

VISUALIZING INFORMATION

ISAT Study 1997: Woods Hole Presentation

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Right Picture In Right Mind At Right Time

- ζ Visualization Is Happening**
- ζ Visualization Will Directly Control Weapons**
- ζ Seeing Is Believing: Misuse Is Life Threatening**
- ζ New Visualization Paradigm Needed To Safely and Effectively Convey and Control The Battlespace**

We live in an age that is driven by information...changing the face of war and how we prepare for it - William Perry

Overview

ζ **What Do We Mean By A New Visualization Paradigm**

Key Change: Visualizations Become The Interface And Medium Of Coordination

Two Scenarios As Examples

ζ **Current Technological Opportunities**

ζ **Technological Roadblocks**

ζ **Research Strategies**

Command Centers

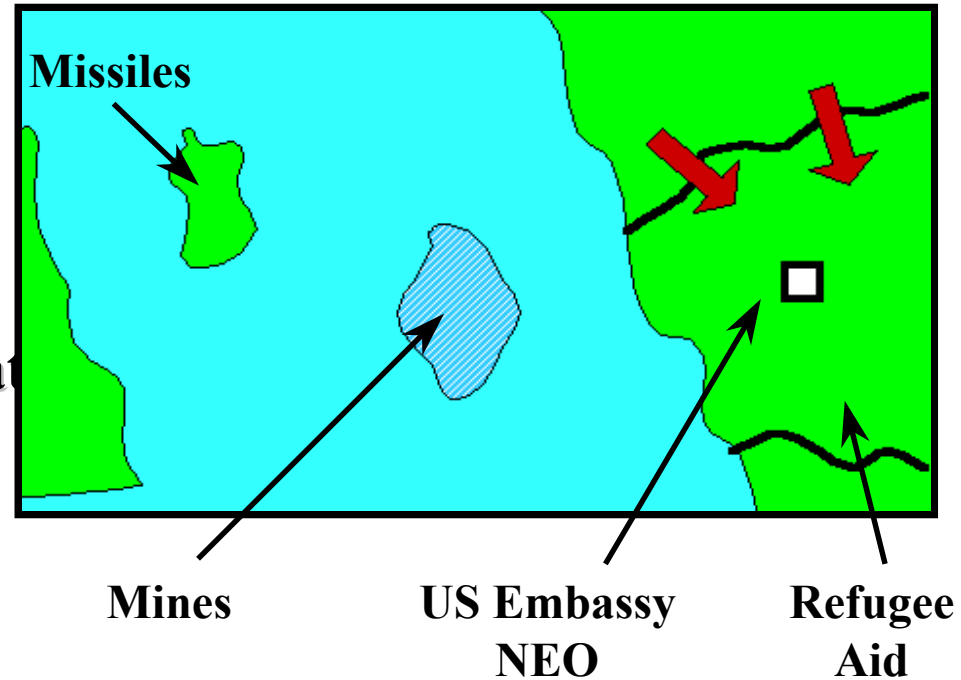
ζ Contingency Team

Multi-service

Multi-language

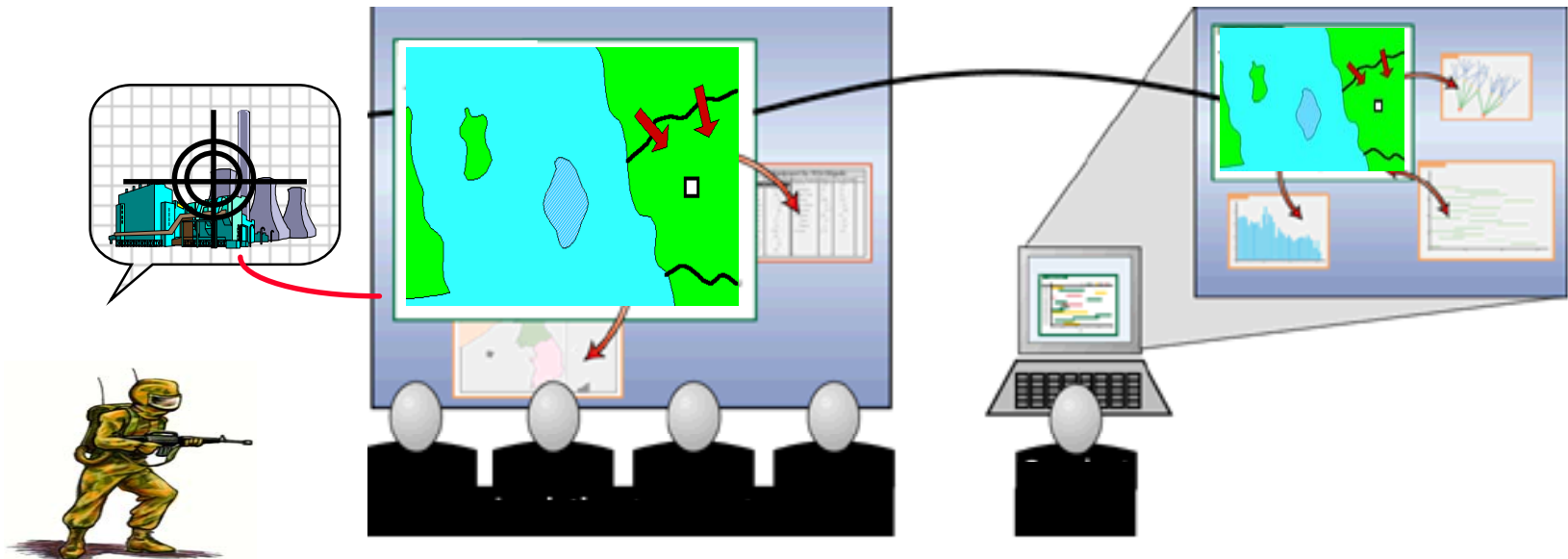
Multi-cultural

ζ Flood Of Incoming Data

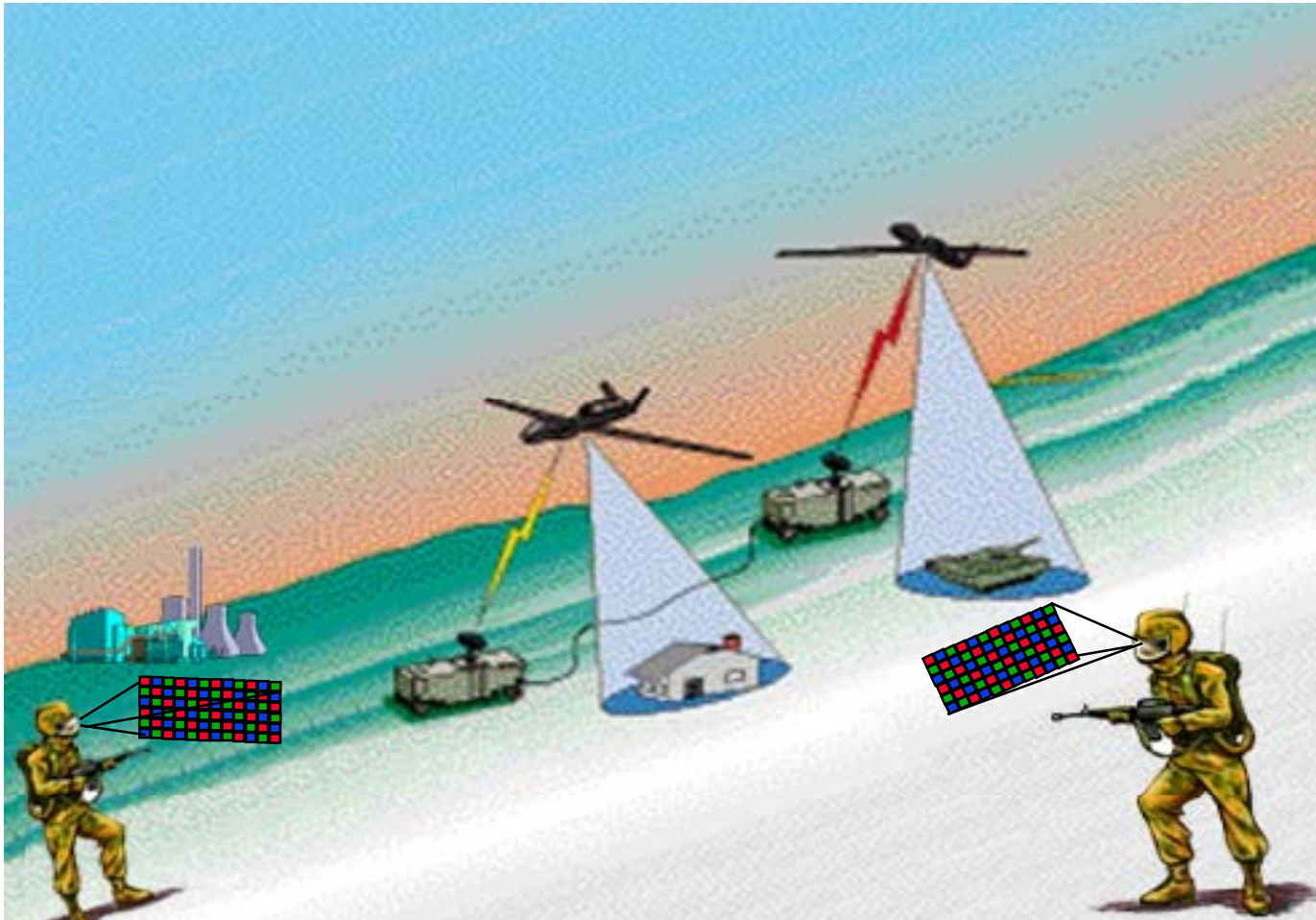


Visualization Needs

- ζ **Accuracy = WYSIWIM**
- ζ **Unambiguous Expression of *Intent* = WYSIWYD**
- ζ **Common View Communicated Up & Down The Hierarchy**



Individual Warfighter



Individual Warefighter

SOCOM Combat Management System



ETO/URBAN

GPS Module

- Antenna
- Rockwell PLGR GPS Engine
- Size 4.5" x 3" x 1"

CPU Module

- 133MHz Pentium CPU
- 64MB DRAM
- 2 GB Hard Drive
- 2 PCMCIA Slots
- 2 RS-232 Ports
- Universal Serial Bus
- Size 6" x 7.25" x 1.25"
- Weight 10.78 Lbs. (est)



Wireless LAN

- Proxim RangeLAN2
- 1.6 Mbps data rate
- Range 1000 ft. LOS
- 2.4 - 2.4835 GHz Spread Spectrum

Battery on Back

- Solid Lithium Ion Polymer
- 9.6 Amp Hour
- System Operation at Least 6 Hrs

MXF-610 Radio

- Computer Control
- Voice
- Data (16Kbps)
- Range > 5KM

Visualization Needs of Warfighter

- ζ **Represent Information Efficiently**
- ζ **Customize Information To Individual Soldier Needs And Situation**
- ζ **Scale To Large Number of Soldiers**
- ζ **Meet Time Critical Requirements**
- ζ **Maintain Military Quality of Service**
 - Select Most Effective Modality: Text, Image, Animation, Voice, Touch
 - Graceful Degradation

Roadblocks

- ζ **Many Visualization Techniques Don't Scale**
- ζ **Not Adapted To Distributed Networked Environment**
- ζ **Don't Convey Data Confidence Or Trust**
- ζ **Batch Mode: Move From Data To Visualization**
- ζ **Difficult To Shift Between Different Levels of Abstraction**
 - From One Perspective To Another
 - From Views Appropriate To One Task To Those Appropriate To Another
- ζ **Effective Visualization Often Require Visualization Experts**
- ζ **Being Pursued Piecemeal With Pre-Paradigm Shift Software**

Why Now

ζ **Massive Amounts Of Data Are Available**

Sensors

Modeling

ζ **Exciting Advancements In Hardware Technology**

Fast Inexpensive Graphics Hardware

Faster Than Moore's Law (Factor of 10 in 3 years; Exploit Parallelism and special HW)

New Sensors and Displays

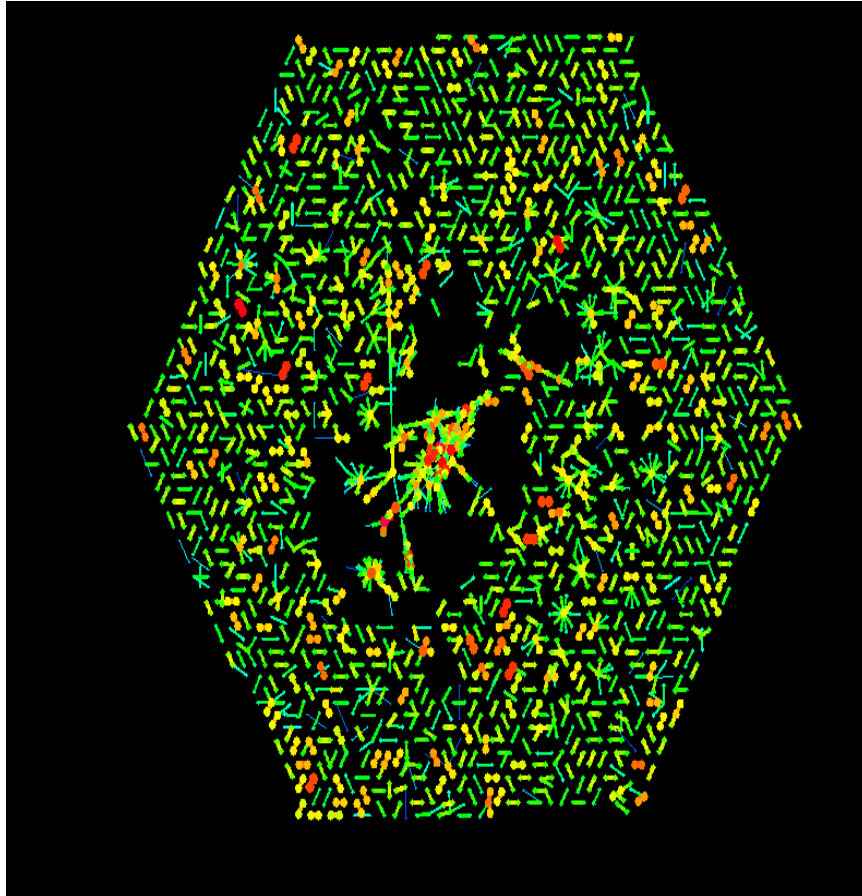
Computing, Networking, and Storage

ζ **Significant Developments In Interactive Visualization**

New Visual Metaphors For Abstract Information Applicable To Networks, Software

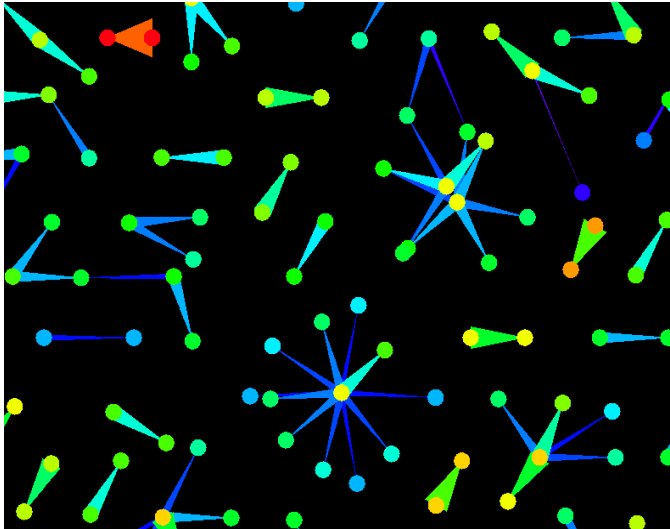
Visual Workspaces

Detecting Patterns

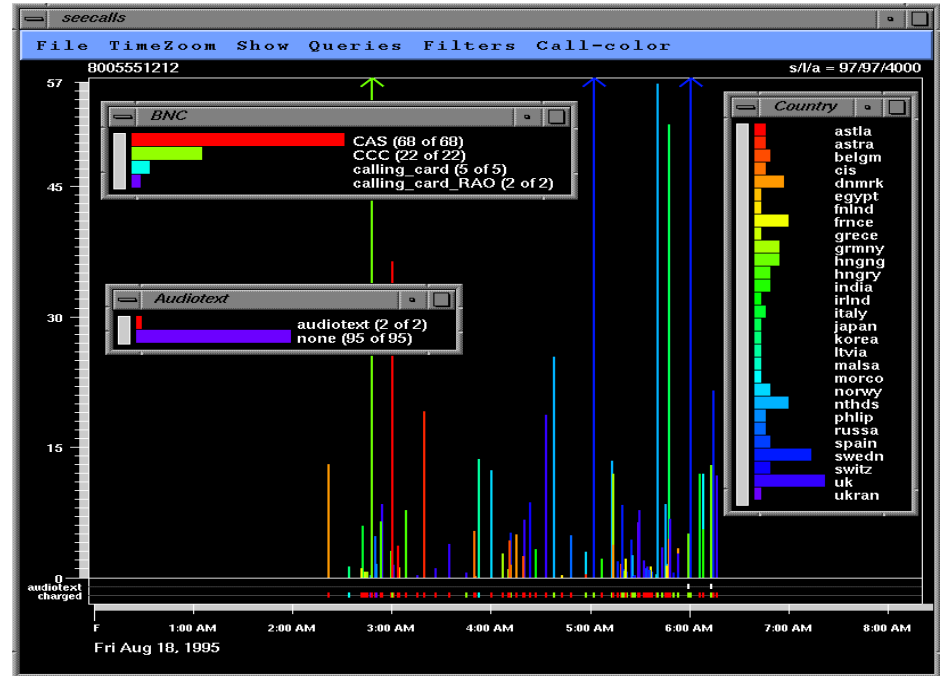


Application: Phone Fraud
Consequences:
Industry Loses Of
Billions/Year

Detecting Patterns



**Result For Unnamed
Long Distance Company:
Something Like Eight
Figure Savings**



Assess Situation

SEESOFT
OPERATIONS COLORBAR VIEW OPTIONS HELP

f6x030c.cob

DX
DC
DO

values 3
lines 1556/1970
files 1

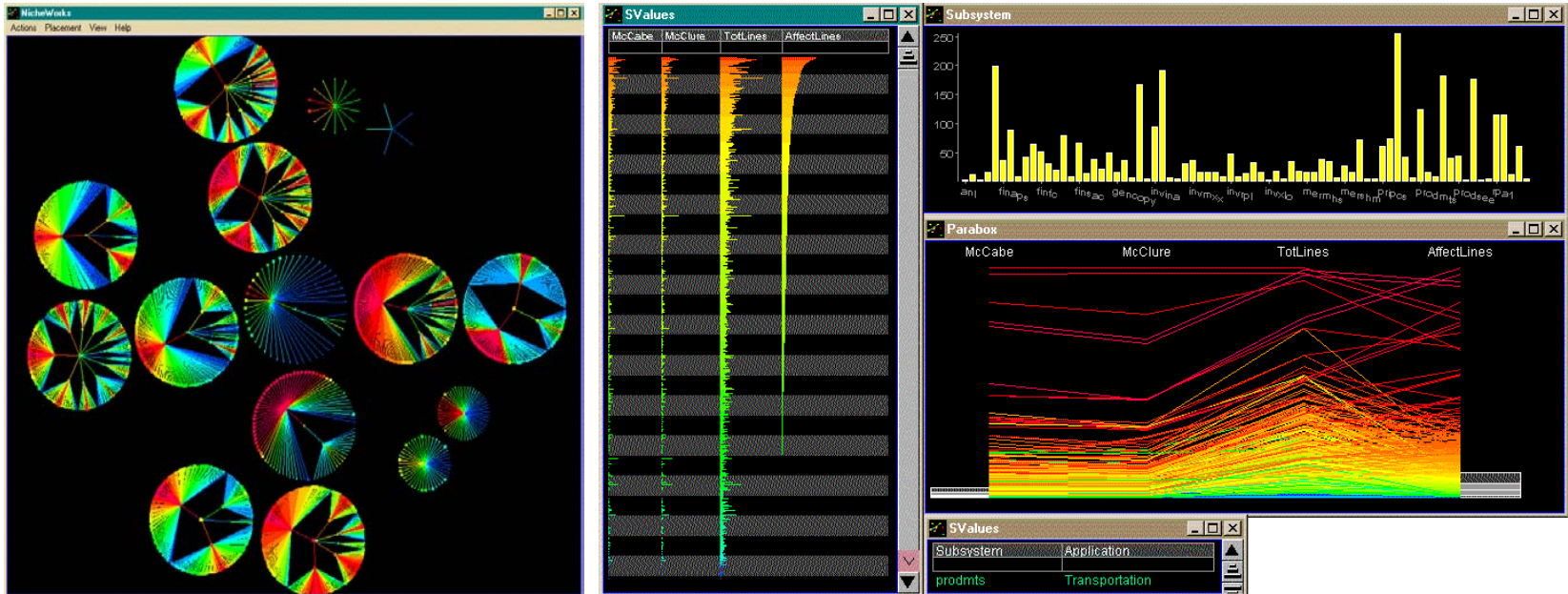
F6X030C.COB, LINE 8831 OF 19708

```
437450 PERFORM J551-REPLACE-BEG-DATE-LITERAL. F6X030
437500 SKIP1 F6X030
437550 IF ITEM-01-TAX-AN-BEG-DEPR-DATE EQUAL TO SPACES-04 F6X030
437600 AND CCR-ACCOUNTING-CYCLE NOT EQUAL TO '1' F6X030
437650 MOVE ORG-CODE-BAS TO ORG-FLG-TAX-BEG-DATE F6X030
437700 MOVE ITEM-00-BASE-AN-BEG-DEPR-DATE F6X030
437750 TO ITEM-01-TAX-AN-BEG-DEPR-DATE. F6X030
437800 SKIP1 F6X030
437900 OR ITEM-01-TAX-A-B-CODE EQUAL TO 'C' F6X030
```

Problem:
Year 2K
Application:
Identifying
Necessary
Code Changes

Heralded As:
600 Billion
Dollar
Problem

Prioritize Tasks



Result: 40-80% Improvement In Identifying Code Needing Changes

Themes From Successful Efforts

ζ **Visualization Supports Problem Solving and Encourages Collaboration**

ζ **Multiple Task-Specific Views Show Different Perspectives**

Often Novel Views To Show Overviews and Details

Views Focus and Filter To Match Different Tasks Needs

ζ **Interactive Views Function As Environments**

Operations Are Fast, Intuitive, and Reversible

Linked Views with Brushing Support Drill Down, and Aggregation

Movement Between Views That Preserves Context

ζ **Visualizations Connected To Analysis Engines With Effective Algorithms Allow Scaling To Real Domains**

Research Goal

Coherent Framework for Visualization Research Addressing Full Information Requirements of the Military

1 Move From Visual Workspace To Visual Decision Space

Visualizations To Convey And Control The Battlespace

2 Understand How To Create Visual Metaphors

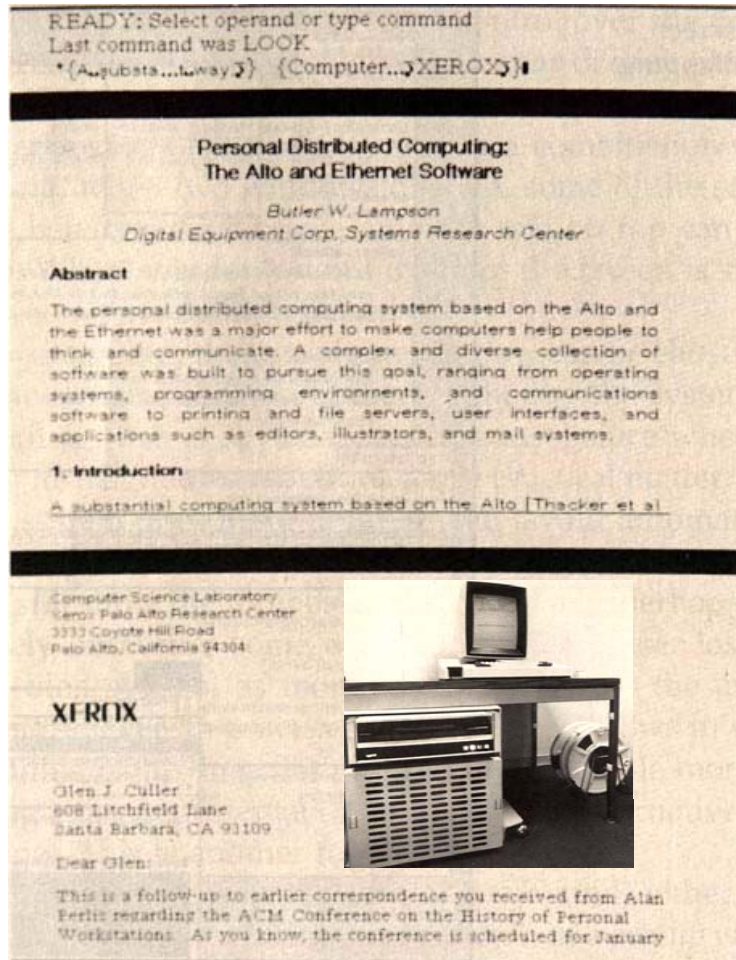
Understand Principles For Creating Effective Visual Metaphors And
Visualizations

Design Effective Integrated Visualizations For Military Applications

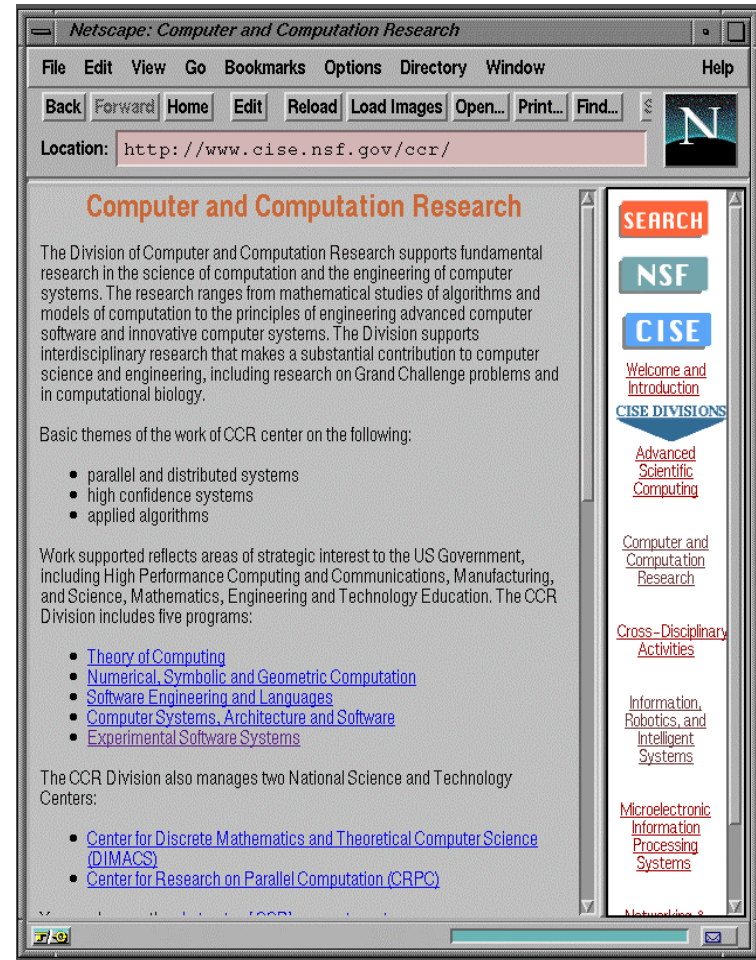
3 Develop A Production Technology

Support Engineering By Domain Experts

Visual Workspace



Xerox Alto 1970's



Netscape 1990's

Visual Decision Space

Visual Workspace To Visual Decision Space

§ Gap

Supporting Individual To Supporting Coordinated Teams

Natural Visualizations Of Battlespace

Linked Across Multiple Resolutions

For Different Command Levels

§ Approach

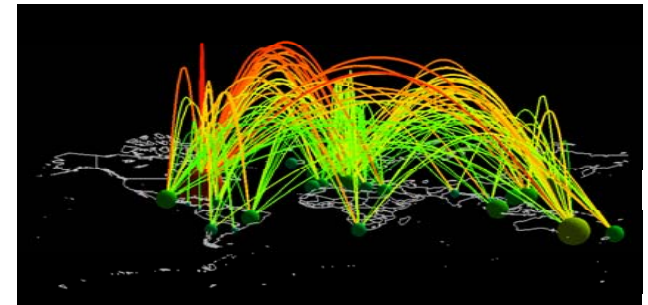
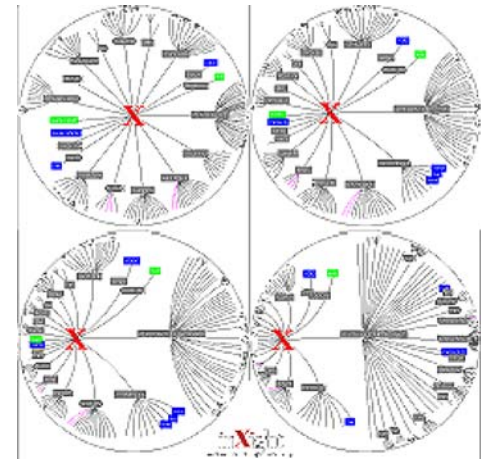
Direct Control Via

Visualizations Themselves



The screenshot shows the Seesoft software interface. The top menu bar includes File, Colors, Rectangles, View, Options, and Help. The main workspace displays a file explorer with a list of files and their corresponding color-coded thumbnails. The files are organized into a grid, with some files having multiple thumbnails. The files listed include:

- rtalocc.c
- rtaloc.c
- rtaloc_20.c
- rtaloc_20b.c
- rtaloc_20c.c
- rtaloc_20d.c
- rtaloc_20e.c
- rtaloc_20f.c
- rtaloc_20g.c
- rtaloc_20h.c
- rtaloc_20i.c
- rtaloc_20j.c
- rtaloc_20k.c
- rtaloc_20l.c
- rtaloc_20m.c
- rtaloc_20n.c
- rtaloc_20o.c
- rtaloc_20p.c
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- rtaloc_20r.c
- rtaloc_20s.c
- rtaloc_20t.c
- rtaloc_20u.c
- rtaloc_20v.c
- rtaloc_20w.c
- rtaloc_20x.c
- rtaloc_20y.c
- rtaloc_20z.c
- rtaloc_20aa.c
- rtaloc_20ab.c
- rtaloc_20ac.c
- rtaloc_20ad.c
- rtaloc_20ae.c
- rtaloc_20af.c
- rtaloc_20ag.c
- rtaloc_20ah.c
- rtaloc_20ai.c
- rtaloc_20aj.c
- rtaloc_20ak.c
- rtaloc_20al.c
- rtaloc_20am.c
- rtaloc_20an.c
- rtaloc_20ao.c
- rtaloc_20ap.c
- rtaloc_20aq.c
- rtaloc_20ar.c
- rtaloc_20as.c
- rtaloc_20at.c
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- rtaloc_20ay.c
- rtaloc_20az.c
- rtaloc_20ba.c
- rtaloc_20bb.c
- rtaloc_20bc.c
- rtaloc_20bd.c
- rtaloc_20be.c
- rtaloc_20bf.c
- rtaloc_20bg.c
- rtaloc_20bh.c
- rtaloc_20bi.c
- rtaloc_20bj.c
- rtaloc_20bk.c
- rtaloc_20bl.c
- rtaloc_20bm.c
- rtaloc_20bn.c
- rtaloc_20bo.c
- rtaloc_20bp.c
- rtaloc_20bq.c
- rtaloc_20br.c
- rtaloc_20bs.c
- rtaloc_20bt.c
- rtaloc_20bu.c
- rtaloc_20bv.c
- rtaloc_20bw.c
- rtaloc_20bx.c
- rtaloc_20by.c
- rtaloc_20bz.c
- rtaloc_20ca.c
- rtaloc_20cb.c
- rtaloc_20cc.c
- rtaloc_20cd.c
- rtaloc_20ce.c
- rtaloc_20cf.c
- rtaloc_20cg.c
- rtaloc_20ch.c
- rtaloc_20ci.c
- rtaloc_20cj.c
- rtaloc_20ck.c
- rtaloc_20cl.c
- rtaloc_20cm.c
- rtaloc_20cn.c
- rtaloc_20co.c
- rtaloc_20cp.c
- rtaloc_20cq.c
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- rtaloc_20ds.c
- rtaloc_20dt.c
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- rtaloc_20ju.c
- rtaloc_20jv.c
- rtaloc_20jw.c



Visual Metaphor Methodology

Visual Metaphors To Methodology For Production

§ Gap

Effective and Reliable Metaphors
General Methodology

§ Approach

Mine The Past

Tufte

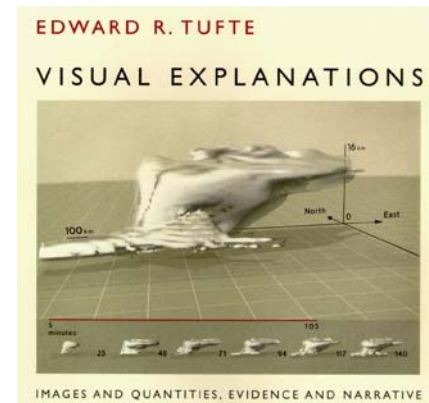
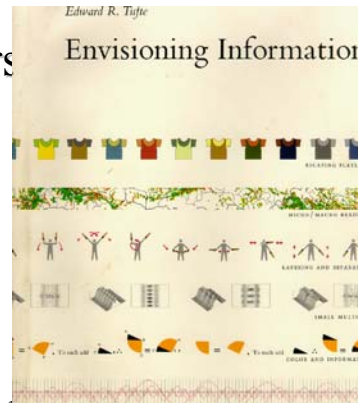
Exploit Existing Military Metaphors

Ground In Principles About Semantics and Perception of Graphics

Advance Automating Design of Graphics

APT, Mackinlay

Visage, Roth



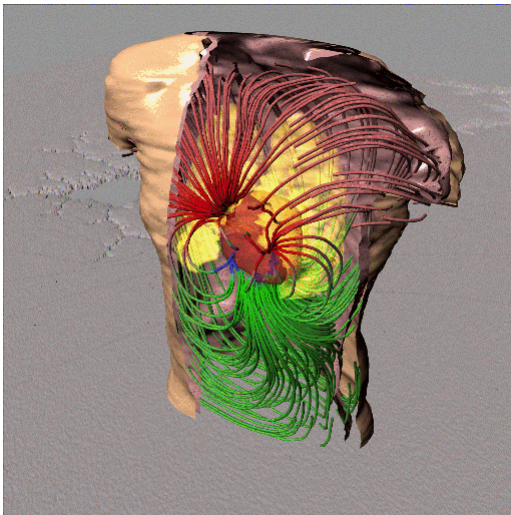
Visualization Production Technology

ζ Current State: Point Solutions

Different Visualizations: GIS SciVis SeeNet SeeSoft ...

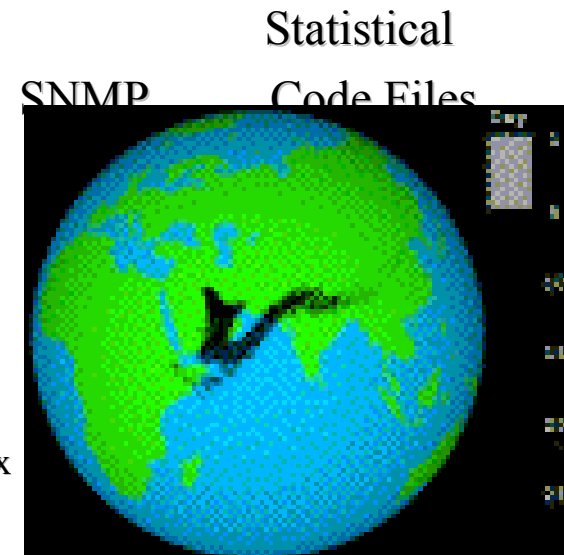
Different Visual Models: Spatial Scalar Networks Document
Processing

Different Data:



Geographic Vector Sim
Satellite
Sensors

3D Vector Field Visualization
of Electric Field within Thorax
*Johnson, Macleod, Matheson
Utah*



Simulated Kuwaiti Oil Fire from
Gulf War, *AdvancedComputing*

Visualization Production Technology

Point Solutions To Integrated Framework

ζ Gap

Connecting Between Types Of Visual Models And Data Types

Example: GIS Integrated With Network Visualization

Developers Need Mix and Match To Best Meet Military Task Requirements

Integrated Multilevel Representations Across Multi-Resolution
Information, Sensor, and Engagement Grids

ζ Approach

Model Specific Languages Connected Via Meta-Languages For Visual
Models

Multiscale Visualization Tools

Pad++

Toolkits With Increased Automation: Visualization Builder

VTK, SCIRun, APT, SageBrush

Summary

Right Picture In Right Mind At Right Time

ζ **Current Situation**

Visualization Is Happening

Visualization Will Directly Control Weapons

Misuse Is Life Threatening: Seeing Is Believing

Imperative We Understand Creation Of Effective Visualizations

ζ **Opportunity**

Massive Data Available From Sensing, Modeling, Network

Dramatic Increase In High Performance Graphics Performance

Existence Proofs For Interactive Information Visualization Effectiveness

ζ **Strategy**

Move From Visual Workplaces To Visual Decision Spaces

Exploit Visual Metaphors: Representation Becomes The Interface

Develop Production Technology For Military Visualizations

ζ **Impact**

Safe and Effective Control Of The Battlespace

Study Participants

Chair: Jim Hollan (UCSD)

Vice Chair: Pat Hanrahan (Stanford) *

DARPAPOC: Kevin Mills (ITO)

ISAT Coordinator: Rich Entlich

Stu Card (Xerox)

F. T. Case (ISO)

Robert Douglass (ISO)

Nat Durlack (MIT) *

Steve Eick (Bell Labs/Lucent)

Nahum Gershon (MITRE)

Paul Haeberli (SGI)

Chuck Hansen (Utah)

Randy Harr (ETO)

John Hoyt (TTO)

Anis Husain (ETO)

Hiroshi Ishii (MIT)

Chris Johnson (Utah)

Shaun Jones (DSO)

David Kirsh (UCSD)

Butler Lampson (Microsoft) *

Bill Lorensen (GE)

Robert Lowell (TTO)

Dave Patterson (ETO)

Daniel Reed (Illinois)

Steve Reiss (Brown)

George Robertson (Microsoft)

Robert Rosenfeld (TTO)

Steve Roth (CMU)

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Rick Williams (US Navy)

Victor Zue (MIT) *