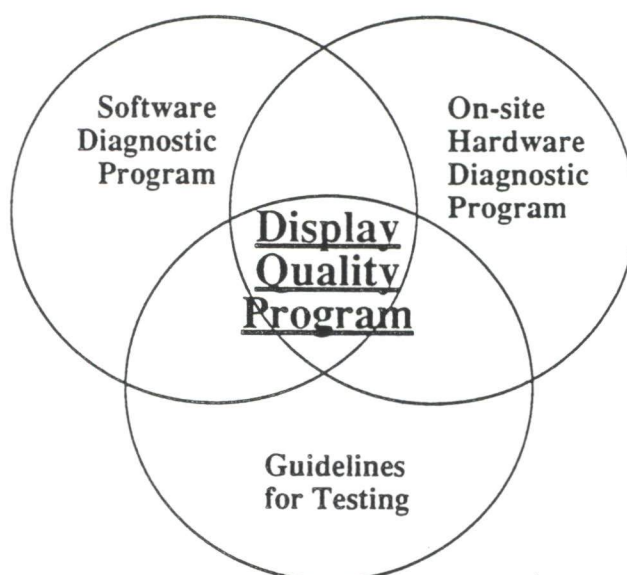
... tests to determine quality in a QC program ...



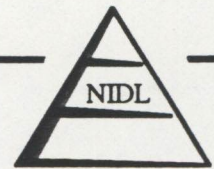
O13

Summary

... three tasks leading to a quality program ...



O14



**The National Information Display Laboratory
Softcopy Review**

Electroluminescent Displays

**P. Niel Yocom
Program Manager, Luminescent Displays**

January 23, 1992

**Partner: Planar Systems, Inc., U.S. Army Laboratory Command - ETDL
Team Member: Jim Kane, Mildred Ling, Sandra McClelland, and
Diane Zaremba**



The National Information Display Laboratory Softcopy Review

Electroluminescent Displays

P. Niel Yocom
Program Manager,
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Partners: Planar Systems, Inc., U.S. Army Laboratory Command - ETDL
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P1

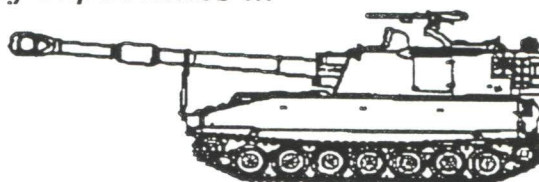


Wanted: A Much Better Display

... powerful range of capabilities ...



- Flat & thin
- Rugged
- Wide temperature range
- Emissive - full color
- Bright/high contrast
- Low power
- Scalable in size
- High resolution
- Wide viewing angle



P2

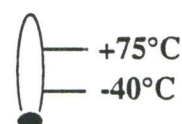
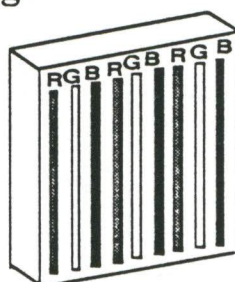
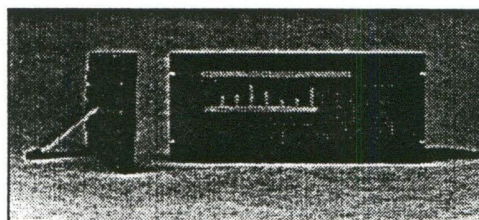
Thin Film Electroluminescence (TFEL)

... poised to be the dominate display of the next decade ...

Present Capabilities:

thin-flat
rugged - all solid state
>160° viewing angle
high resolution
wide temperature range
high contrast

Needs Full Color

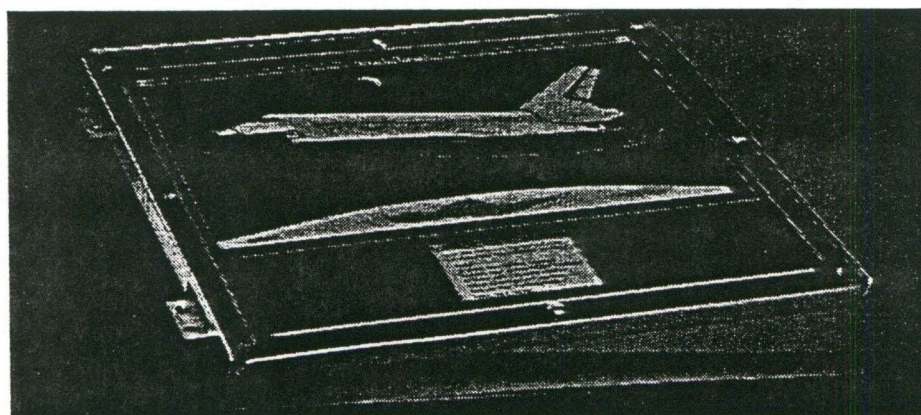


P3

TFEL Displays 1991

... present state-of-the-art ...

- Commercial displays
 - In production:
 - monochrome yellow: up to 18-in. diagonal

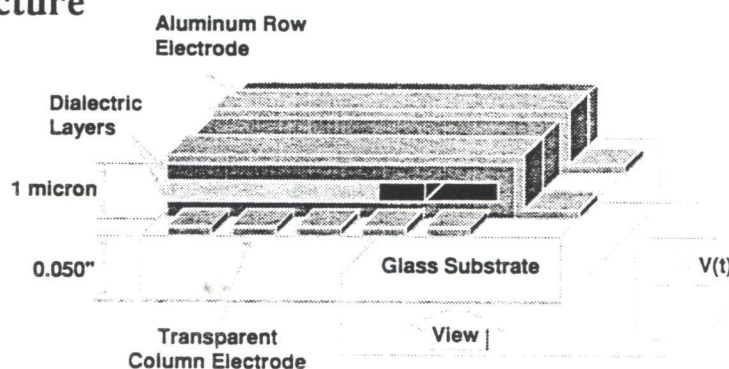


P4

Structure of Present Commercial Displays

... films and strips ...

- Technology Benefits
 - high resolution
 - ease of manufacture
 - all solid state



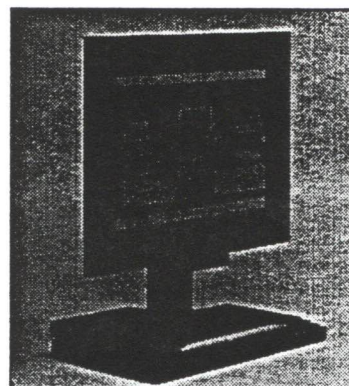
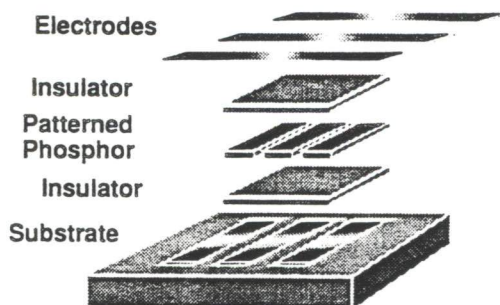
P5

Multicolor EL Displays

... multiplexed color ...

Structure of multicolor display

Two color
- red, green prototypes available



P6



Partners in NIDL Technology Development

... bringing EL to commercial and government users ...

Planar Systems, Inc. of Beaverton, Oregon
World's major producer of EL displays

U.S. Army Laboratory Command - ETDL
Fort Monmouth, New Jersey

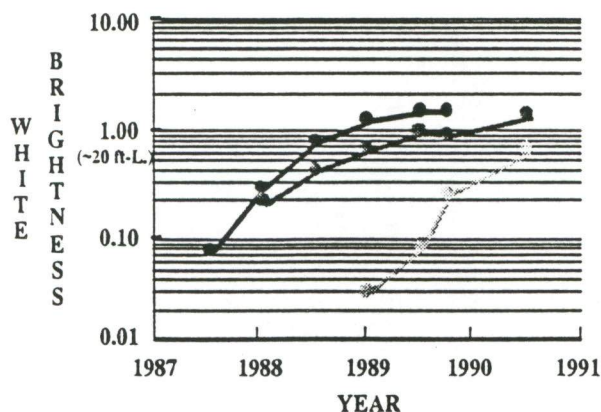
University Researchers - To be designated

P7



Blue Phosphor Development

... blue rapidly improving ...



Required Brightness
Based on
1988 ANSI/HFS - 100
Luminance Standard

Red = 37.1 cd/sq m
Green = 92.0 cd/sq m
Blue = 10.8 cd/sq m

—●— Red Brightness
—●— Green Brightness
—●— Blue Brightness

- Over the past two years, blue brightness has increased over an order of magnitude
- Nearly at brightness needed for a practical display

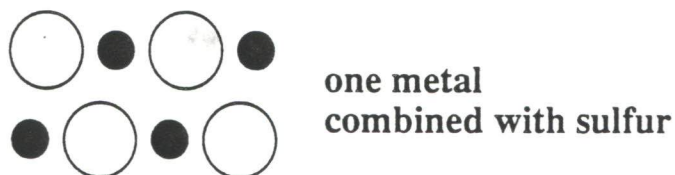
P8



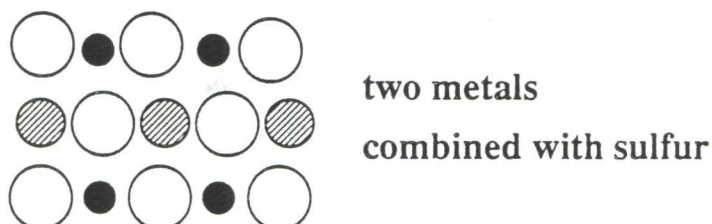
New Materials for Improved Blue

... *TFEL phosphors are sulfides* ...

- Old phosphors are binary compounds



- New phosphors are ternary compounds



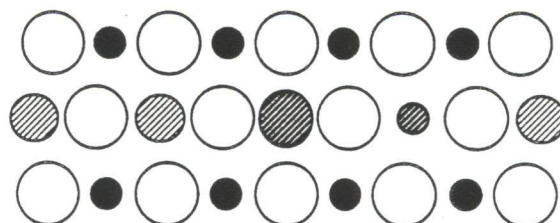
P9



Operation of Phosphors

... *activators, compensation of charge and size, etc.* ...

- Some of the host metal ions are replaced by ions that produce light (activators); e.g., rare earth ions.
- Many activator ions are of a different size and/or charge than host ions and, therefore, need to be compensated in order to achieve solubility.



P10



Phosphor Development

... blue development ...

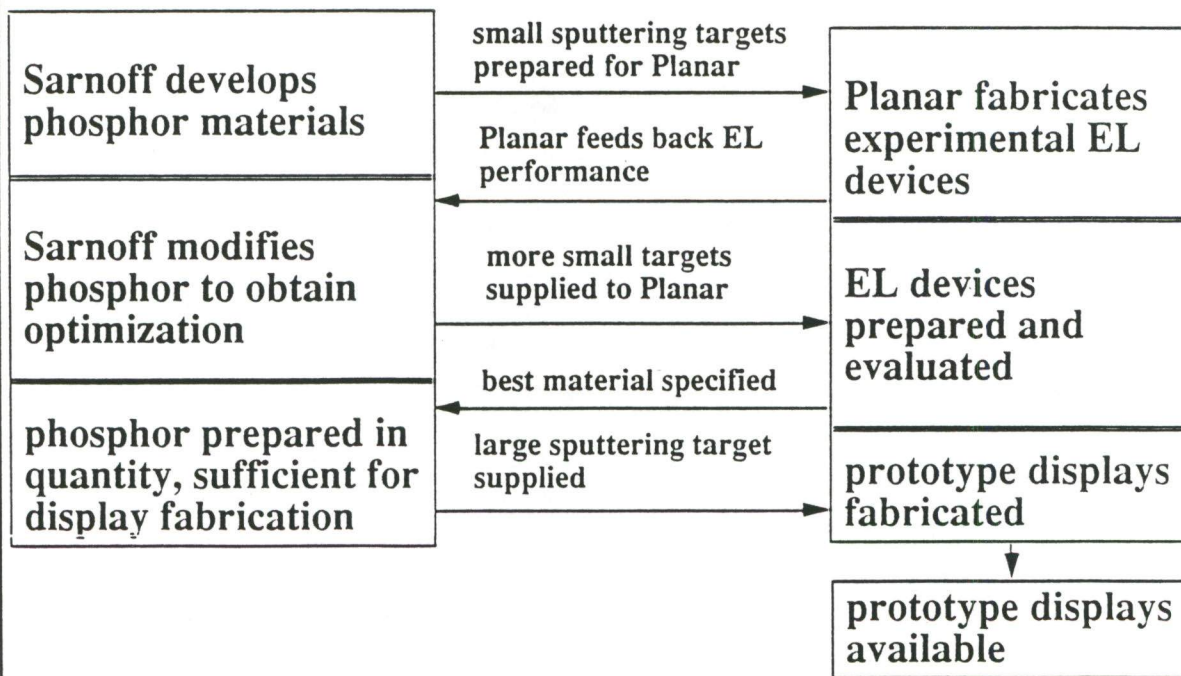
- Select activators that can produce blue emission
- Select ternary sulfide lattices that will accept activators
- Lattices should minimize thermal quenching
- Annealing temperature of phosphors compatible with substrate (glass)

P11



Present Project Plan

... phosphor development for prototype displays ...

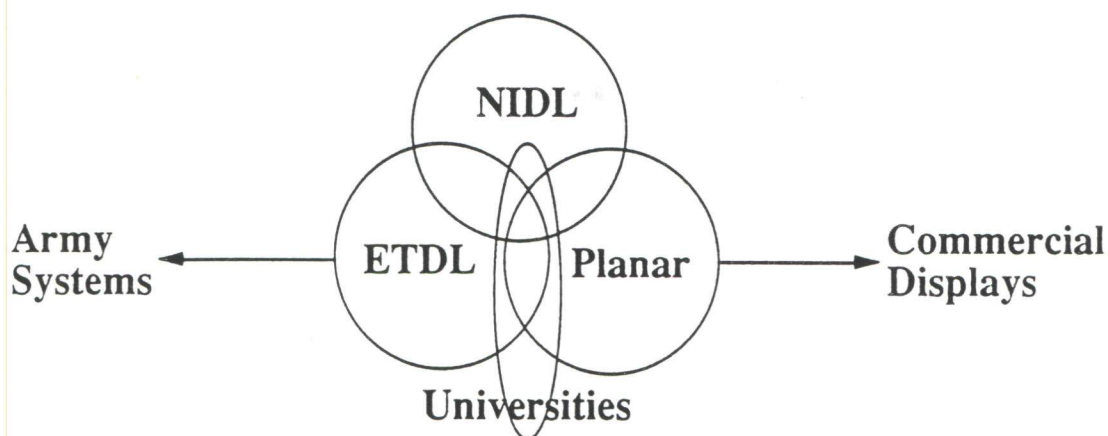


P12



Expanded Program

... new partners ...



P13

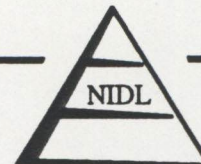


Summary

... roadmap to a better display ...

- TFEL can eventually satisfy all display needs
- Improved blue phosphor is the next step for full color COTS display
- New ternary sulfide TFEL phosphors being developed to meet blue requirements
- After attaining full color, display brightness is next improvement required, probably by operating at higher frequency and with further improved phosphors

P14



**The National Information Display Laboratory
Softcopy Review**

Seamless Tiling for Large Panel Displays

**Gerard A. Alphonse
Project Leader**

January 23, 1992



**The National Information Display Laboratory
Softcopy Review**

Seamless Tiling for Large Panel Displays

**Gerard A. Alphonse
Project Leader**

January 23, 1992

Q1



Outline

- **Need for large high resolution displays**
- **Why tiling?**
- **Critical issues**
- **Approaches**
- **Status**
- **What next?**

Q2

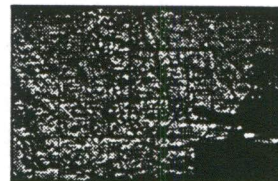


Need for Large Displays

... military and civilian centers have applications requiring large area high resolution displays ...

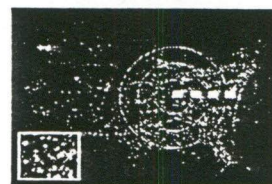
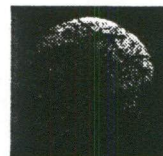
- **Military**

- Command control centers
- Simulation and training
- Need real time, high resolution



- **Civilian**

- Air traffic control (real time)
- Weather (real time and high res.)
- Medical imaging (high resolution)
- Multimedia
 - Teleconferencing/training
 - Advertising
 - Telepresence
 - Virtual reality

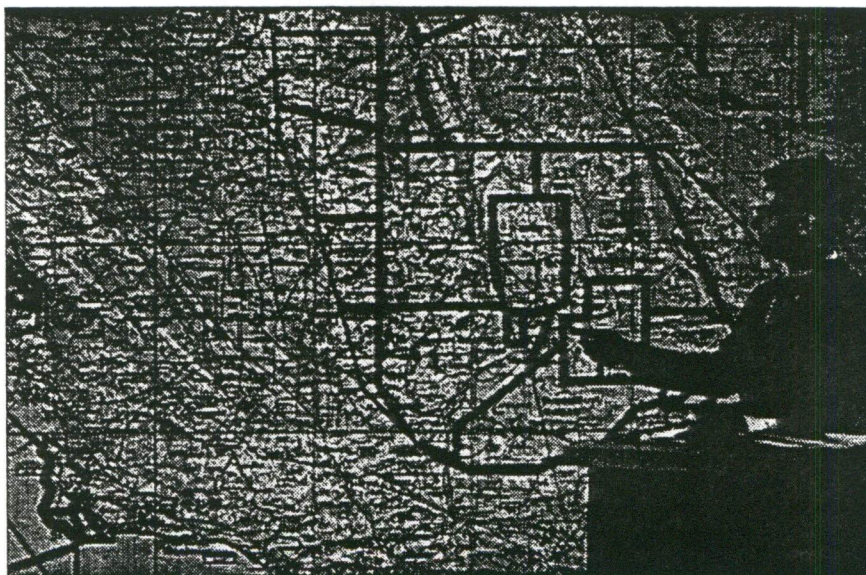


Q3



Greyhawk's Large Screen Display

... 6.5 ft x 10 ft ...



Courtesy: Greyhawk Systems, Inc.

Q4



Why Tiling?

... existing manufacturing technologies not expandable to fabrication of arbitrary size displays ...

- Problems with CRTs
 - Bulky
 - Requires high voltage
 - Requires high vacuum
- Problems with monolithic flat panels (LCD, EL, Plasma, etc...)
 - Expensive capital equipment
 - Poor yield
- Problems with conventional projectors
 - Low brightness
 - Poor resolution
- Advantages of tiling
 - State of the art panels
 - Any type of panel
 - Expandable to arbitrary size



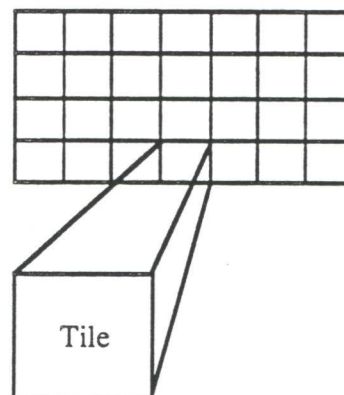
Q5



Tiling Displays

... cost-effective approach for addressing need for large panel high resolution displays ...

- Characteristics
 - 70 in. diagonal or larger
 - 6000 x 3800 pixels and higher
 - 90 pixels/in. (state of the art)
 - Up to 400 pixels/in. (wall maps)
- Example of individual tile
 - 14 inch diagonal XGA monitor
 - 1024 x 768 pixels
 - 0.28 mm per pixel



Q6



Critical Issues - Psychophysical Requirements

*... seams and tile variabilities must be below visibility
or discrimination thresholds. This requires extremely tight tolerances ...*

- Seams between tiles
 - must be invisible
- Luminosity variability
 - must be undetectable
- Chromaticity variability
 - must be undetectable
- Vernier misalignments
 - no segmentation of line patterns across tiles



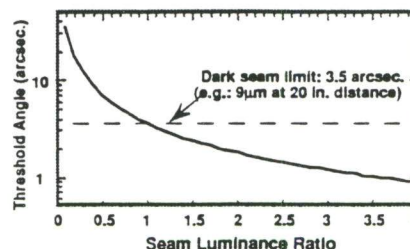
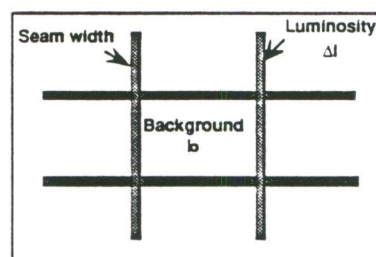
Q7



Psychophysical Requirements - Seams

... must be invisible ...

- Causes
 - Cement thickness
 - Cement optical parameters
 - Light guiding in substrate
- Consequences
 - Bright seams
 - Dark or gray seams
- Requirements
 - Bright seams not acceptable
 - Dark seams
 - Width $< 9 \mu\text{m}$ at 20 inch distance
 - Visual angle $< 3.5 \text{ arcsec}$ at any distance

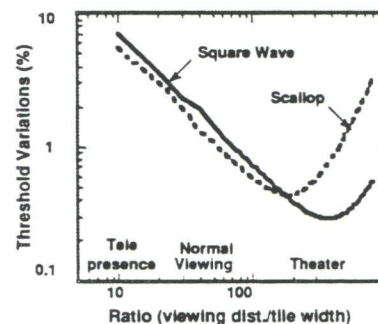
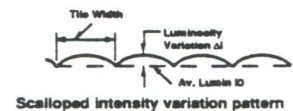


Q8

Psychophysical Requirements - Luminosity Variability

... must be undetectable ...

- Causes
 - Luminance variations within tiles
 - Luminance variations from tile to tile
- Consequences
 - Visible pattern on screen
 - Visibility depends on viewing distance
- Requirements (thresholds)
 - About 5% variations at 10 tile distance
 - About 1% variations at 60 distance
 - 0.25% to 0.5% at dist. of peak sensitivity

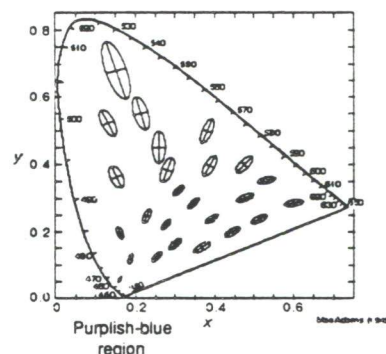


Q9

Psychophysical Requirements - Chromaticity Variations

... must be undetectable ...

- Causes
 - Batch to batch color variability in tile fabrication
- Consequences
 - Color non-uniformities across screen
 - Ranges of constant color represented by ellipses on chromaticity diagram
- Requirements
 - Worst case in purplish-blue region (smallest ellipse)
 - Allowed variability of primary colors <1%



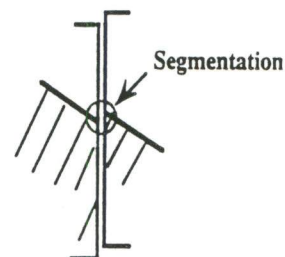
Q10



Psychophysical Requirements - Vernier Acuity

... no segmentation of line patterns across tiles ...

- Causes
 - Tolerances of individual tiles
 - Tolerances in display assembly
- Consequences
 - Segmentation of continuous lines
 - Segmentation of continuous line pattern
- Requirements
 - Visual angle of vernier step < 5 arcsec at any distance
 - Vernier steps $< 12 \mu\text{m}$ at 20 inch view distance



Vernier Misalignment

Q11



Requirements are Very Stringent

... but ...

- Values indicated are *psychophysical thresholds* only.
Psychological tolerances may be 3 to 4 times threshold
- *Dark seam* and *vernier* requirements are within available fabrication technologies
- *Luminosity variations* thresholds can be increased significantly by using ROM look-up compensation table to soften edges
- *Chromaticity variations* can be compensated by shifting intensity of primary components, also using ROM look-up table
- Conclusions
 - Requirements can be met with current technologies and compensation techniques
 - Tiling is viable

Q12



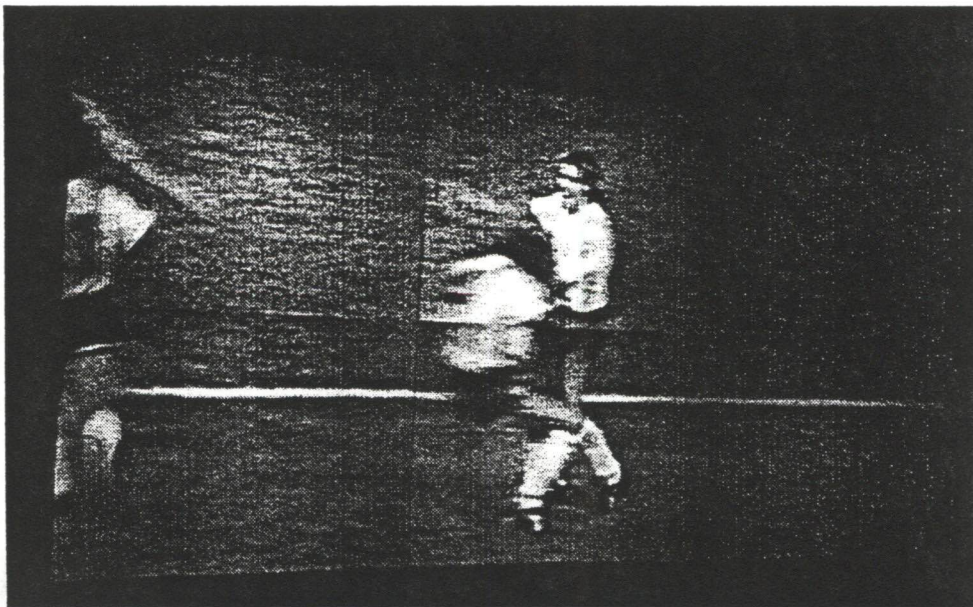
Illustration of Seam Visibility and Tile Luminosity Variations



Q13



Illustration of Possible Chromaticity Variations

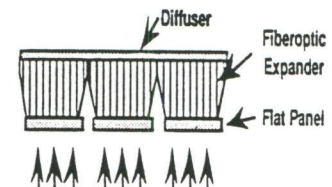
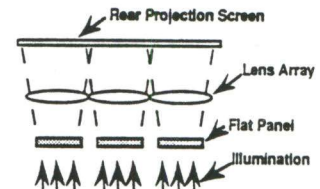
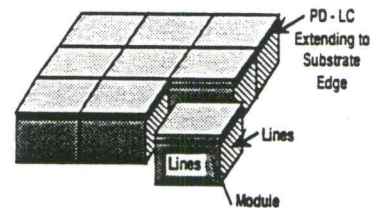


Q14

Technical Approaches

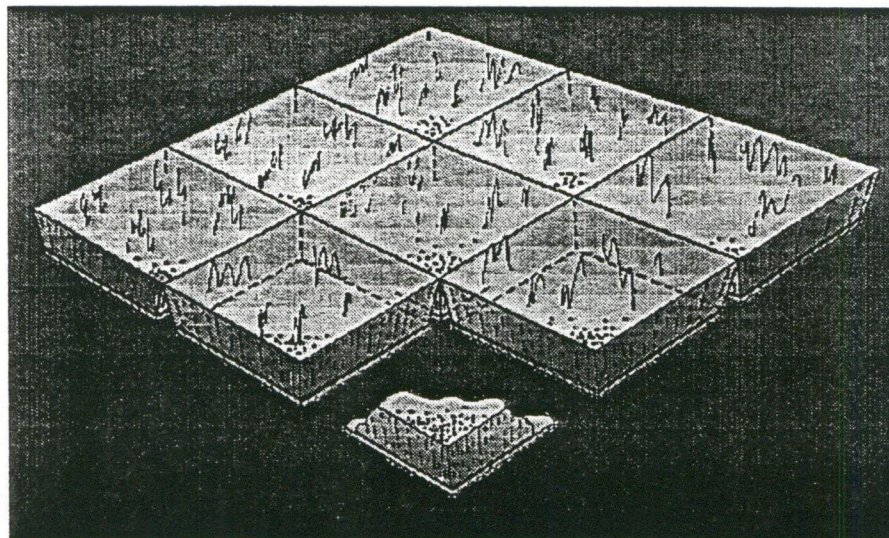
... means are required to block from view circuits on tile substrates, besides meeting psychophysical requirements ...

- Direct tiling of flat panels
 - Polymer-dispersed LCD (Magnascreen)
- Methods using optical elements
 - Imaging
 - Virtual image (DTI)
 - Real image - Rear projection (Covid)
 - Non-imaging
 - Fiber optic faceplate (OIS, POC, Sarnoff)
 - Combining CRTs with mirrors (MIT)



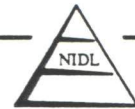
Q15

OIS Fiberoptic Faceplate Flat Panel Display



Courtesy: Optical Imaging System, Inc.

Q16



Status

- Psychophysics requirements established
- Performed experiments to verify seam and luminosity requirements
- Contacted developers to evaluate approaches, identify and prioritize most promising approaches
 - Fiber optic faceplate
 - Rear projection
 - PD - LC
 - Other
- Seeking to collaborate with others to develop toward manufacturability best technology meeting requirements

Q17

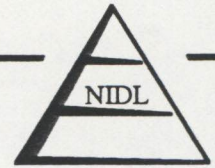


What Next?

*... develop most promising technology
toward manufacturability ...*

- Explore simulation techniques to evaluate designs and requirements
- Select most promising approaches to develop and work with industrial collaborators toward manufacturability, through NIDL
- Develop prototype of wall size display
- Investigate systems (data handling) issues

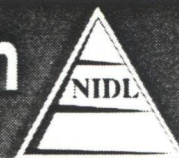
Q18



**The National Information Display Laboratory
Softcopy Review**

Demonstration and Poster Session Displays

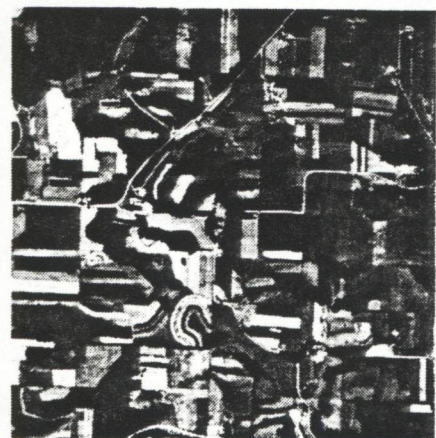
Neural Network Texture Classification



...An aid to rapid search through image databases...

Need: Rapid extraction of images containing particular features from large databases.

Approach: Design and train neural networks to classify patterns in pyramid image representations.



Original Image

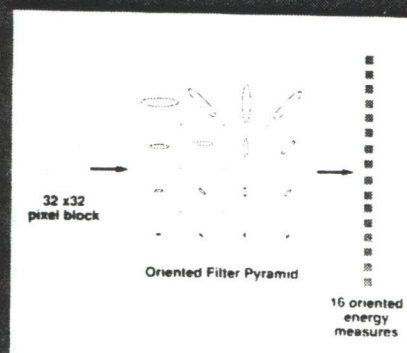
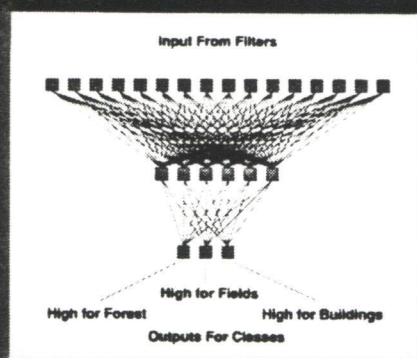
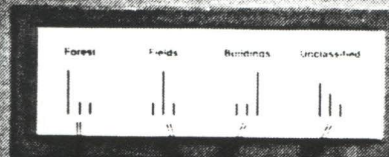
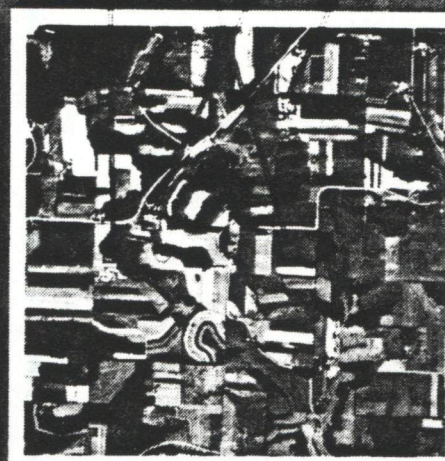


Image Preprocessing



Neural Network Architecture



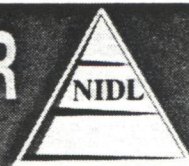
Neural Network Output

Exploitation of image databases requires searching on the basis of image content. Some image features, such as terrain types, can be characterized by the textures they produce in an image. Oriented, scaled filters yield a small number of measures which contain sufficient information for determining texture regions. Neural networks are useful for this kind of pattern classification problem because: they can divide an input space into regions with nonlinear boundaries; they can be trained by example without the necessity for

detailed knowledge of the algorithm; and they run very quickly once they are trained. Our initial results on the texture problem have been promising. A network trained on a small set of examples can successfully classify other examples. In addition to training networks with simple architectures of the sort shown above, we are working on algorithms which automatically determine an optimal architecture during the training process.

Cost Effective Algorithm Development: SAR

...Working with algorithm developers to increase throughput...



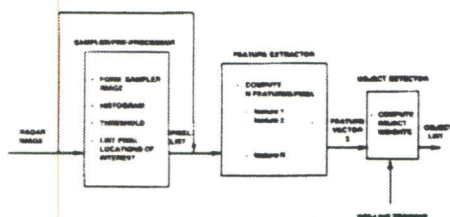
The Algorithm Understanding Laboratory (AUL)

AUL ==> A new paradigm for algorithm development & evaluation

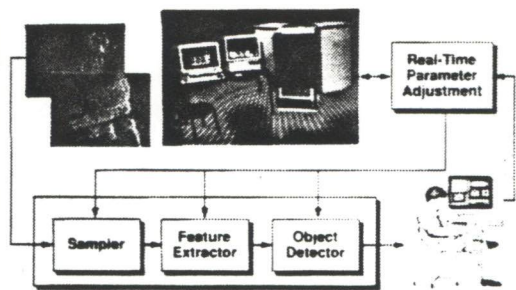
- Parallel processing capability for interactive algorithm development
- Unbiased resource for:
 - Development
 - Testing
 - Evaluation

- Uniform standards
- Standard benchmarks for algorithm performance

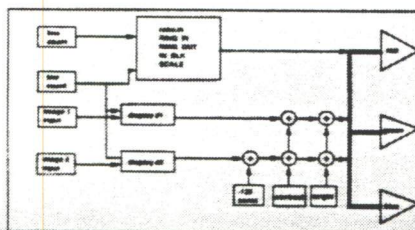
NIDL PARTNER'S TARGET RECOGNITION ALGORITHM



Real-Time Interactive Algorithm Development and Evaluation

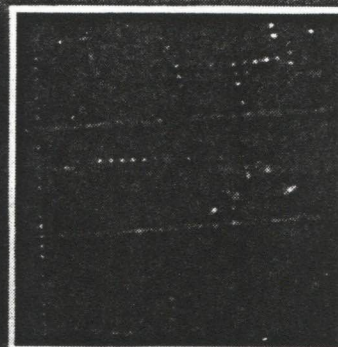


MAPPING ALGORITHMS ONTO THE PRINCETON ENGINE



- EACH ALGORITHM COMPONENT IS MAPPED ONTO THE ENGINE & VERIFIED.
- ROUTINES SPECIFICALLY DEVELOPED FOR:
 - PREL. REMOVAL/REMOVAL OPERATIONS
 - HETEROGENEOUS
 - BOTH FUNCTIONS

Comparison of sampler processing between Princeton Engine & standard workstation



SPEED - UP FACTOR

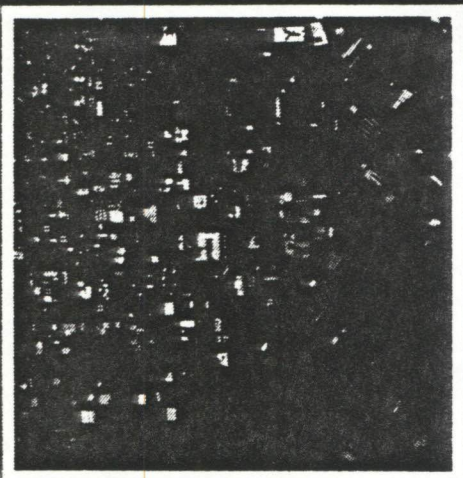
P.E. / WORKSTATION = 2400 / 1

Benefit: Interactive Parameter Adjustment
→ Rapid Algorithm Development

A 200 f-Lambert B/W CRT Monitor With 2000x2500 Pixel Resolution

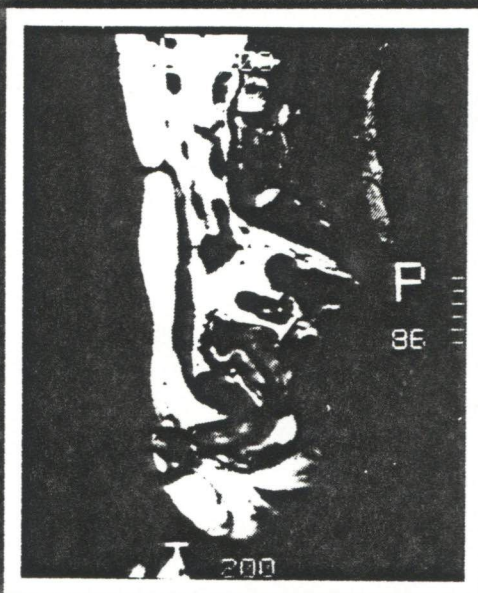
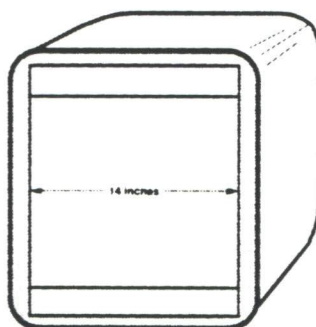


...A product for analysts and radiologists in '94...



Square or Portrait Format in 23" Tube

- 14 x 14 inch, 2000 x 2000 pixel format for image analysts
- 14 x 17.5 inch, 2000 x 2500K pixel format for medical imaging
- Increases market, reduces cost



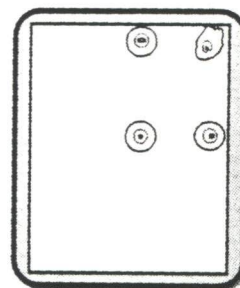
Gun Redesigned for Manufacturability, Performance Maintained

Spot size. Red = 50%, Blue = 5%

	3 fL	33 fL	200 fL
Laboratory gun			
Redesigned for manufacturability			

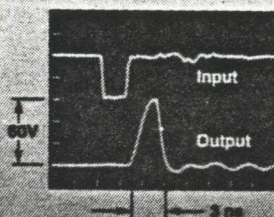
Yoke Design for Uniform Resolution

- Distortion-free deflection is a challenge with high resolution, large beam gun
- Simulation of latest yoke design plus NIDL high resolution gun shows uniform resolution at edges
 - 5.1 mil spot in center
 - 5.1 mil spot at 12 o'clock edge
 - 5.1 mil spot at 3 o'clock edge
- Smaller spot, some come in corner
 - 3.7 mil average spot in corner



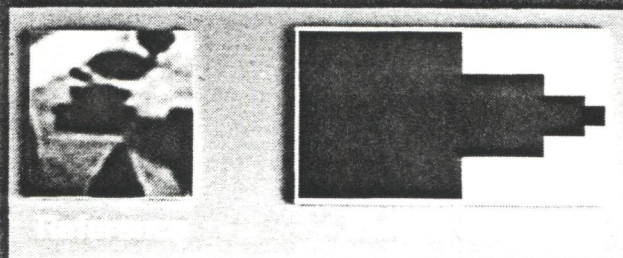
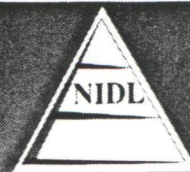
Video Amplifier Approaching Minimum Requirement

- Modified commercial amplifier (Tollitronics LBT) produces 60 V output, 3 ns pulse
- Near minimum requirement for NIDL monitor
- Developing new architecture for higher speeds at 60 V



Visual Modeling

...Evaluating display performance with a real visual task to expedite display development...



Reference

Simulated

Discriminability Map



Visibility Map:
A Measure of the
Information Content

**Human Evaluation
By Rating**

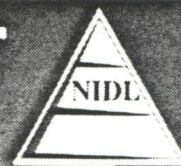
**Model Evaluation
Visibility**

**Visual Modeling is a cost effective method to replace
trained observers with engineering evaluation**



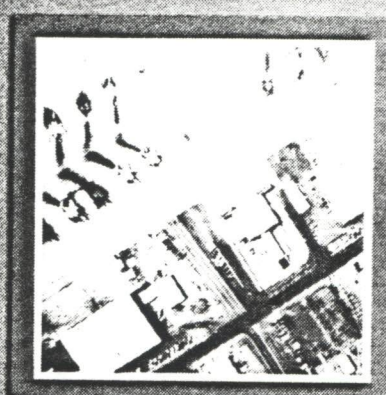
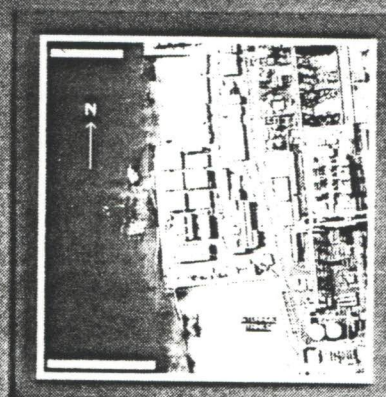
NAVY USER SUPPORT

... Improving FIST printer image quality...



Before

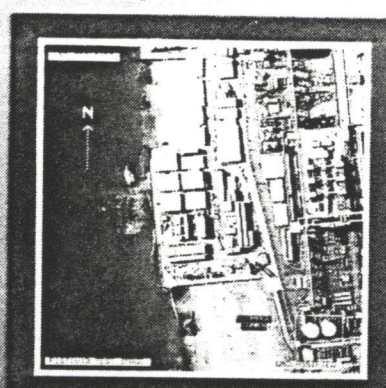
After



**With deployed
3x repeat**

**After NIDL 2D FIR
image processing**

**Before and after images showing the additional
effects of high (10:1) compression**





NAVY USER SUPPORT



*...Examining critical bottlenecks in afloat LANs
to ensure free flow of images...*

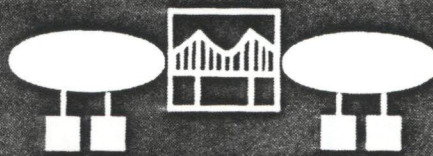
- Model image and text traffic
- Simulate operation on LAN
- Analyze alternative LAN architectures



LAN

\$

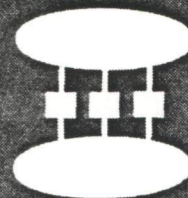
7 Images/min
45 Kilomessages/min



Bridged LAN

\$\$

9 Images/min
60 Kilomessages/min



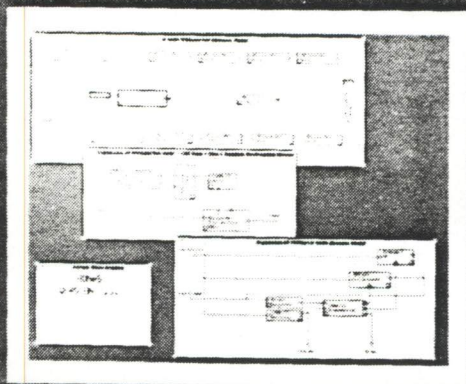
Double LAN

\$\$\$

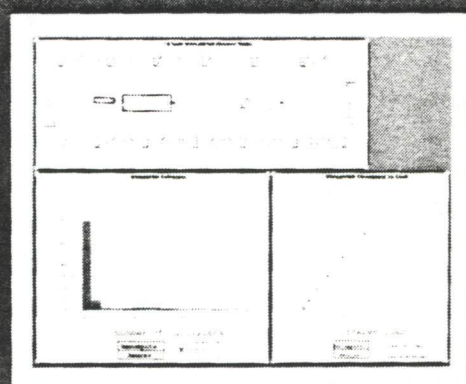
17 Images/min
110 Kilomessages/min

**Different LAN architectures showing
data carrying capacities**

CUSTOMIZED COMPUTER TOOLS FOR NAVY USE



**Graphical Programming
Interface permits nested
detail level**



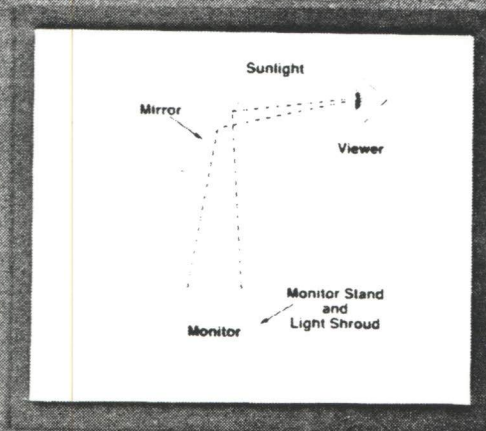
**Quick Generation
of Traffic Statistics**

Presidential Teleprompter

...Providing display expertise to the White House Communication Agency for the President...

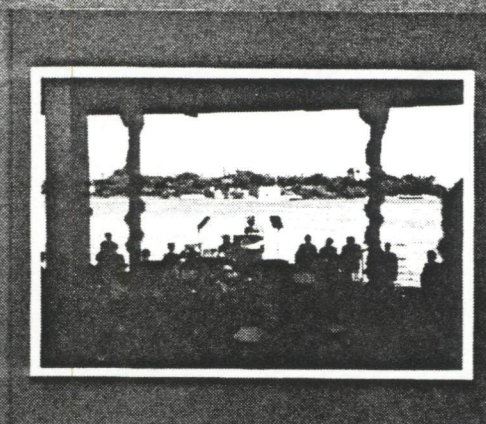
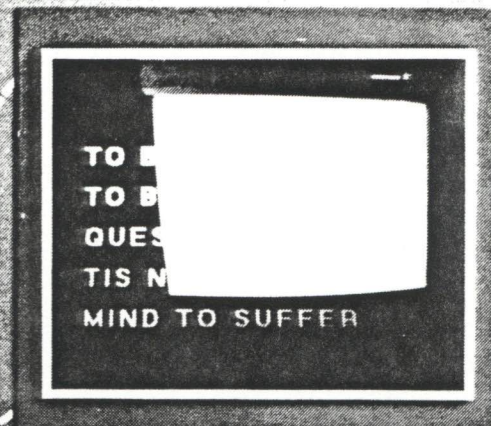
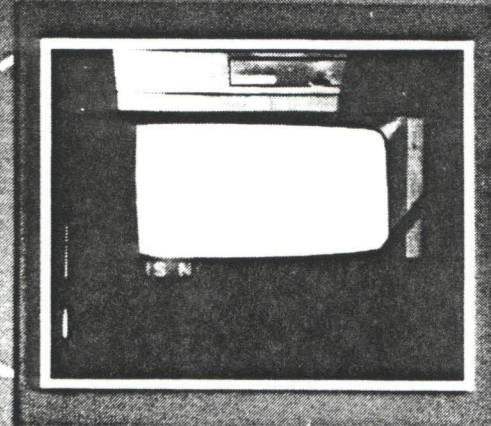


The problem: The contrast of the teleprompter image is too low to be read outdoors
The solution: NIDL teamed with a commercial partner to retrofit a television monitor with a special high-luminance CRT and then added a light control film for even greater contrast



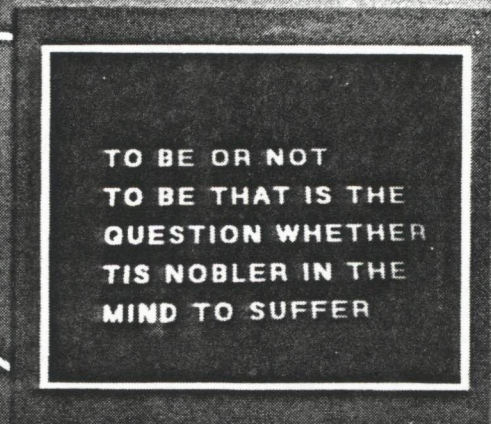
Current System

- low luminance CRT
- minimal sunlight control



NIDL Designed System

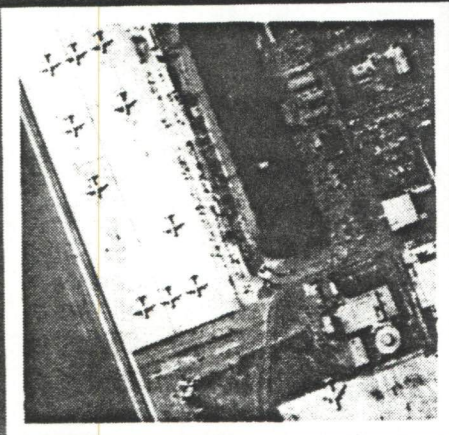
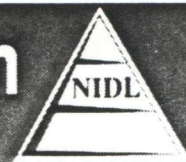
- high luminance CRT
- light control film blocks sunlight



with light control filter

Wavelet Based Image Compression

...Smart Compression and Progressive Transmission...



Original Image

Needs

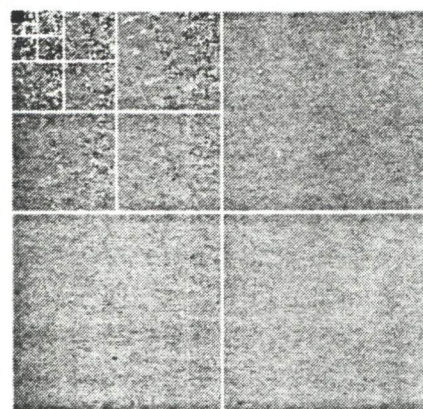
- High quality at low rates
- Progressive transmission
- Fast browsing
- Smart Compression
- Independent of image type

Approach

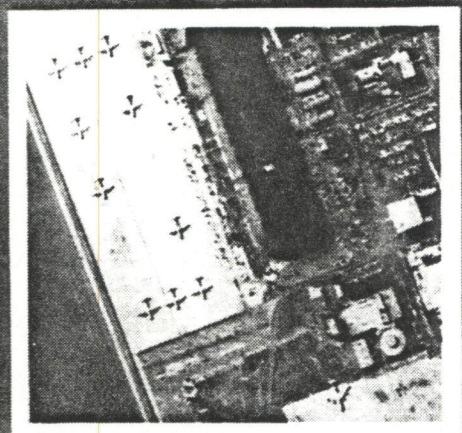
- Wavelets: Compact multiresolution representation
- Zerotrees: Predict insignificance across scales
- Successive approximation quantization: Compact multiprecision representation
- Magnitude Prioritization
- Bits are ordered in order of importance
- Target bit rate is obtained exactly

Benefits

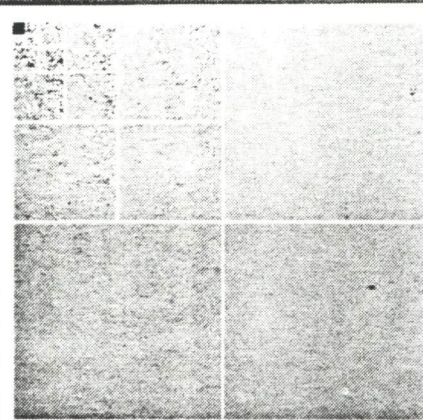
- Best performance that we know of at high compression ratios (Substantially better than baseline JPEG)
- Fully embedded bit stream ideal for browsing and progressive transmission
- Preserves high contrast details
- Allows smart compression
 - No training required
 - No prestored tables or codebooks



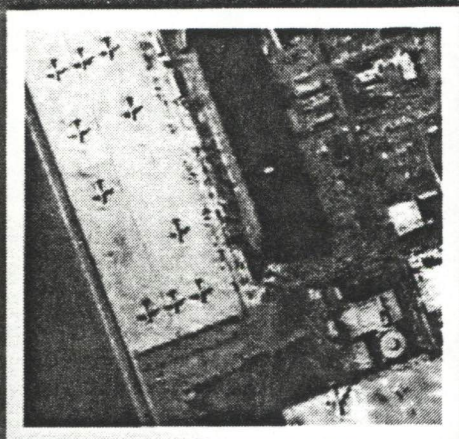
Discrete Wavelet Transform



Compression Ratio 16:1



Discrete Wavelet Transform at 16:1 Compression

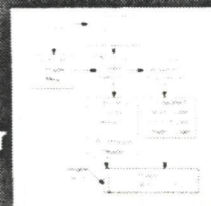


Compression Ratio 32:1

Smart Compression Variable Quality Image Compression

← Target Region is encoded for high quality

Context is preserved



300 MOPS

VITec designs and builds a family of HARDWARE and SOFTWARE PRODUCTS and provides SYSTEM INTEGRATION SERVICES, spanning the price/performance spectrum, to solve IMAGING problems for customers in business, industry, government, and science.

1. QUESTION

Q. 1. a) Explain the following:-
i) Software Engineering
ii) Software Engineering Process
iii) Software Engineering Model
iv) Software Engineering Methodology
v) Software Engineering Standards

2. ANSWER

a) i) Software Engineering is the application of engineering principles and practices to the development, testing, and maintenance of software systems. It involves a systematic approach to the design, development, and testing of software, ensuring that the final product meets the requirements and is reliable, efficient, and maintainable.

ii) Software Engineering Process refers to the sequence of steps or phases that are followed in the development of software. It typically includes requirements gathering, analysis, design, development, testing, and deployment. The process is designed to ensure that the software is developed in a structured and controlled manner, minimizing errors and maximizing quality.

iii) Software Engineering Model is a framework or template that defines the phases and activities of the software engineering process. It provides a structured approach to the development of software, ensuring that all necessary steps are followed and that the process is consistent across different projects. Examples of software engineering models include the Waterfall Model, the Spiral Model, and the V-model.

iv) Software Engineering Methodology is a specific set of rules, guidelines, and practices that are used to develop software. It provides a detailed framework for the development process, including the tools, techniques, and standards that are used. Examples of software engineering methodologies include RUP (Rational Unified Process), ITIL (Information Technology Infrastructure Library), and CMM (Capability Maturity Model).

v) Software Engineering Standards are a set of rules and guidelines that define the requirements and practices for the development of software. They provide a common framework for the development process, ensuring that all software developed according to the standards is of high quality and meets the same requirements. Examples of software engineering standards include ISO 9000, ISO 15504, and IEEE 830.

2. QUESTION

Q. 2. a) Explain the following:-
i) Software Engineering Process
ii) Software Engineering Model
iii) Software Engineering Methodology
iv) Software Engineering Standards
v) Software Engineering Best Practices

2. ANSWER

a) i) Software Engineering Process refers to the sequence of steps or phases that are followed in the development of software. It typically includes requirements gathering, analysis, design, development, testing, and deployment. The process is designed to ensure that the software is developed in a structured and controlled manner, minimizing errors and maximizing quality.

ii) Software Engineering Model is a framework or template that defines the phases and activities of the software engineering process. It provides a structured approach to the development of software, ensuring that all necessary steps are followed and that the process is consistent across different projects. Examples of software engineering models include the Waterfall Model, the Spiral Model, and the V-model.

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iv) Software Engineering Standards are a set of rules and guidelines that define the requirements and practices for the development of software. They provide a common framework for the development process, ensuring that all software developed according to the standards is of high quality and meets the same requirements. Examples of software engineering standards include ISO 9000, ISO 15504, and IEEE 830.

v) Software Engineering Best Practices are a set of guidelines and recommendations that are based on the experience of experts in the field of software engineering. They provide a framework for the development process, ensuring that all software developed according to the best practices is of high quality and meets the same requirements. Examples of software engineering best practices include the use of version control, code reviews, and automated testing.

- Open Architecture Standards Based, Platform Independence
- Supports C, UNIX, Ethernet, Windows, iSCSI, Openloop
- VME bus, 5 bus Turbo Channel, Micro Channel and others
- Full Networking Capability with Servers
 - Input/Output Bus Computer
 - Single 3U board or Field Deployable 6U boards
 - True color monitor can be configurable
 - Full system VLSI chip technology
 - up to 24 MB/s in memory
 - 16MB memory management
 - Parallel Co-Processor, ADSP
 - Images up to 32K x 24K Stereo

Figure 1 consists of six panels, labeled (a) through (f), arranged in a 3x2 grid. Each panel shows a grayscale image of a turbulent flow field. Panel (a) shows a single, large, bright, circular vortex. Panel (b) shows the vortex elongated and beginning to filament. Panel (c) shows the vortex further elongated and more filamentary. Panel (d) shows the vortex highly elongated and very filamentary. Panel (e) shows the vortex highly elongated and very filamentary. Panel (f) shows the vortex highly elongated and very filamentary.

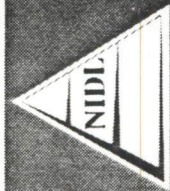
- Contains hooks for customer database management system
- Performs image compression/decompression
- Collects and stores image-based information
- Provides Electronic Light Table functionality
- Supports resource sharing of peripherals

- Uses image icons for speed of viewing
- Operates in a networked environment
- Allows transfer of packets of images
- Accepts multiple file formats

Interactive 3D Data Visualization

...Towards real-time mission planning...

Fast terrain and volume rendering project: Herb Taylor, Pat Hanrahan (Princeton University),
Jim Matey, Jim Kaba, Gordon Stoll, Dave Kalokitis



The Mission Planning Bottleneck

- Massive accumulation of diverse types of data
- Mission plan only useful NOW, not tomorrow

Global Scope to Data Acquisition

Terrains of Mission Processing

Synthesizing Mission Data

... 3D Display of relevant data ...

- 3D Data sets should include: Statistics, Hypertext, etc.

3D Data Types

3D Data Types

Synthesizing Mission Data

... 3D Display of relevant data ...

- 3D Data sets should include: Statistics, Hypertext, etc.

3D Data Types

3D Data Types

Mission Planners Objective

... achieve a unified view of the Battlefield ...

- Motivation
 - Mission Planners must be able to keep pace with the rapidly developing Global Battlefield
 - They must have the ability to plan a mission anywhere in the world while critical events are unfolding
 - They must be able to combine within a single computational framework diverse data types synthesizing where necessary under new views of the theatre of operation

Mission Planning Tomorrow

... the Virtual Battlefield of the Future ...

"Virtual" with Map of Battlefield

Compass Image Generator

Real-time 3D Data Types

Real-time 3D Data Types

Real-time 2D Rotate

... simple horizontal and vertical shears ...

- Rotations are built from X and Y shears
- Princeton Engine real-time transpose facility turns X shears into Y transpose + Y shears

1. Original Image
2. Shear Columns
3. Transpose Rows and Columns
4. Final Image

Parallel Volume Rendering

... single axis Volume rotation (about Z) ...

- Rotate Volume About the Z axis (X-Y plane)
- Same as 2D rotate algorithm

1. Original Image
2. Shear Columns
3. Transpose Rows and Columns
4. Final Image

Parallel Volume Rendering

- General Rotation
 - Combine Single Axis and 2D rotation Algorithms

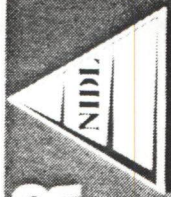
Original Volume

Rotate About X Axis

Rotate About Y Axis

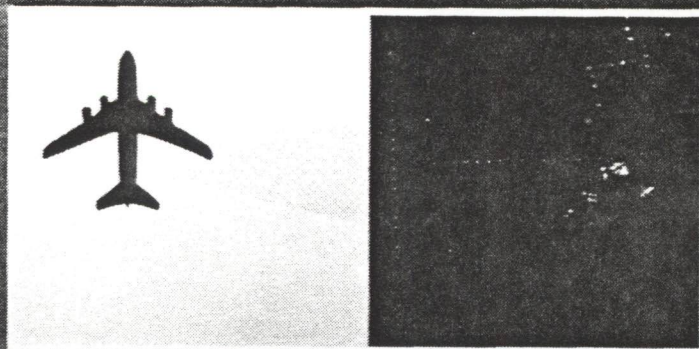
Rotate About Z Axis

Cost Effective Algorithm Development: SAR



... Working with algorithm developers to increase throughput...

- Each algorithm component is mapped onto the Princeton engine & verified
- Routines specifically developed for-
 - Pixel neighborhood operations
 - Histograms
 - Math functions

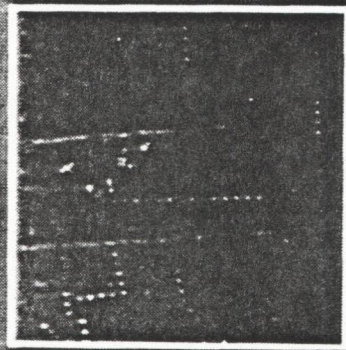


Input Image

Radar Image

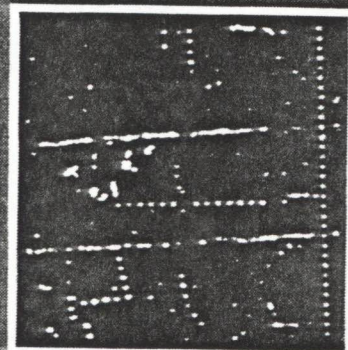
SAMPLER/PRE-PROCESSOR

- Form sampler image



Sampler Image

- Histogram
- Threshold

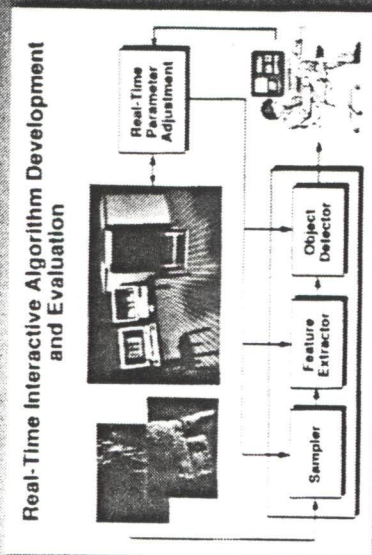


Thresholded Image
(Regions of Interest)

- List pixel locations of interest

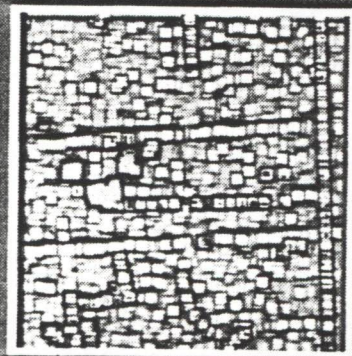
SPEEDUP=2400/1

Pixel List



FEATURE EXTRACTOR

- Compute N features/pixel



Feature Display

SPEEDUP ~2000/1

Feature Vectors

OBJECT DETECTOR

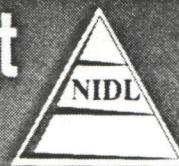
- Compute Object Weights

Off-Line Training

Object List

Cost-effective Algorithm Development

...Parallel processing enhances multispectral terrain characterization...



NEED:

- Enhance throughput of multispectral terrain classification
- Reduce days of analysis to minutes

BENEFIT:

- More effective broad area land characterization
- Faster turnover
- Interactive control of algorithms → more accurate analysis
- Process more scenes in less time
- Applicability to diverse multispectral image exploitation needs

APPROACH:

- Perform supervised classification of Landsat TM imagery
- Classification performed over 6 bands at each pixel
- Make use of coarse grained parallelism on the Princeton Engine
- Process 1024 pixels simultaneously → roughly 1000-fold processing time reduction from that of conventional workstations
- Rapid processing facilitates algorithm prototyping through interactive parameter tuning



1K by 1K Landsat Thematic Mapper scene over Central Florida Band 1 shown



Same scene after classification. Different colors represent different classes of terrain areas. Execution time: 16 sec.(SUN Sparcstation ~45 min).

Processing Time for Full Landsat Image (6K x 7K)

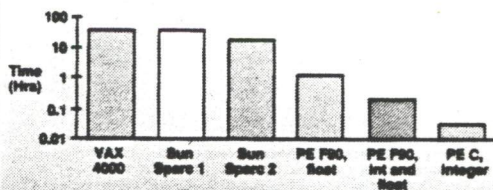
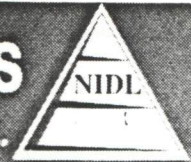
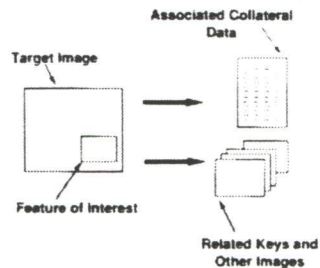


Image & Collateral Database Access

...Power of human vision combined with HSS matching algorithms...



Need for
INCREASED EFFICIENCY
in
IMAGE EXPLOITATION
may be met by
FAST CONTENT BASED RETRIEVAL
of
SOFT COPY KEYS
from an
IMAGE DATABASE



Problem:

- Human Vision is very fast and accurate but is overwhelmed by large volume.

Image understanding techniques are not mature enough to handle the job alone. Existing algorithms require expensive computing resources.

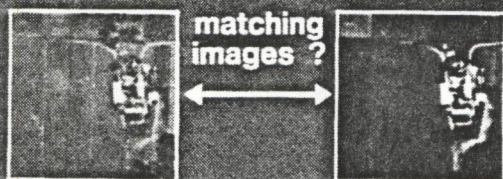
NIDL Approach

Combine user interaction with hierarchical structured search algorithms to obtain efficient content based retrieval of images from a database

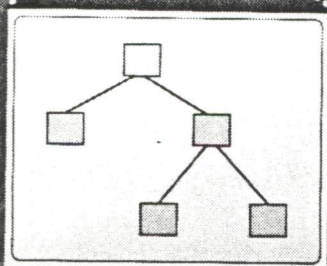
HIERARCHICAL STRUCTURED SEARCH

When do two
images "match" ?

When they each
match the same
matchable model



Matchable Model



User
sets initial query by making selection of image
feature to be matched and collateral data
values

User
refines conditions of query

System
finds matching images which conform to
specified constraints on collateral data
values

User
evaluates retrieved images

System
displays user selected image from images retrieved
along with relevant collateral data

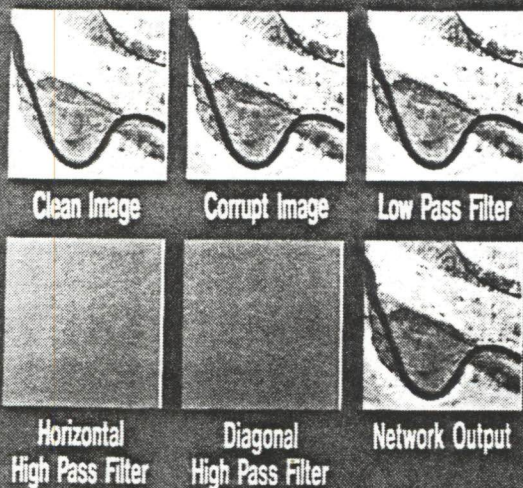
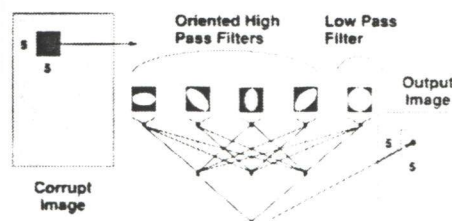
Interactive Neural Network Training



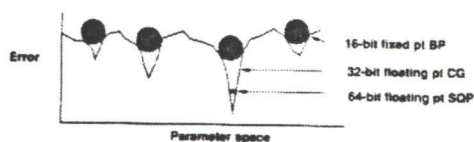
...Keeping human creativity in the design loop...

- Need: Interactive training
 - Human creativity in the loop
 - Training time reduced
- Overnight → Minutes
- Approach: 1024 processor SIMD parallel computer
- Demo: Application of neural nets to noise reduction
 - Gaussian noise corrupted satellite image (Abadan)
 - Cleaning front-end for other automated image processing

Neural Network Architecture



Future Developments

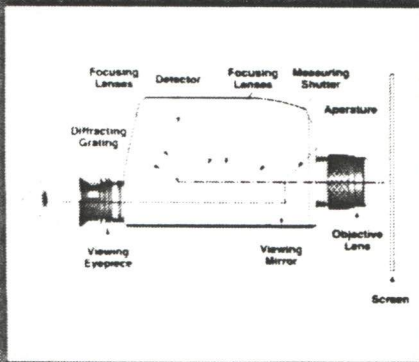


- Training
 - Coarse, broad search of parameter space
 - Fine, narrow optimization with SQP
 - Psychophysically derived training metrics
- Signal processing paradigm
 - Coring controlled by neural network
 - Pyramid representations

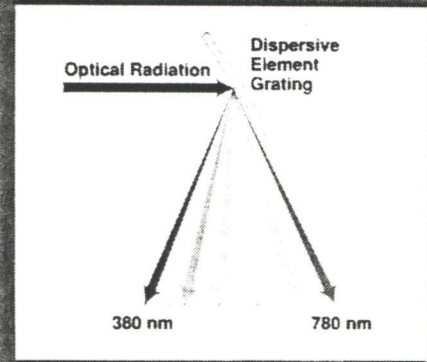
Display Evaluation and Certification

...Characterization of color purity of monitors through the measurement of spectral radiance...

Spectroradiometry

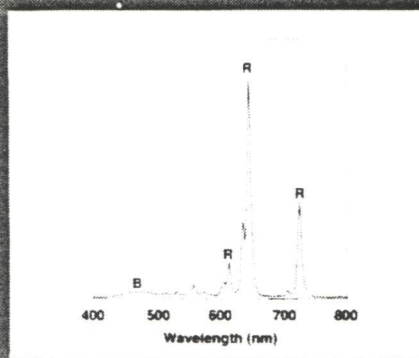


Optical Path

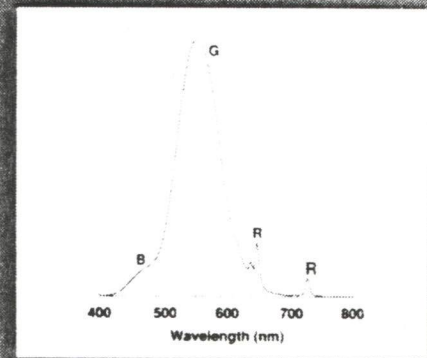


Diffraction Grating

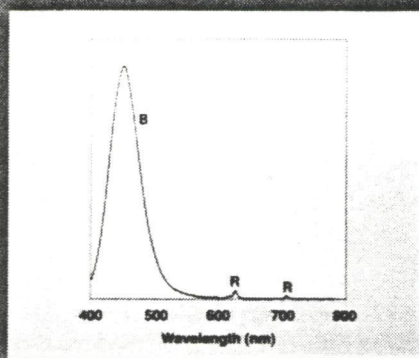
Emission Spectra-evidence of color mixing from phosphor contamination or electron beam misregistration which impacts on Monitor Color Fidelity



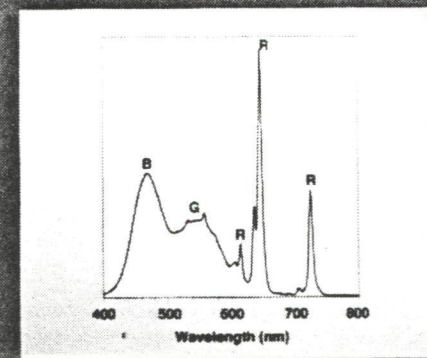
Red Field



Green Field



Blue Field



White Field