The Director of Central Intelligence

Washington, D.C. 20505

Intelligence Research & Development Council

ARTIFICIAL INTELLIGENCE STEERING GROUP MEETING MINUTES

DATE/PLACE

18 June 1984
Navy Center for Applied Research
in Artificial Intelligence

ATTENDEES

Ray Bernstein
[redacted] STAT
Bob Cutter
Jude Franklin
George Forsen
Howard Greyber
Jim Jones
Mark Macomber
[redacted] STAT
Ken Richhart
[redacted] STAT
Jim Thomas
Bruce Waxman

NEXT MEETING

The next meeting of the AI Steering Group will be held on Monday, 27 August at 1330 in Dining Room C of the National Bureau of Standards in Gaithersburg, Maryland. In addition to our regular business meeting, we will receive a presentation on the Bureau's Automated Manufacturing Research Facility (machine vision and robotics).

ANNOUNCEMENTS

The American Association for Artificial Intelligence annual conference will be held 6-10 August 1984 in Austin, Texas. More information can be obtained from AAAI at (415) 328-3123.

The Armed Forces Communications and Electronics Association will hold a symposium on The Role of Knowledge-Based Systems in Command and Control in Kansas City, Missouri on 17-19 October 1984. More information is available from the General Chairman Mr. Gary W. Dozier on (913) 651-7800.

The First International Workshop on Expert Database Systems will be held at Kiawah Island, South Carolina on 25-27 October 1984. For more information contact Professor Larry Kerschberg on (803) 777-7159.

BUSINESS

An unclassified summary of the FY-84 AI Symposium has been prepared and is at the printers. Several copies will be sent to each AISG member in a few weeks. You are asked to pass them along to interested parties in your organization.

We have begun planning for the FY-85 AI Symposium. We are targeting the Symposium for March to give more time for preparation. DIA is considering hosting the Symposium at their new facility at Bolling Air Force Base. The IC Staff has provided funds again this year to help with the expenses. This year we would like greater participation by Government personnel in discussing actual intelligence applications for AI.

[redacted] has agreed to coordinate a technical seminar on Image Understanding for the Steering Group. The 1/2-1 day session will be held in Rosslyn in the early Fall. You will be asked to pass the word to other interested parties in your respective agencies. If you have any suggestions for other similar seminars which the Steering Group should sponsor, please contact [redacted]

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The CIA's internal AI Applications Working Group has prepared a 60-page report on potential applications for AI in the CIA. The SECRET-level report has been approved by the Agency's Information Systems Board and copies will be sent to each AI Steering Group member in the next few weeks (when they are returned from the printers).

[redacted] reported that he has received input from CIA, DIA, DMA, and the three Services for our AISG report. NSA is still finishing their response on their AI program. No further action has been taken regarding the draft recommendations which we discussed at our March meeting. The general sense of the members present at this meeting was that we should press on to produce a report in the relatively near future.

STAT

Dr. Jude Franklin, NCARAI, mentioned that the FY-84 update to the Joint Directors of Laboratories report on DoD AI projects will be out in the next few months. This report typically will exclude intelligence applications. NRL will also be compiling a library of all reports on AI ever funded by DoD. A bibliographic index will be made available over the ARPAnet.

[redacted] has been giving some thought as to how to run the proposed AI Advisory Panel. A strategy paper is forthcoming. You are requested to submit the names of any of your cleared contractors whom you feel would be qualified to serve on such a panel. [redacted] can be reached on [redacted]

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Dr. Jude Franklin is the Director of the Navy's Center for Applied Research in Artificial Intelligence (NCARAI). The Center is organizationally attached to the Naval Research Laboratories and located on Bolling Air Force Base. It was started three years ago in an effort to bring to fruition 15 years of Navy-sponsored AI research and to apply it to military problems. Their work is mostly applied research/exploratory development in providing a transition from university research to military applications. Their charter is to establish an AI laboratory of national stature with an active visiting scientist program throughout the military, academia, and industry. In 1983 the Joint Directors of Laboratories endorsed NCARAI as the lead laboratory for military AI research, and several joint-Service projects have begun.

NCARAI has a few projects under way in three general classes: Expert Systems, Natural Language, and Distributed Problem Solving. Dr. Franklin briefly described three of their expert system projects, and two members of the NCARAI staff described their work in natural language processing and multi-sensor fusion. A set of viewgraphs is attached.

The Maintenance and Troubleshooting of Electronic Equipment Expert System has been developed to provide support for maintenance personnel in the field and to generate automatic test equipment (ATE) code automatically. In an effort to resolve the typical knowledge acquisition bottleneck problem they have developed a semi-automated rule generator. The system follows a mixed-initiative approach to diagnose failures in electronic circuitry and to isolate faults. The system was written in FRANZLISP and operates on the SUN workstation.

The Combat Management System (BATTLE) was developed for the Marines to allocate weapons to targets during combat. The system has been designed as an advisor to the operator and to provide warnings about the operator's proposed strategy. A particularly noteworthy point is that by analyzing and improving the heuristics employed by the system the performance in achieving an allocation was improved from over 45 minutes to less than 1 second. The Combat Management System is a general resource allocation system and NCARAI intends to study applying it to other resource allocation problems. In Dr. Franklin's view, there is no truely domain independent expert system available in industry today.

A third project concerns the development of a target classification system using Inverse Synthetic Aperature Radar (ISAR). The project attempts to combine AI with existing, more traditional statistical pattern recognition techniques. The prototype system is heavily interactive and leads the operator to conduct certain signal processing operations. In a recent test the system identified 84% of the targets correctly. More tests under varying imaging conditions are planned.

Dr. Elaine Marsh described her Message Automation project which deals with the automated distribution of Casualty Reports by their content and the generation of message summaries. The approach uses grammar-based natural language processing techniques to (1) parse the message narrative fields, (2) regularize the expressions into a common assertion form, and (3) map the assertions into a special information format. This format is then sent to a Dissemination System, written in OPS-5, which uses production rules to analyze both the formatted and (processed) narrative fields to determine proper dissemination.

The summarization system operates solely on the narrative field. It employs three types of rules: (1) to perform inferencing, (2) to rate format rows according to their potential importance to the summary, and (3) to select the row with the highest rating to generate the summary. Future plans call for making the system more robust and using it to control message entry.

Dr. Y. T. Chen described his project in integrating multi-sensor information. The application environment is to support the Tactical Coordinator (TACCO) aboard a submarine-hunting P3 aircraft. The system addresses sensor utilization, threat assessment, weapons deployment, situation description, and mission strategic planning. The knowledge base of the system consists of object-level knowledge (facts, heuristics, and judgments about sensors and targets) and meta-level knowledge (which determine the order in which object-level rules are to be applied). There will be a hierarchy of sensor specialists, each with a different sensor. The results of the various experts are then combined by a "Platform Specialist" which can also direct specific requests back down to the individual sensor specialist.

Dr. Chen is targeting to finish the knowledge base by the end of the summer with a demonstration by the end of the year. The system will be implemented on LMI machines. Dr. Chen has concluded that OPS-5 does not have an adequate facility for developing a flexible enough control strategy (meta-rules).

Executive Secretary
AI Steering Group

STAT

PRESENTATION TO NAVSEA CORPORATE BOARD

ARTIFICIAL INTELLIGENCE

THE MEANING OF ARTIFICIAL INTELLIGENCE

- THERE ARE AS MANY DEFINITIONS OF "ARTIFICIAL INTELLIGENCE" AS THERE ARE PRACTITIONERS -- AND NO ONE ACCEPTS ANYONE ELSE'S

- WHAT IS IMPORTANT TO KNOW ABOUT AI ARE THE FEATURES THAT DISTINGUISH IT FROM CONVENTIONAL COMPUTER SCIENCE

WHAT IS NEW ABOUT ARTIFICIAL INTELLIGENCE?

* IT USES COMPUTERS FOR SYMBOLIC PROCESSES, AKIN TO MODES OF HUMAN THOUGHT, RATHER THAN FOR NUMERIC MANIPULATION

* IT SEEKS TO REPRESENT KNOWLEDGE IN THE COMPUTER IN A MANNER THAT FACILITATES THESE SYMBOLIC PROCESSES AND USES KNOWLEDGE THAT IS OFTEN INCOMPLETE AND SUBJECTIVE

* IT STRESSES INTERACTIONS BETWEEN MAN AND MACHINES THAT ARE COMFORTABLE AND THAT CREATE CONFIDENCE

* IT EMPLOYS THESE PROCESSES TO PERFORM AUTOMATED REASONING

  - DRAWING INFERENCES

  - PRUNING DECISION TREES

  - SELECTING OPTIONS

TYPICAL EXAMPLES OF ARTIFICIAL INTELLIGENCE APPLICATIONS

SOLVE INTEGRAL CALCULUS PROBLEMS USING HEURISTICS TECHNIQUES

PERFORM MEDICAL DIAGNOSIS AND MAKE PRESCRIPTIONS

- PULMONARY DISEASE (**PUFFS**)
- INFECTIOUS BLOOD DISEASE (**MYCIN**)
- INTERNAL MEDICINE (**INTERNIST**)

INTERPRET GEOLOGICAL SURVEY DATA FOR MINERAL AND OIL EXPLORATION (**PROSPECTOR**)

ANALYSIS OF MOLECULAR STRUCTURES BASED ON NMR, MASS SPECTROSCOPY, AND CHEMICAL DATA (**DENDRAL**)

DESIGN OF COMPUTER SYSTEMS CONFIGURATIONS TO MEET GIVEN CUSTOMER REQUIREMENTS (**R1, XCON**)

HOW CAN ARTIFICIAL INTELLIGENCE MAKE A DIFFERENCE TO THE NAVY?

APPLICATIONS

A) EXPERT SYSTEMS
DECISION SUPPORT SYSTEMS
TARGET CLASSIFICATION
VISION PROCESSING

B) NATURAL LANGUAGE
- MESSAGE AUTOMATION
- QUERY/RESPONSE FOR LARGE DATA BASE
- MESSAGE ENTRY SYSTEM
- SPEECH UNDERSTANDING

C) DISTRIBUTED PROBLEM SOLVING
- MULTISENSOR INFORMATION INTEGRATION
  FOR:
    P3C
    DDG 51
    SUBACS
- AUTONOMOUS VEHICLES
- SMART WEAPONS

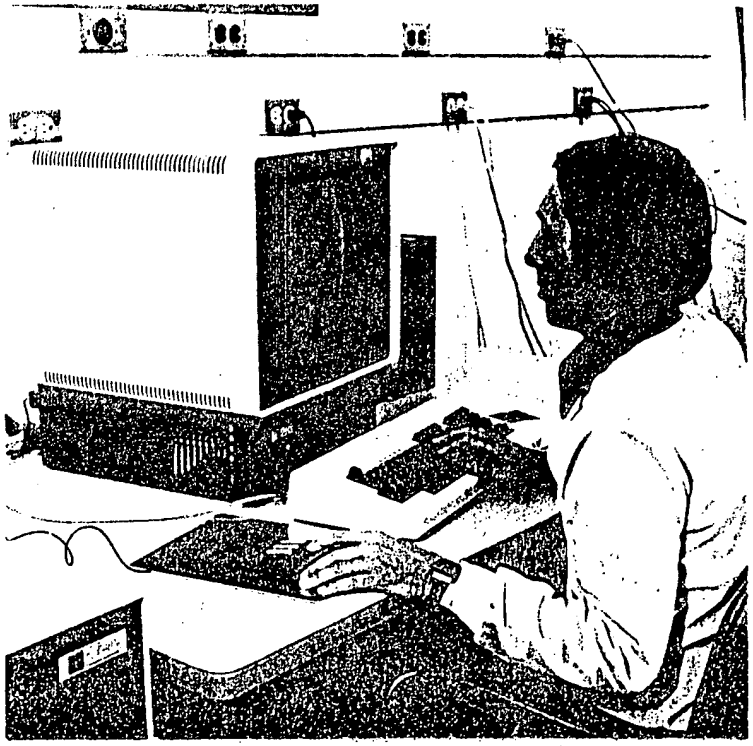
EXPERT SYSTEMS:

- CAPTURE KNOWLEDGE AND REASONING PROCESSES USED BY HUMANS IN COMPLEX PROBLEM SOLVING.

- CHARACTERIZED BY KNOWLEDGE-INTENSIVE SYMBOLIC COMPUTATIONS.

- APPLIED TO COMPLEX PROBLEMS NOT WELL-CAPTURED BY MATHEMATICAL MODELS.

EXPERT SYSTEM FOR MAINTENANCE AND TROUBLE-SHOOTING



Approved For Release 2008/09/04 : CIA-RDP86M00886R000500040011-4

EXPERT SYSTEM FOR MAINTENANCE AND TROUBLESHOOTING

PURPOSE - USE AI, ATE AND MAN MACHINE INTERACTIONS TO GUIDE A TECHNICIAN IN TROUBLESHOOTING ELECTRONIC EQUIPMENT

- USE AI EXPERT SYSTEM TECHNOLOGY TO GENERATE ATE CODE AUTOMATICALLY

APPROACH - DEVELOP GENERAL AI TOOLS TO BE APPLIED TO DIVERSE MILITARY ELECTRONIC SYSTEMS

MOTIVATION:

- LACK OF SKILLED TECHNICIANS
- LIMITATIONS OF CURRENT ATE
  - TIME REQUIRED
  - COST OF ACQUISITION
  - SPEED OF FAULT ISOLATION
  - RESOLUTION OF FAULT ISOLATION
  - RIGIDITY

NATURAL LANGUAGE SYSTEMS

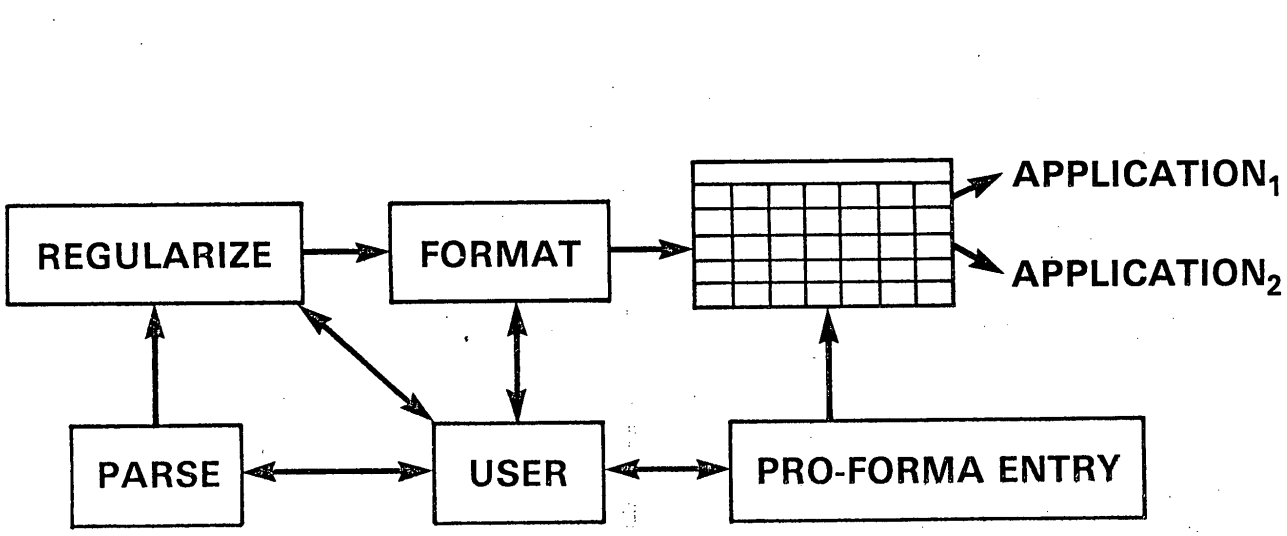
- CAPTURE THE COMPLEX KNOWLEDGE AND TECHNIQUES THAT A HUMAN USES TO UNDERSTAND SPOKEN OR WRITTEN LANGUAGE BY:

    * PARSING
    * PERFORMING SYNTACTIC AND SEMANTIC ANALYSIS
    * UNDERSTANDING THE CONTEXT

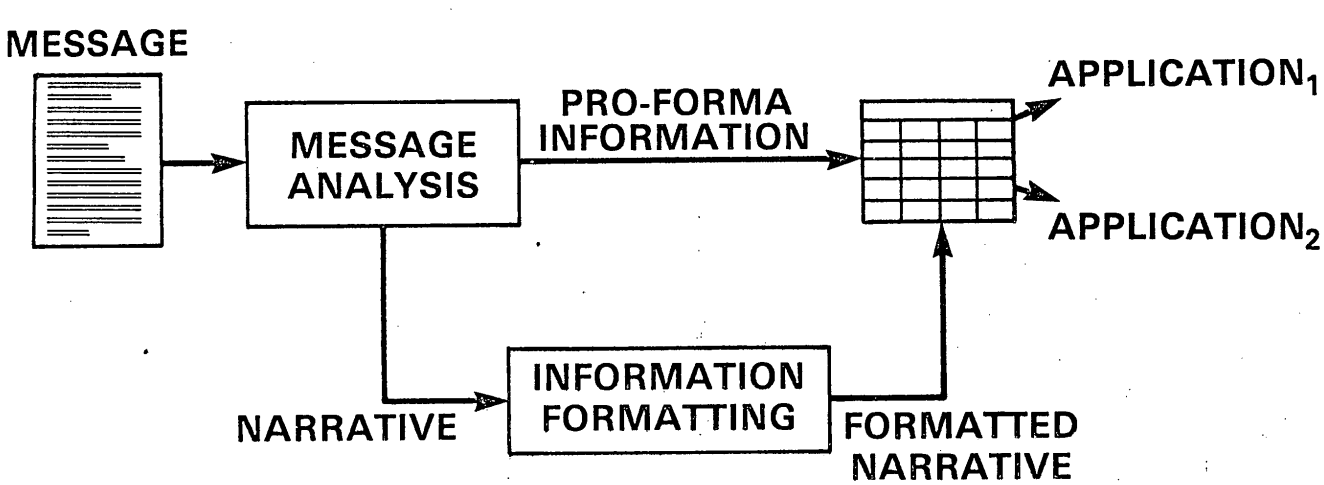
- CHARACTERIZED BY THE USE OF LINGUISTIC KNOWLEDGE AND COMPUTATIONAL LINGUISTICS COUPLED WITH WORLD KNOWLEDGE

- APPLIED TO THE AREAS OF COMPUTER UNDERSTANDING OF WRITTEN TEXT OR SPOKEN LANGUAGE

MESSAGE ENTRY SYSTEM



CURRENT SYSTEM STRUCTURE



INFORMATION FORMATTING
= CONVERSION OF NARRATIVE INTO A STRUCTURED DATA BASE

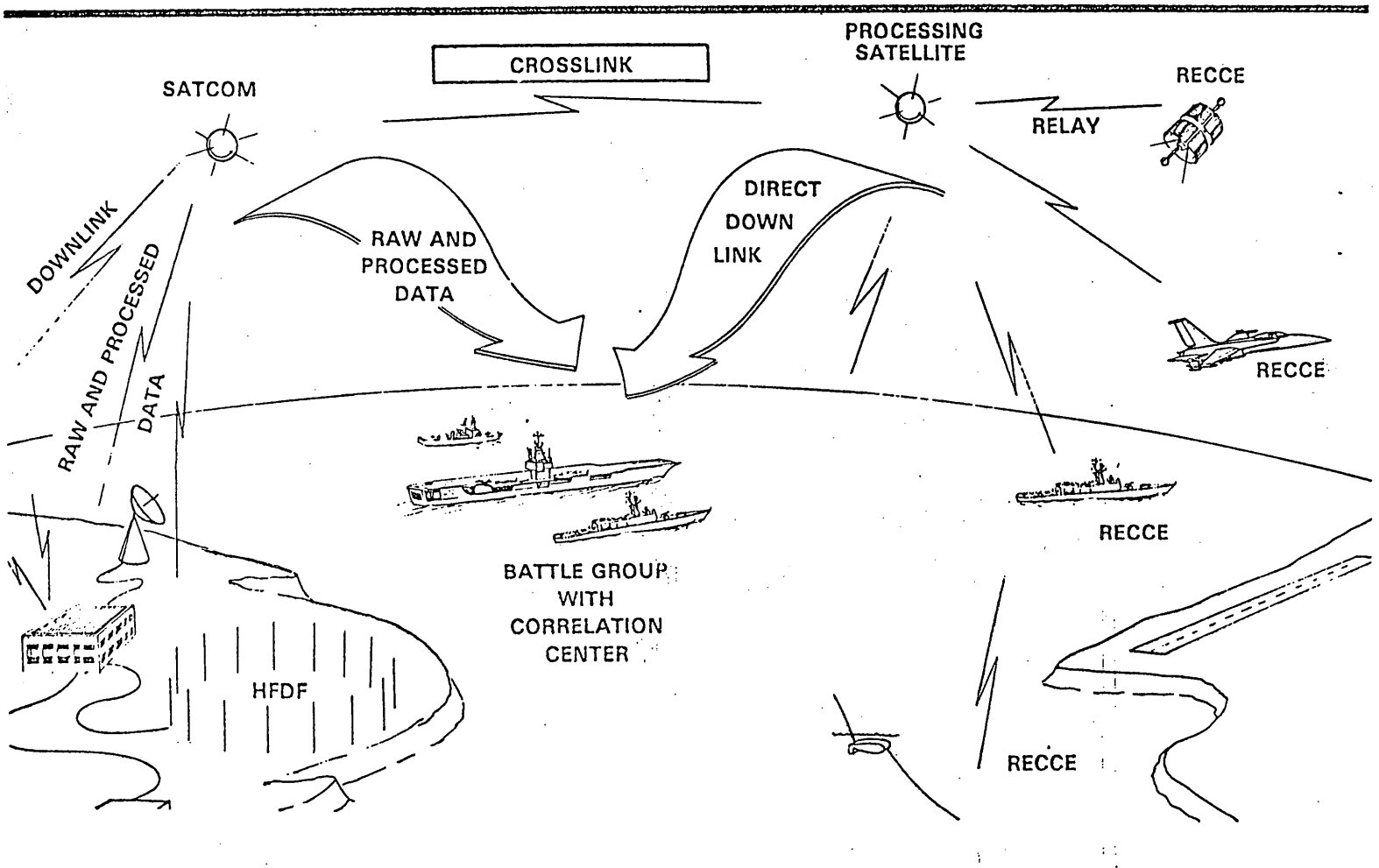
DISTRIBUTED PROBLEM SOLVING SYSTEMS

- CAPTURE THE KNOWLEDGE AND REASONING POWERS THAT ARE REQUIRED TO MAKE AUTONOMOUS OR SEMI-AUTONOMOUS DECISIONS

- CHARACTERIZED BY DISTRIBUTED NETWORKS OF SEMI-AUTONOMOUS PROBLEM SOLVING NODES THAT ARE CAPABLE OF COOPERATING WITH OTHER NODES TO SOLVE A SINGLE PROBLEM

- APPLIED TO AREAS SUCH AS MULTI-SENSOR FUSION AND/OR SOPHISTICATED AUTONOMOUS VEHICLES SUCH AS SMART WEAPONS AND INTELLIGENT ROBOTS

TOMORROW'S CARRIER BATTLE GROUP MANAGEMENT PROBLEM



NAVY AI PROGRAMS ARE AIMED AT SOLVING PROBLEMS

1) INCREASE READINESS AND REDUCE COST

- EXPERT SYSTEM TO MAINTAIN ELECTRONIC EQUIPMENT AND TO GENERATE ATE CODE AUTOMATICALLY (NAVAIR)
- DECISION SUPPORT SYSTEMS FOR COMBAT MANAGEMENT (MARINE CORPS)
- TRAINING (JDL)

2) REDUCE MANPOWER REQUIREMENTS AND OPERATOR OVERLOAD

- NATURAL LANGUAGE PROCESSING TO AUTOMATE MESSAGE HANDLING AND TO REDUCE ERRORS (3M)
- MULTISENSOR INFORMATION INTEGRATION, DISPLAY AND INTERPRETATION
- EXPERT SYSTEM FOR OPERATIONAL PLANNING
- SPEECH UNDERSTANDING (NAVAIR-DARPA STRATEGIC COMPUTING INITIATIVE)

CRITICAL AI TECHNOLOGIES

EXPERT SYSTEMS

A) AUTOMATED KNOWLEDGE ACQUISITION SYSTEMS

B) ADAPTIVE LEARNING SYSTEMS

C) INFERENCE METHODS FOR TIME CRITICAL SITUATIONS

NATURAL LANGUAGE

A) HIGH SPEED PARSER

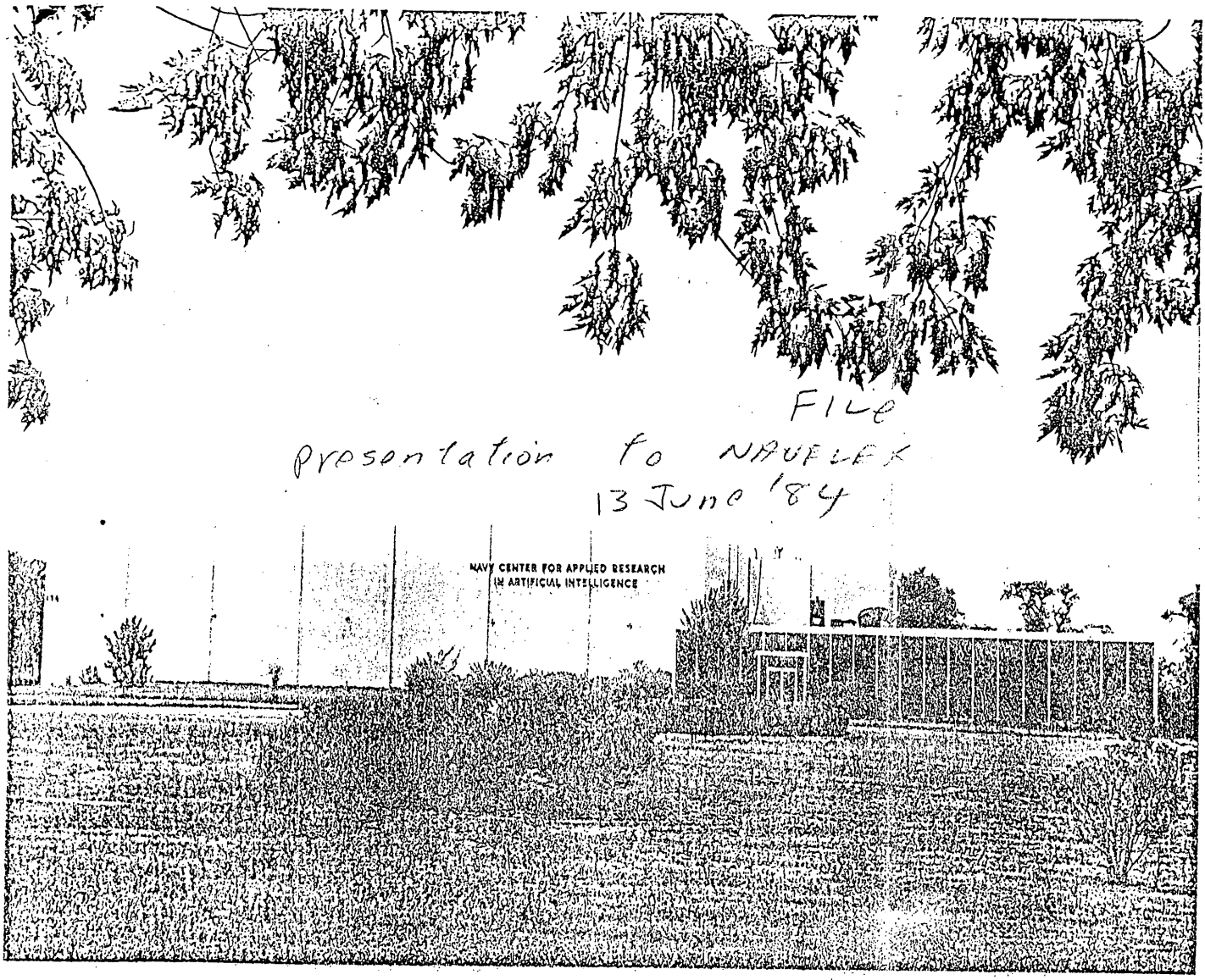
B) VERSATILE GRAMMAR

C) IMPROVED SPEECH UNDERSTANDING SYSTEMS

DISTRIBUTED PROBLEM SOLVING

A) AUTONOMOUS PROBLEM SOLVING

B) ADAPTIVE SEARCH TECHNIQUES



File

Presentation to NAVELEX

13 June '84

OUTLINE

1) OVERVIEW OF NCARAI

   - PROJECTS

2) TECHNICAL DISCUSSION OF PROJECTS

   - MAINTENANCE AND TROUBLESHOOTING
   - MULTISENSOR INFORMATION INTEGRATION AND ISAR CLASSIFIER

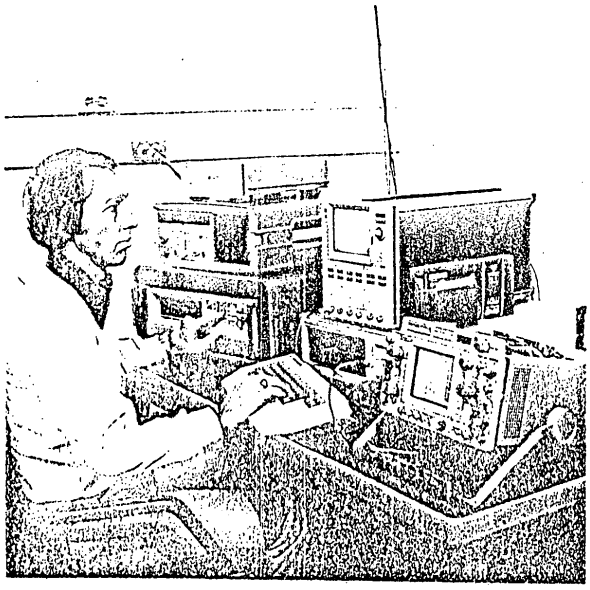
3) POTENTIAL NAVELEX/NRL PROGRAMS

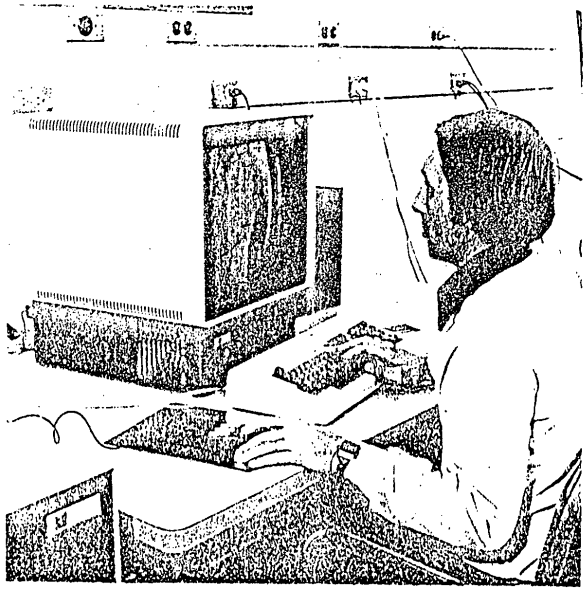
   - DIAGNOSTICS FOR MAINTENANCE AND TROUBLESHOOTING
   - SURVEILLANCE
   - TARGET CLASSIFICATION (ACOUSTICS AND NON ACOUSTICS)
   - BATTLE GROUP LEVEL MANAGEMENT AND ASSESSMENT

CLASSES OF NCARAI PROJECTS

EXPERT SYSTEMS	NATURAL LANGUAGE	DISTRIBUTED PROBLEM SOLVING
MAINTENANCE AND TROUBLESHOOTING	MESSAGE AUTOMATION	MULTISENSOR FUSION
COMBAT MANAGEMENT		ADAPTIVE CONTROL
TARGET CLASSIFICATION		
OPERATIONAL PLANNING		

EXPERT SYSTEM FOR MAINTENANCE AND TROUBLE-SHOOTING





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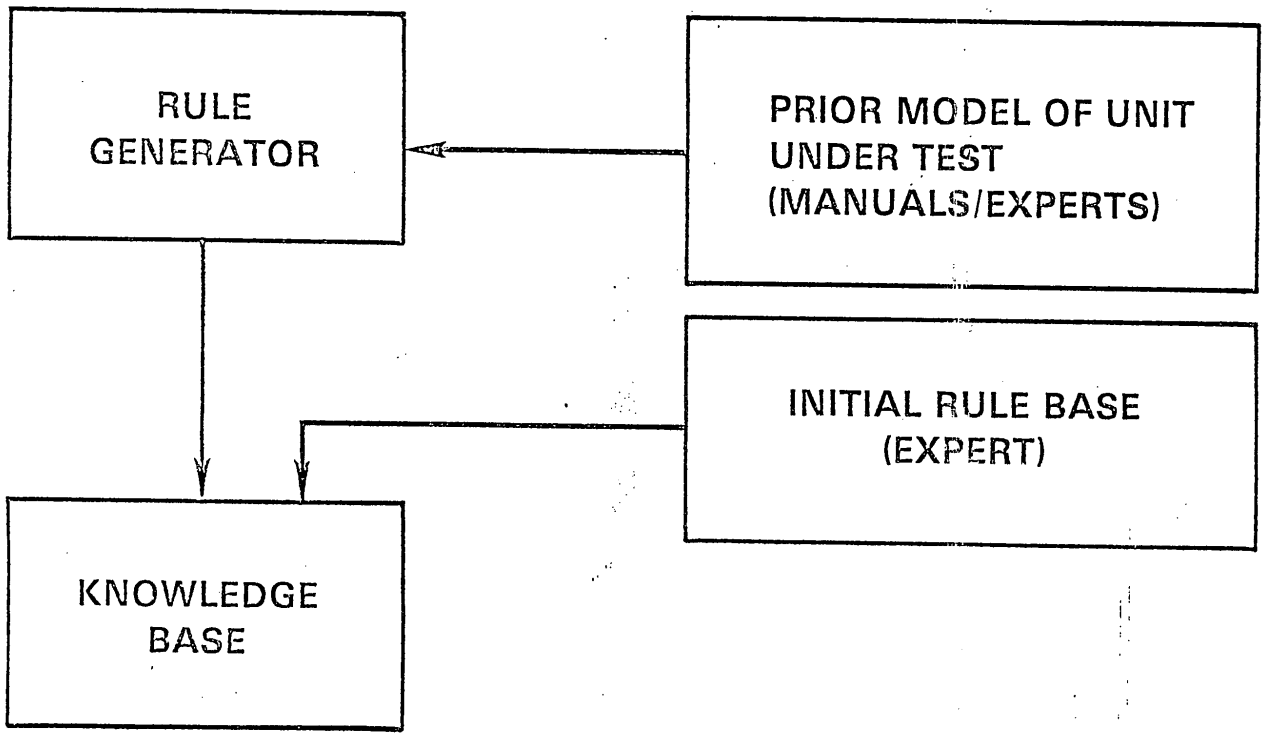
- LIMITATIONS OF CURRENT ATE
  - TIME REQUIRED
  - COST OF ACQUISITION
  - SPEED OF FAULT ISOLATION
  - RESOLUTION OF FAULT ISOLATION
  - RIGIDITY

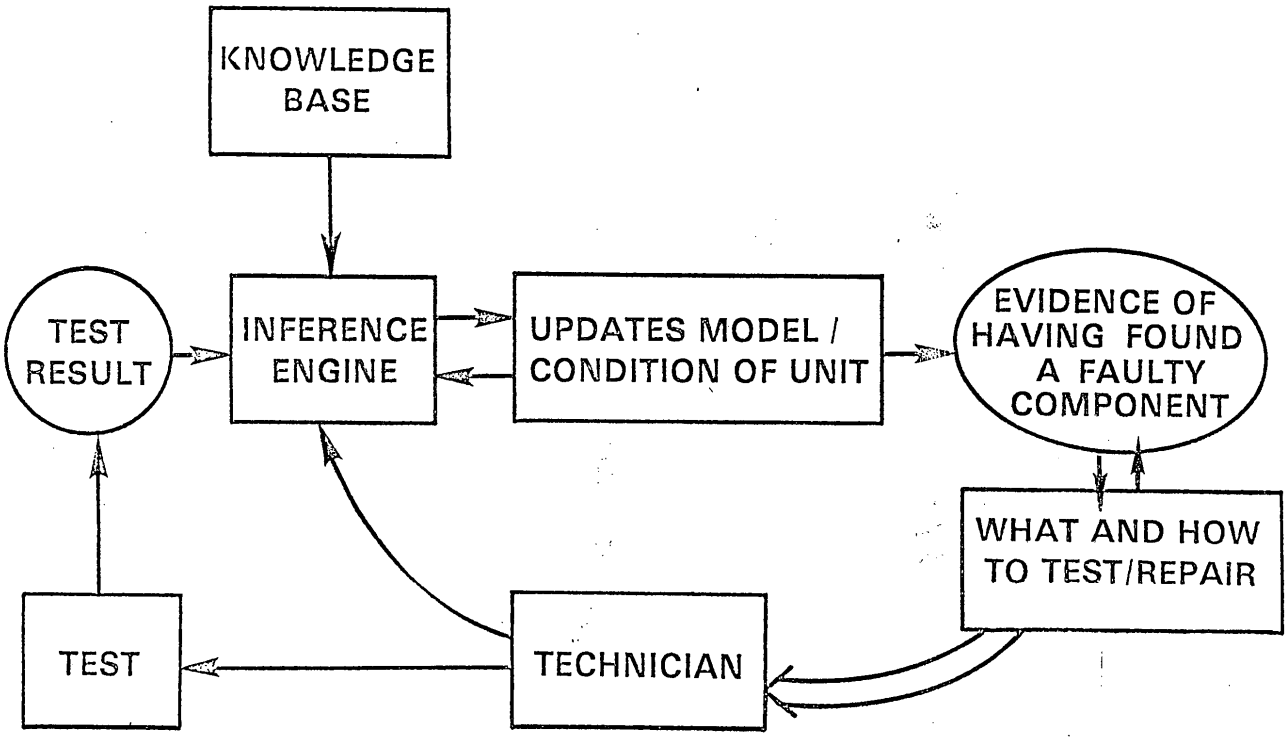
TECHNICAL ISSUES:

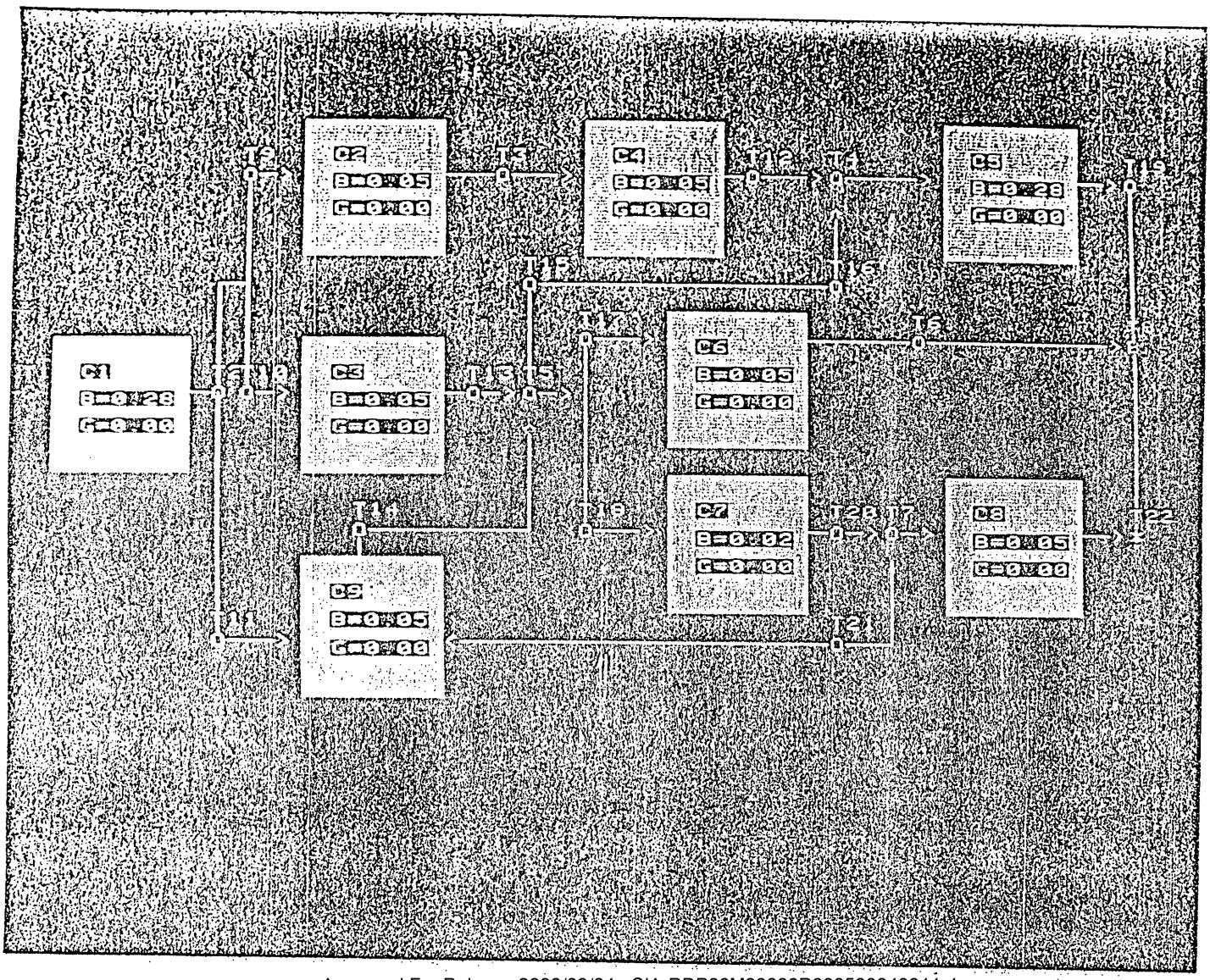
- EXPLOIT AI DECISION AID TECHNOLOGY
- AVOID KNOWLEDGE ACQUISITION BOTTLENECK
- EXPLOIT EXISTING ATE GEAR
- PROVIDE HIGH QUALITY USER INTERFACE
- USE AI TO GENERATE ATE, AUTOMATICALLY

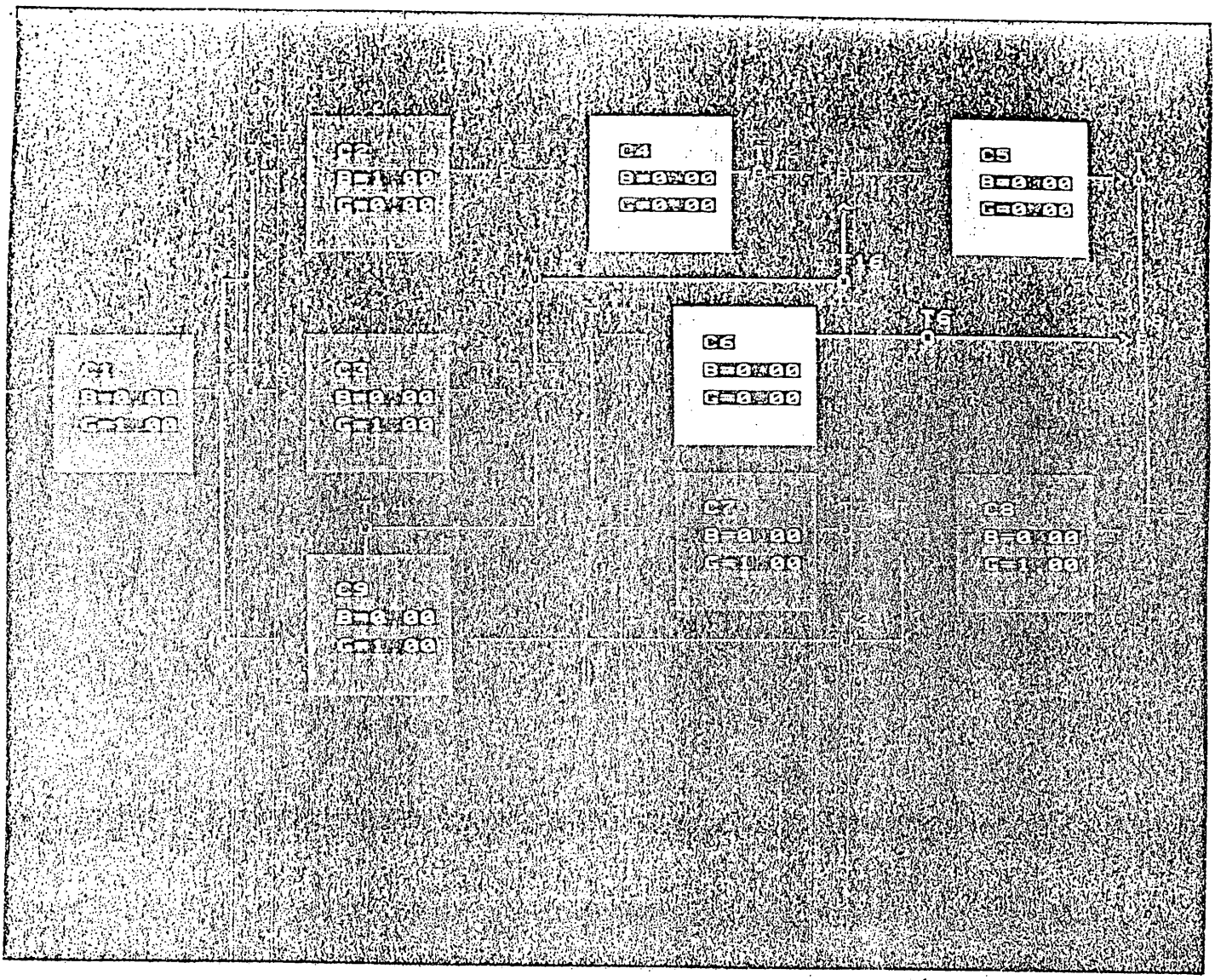
KNOWLEDGE BASE COMPILER



DIAGNOSTIC SYSTEM







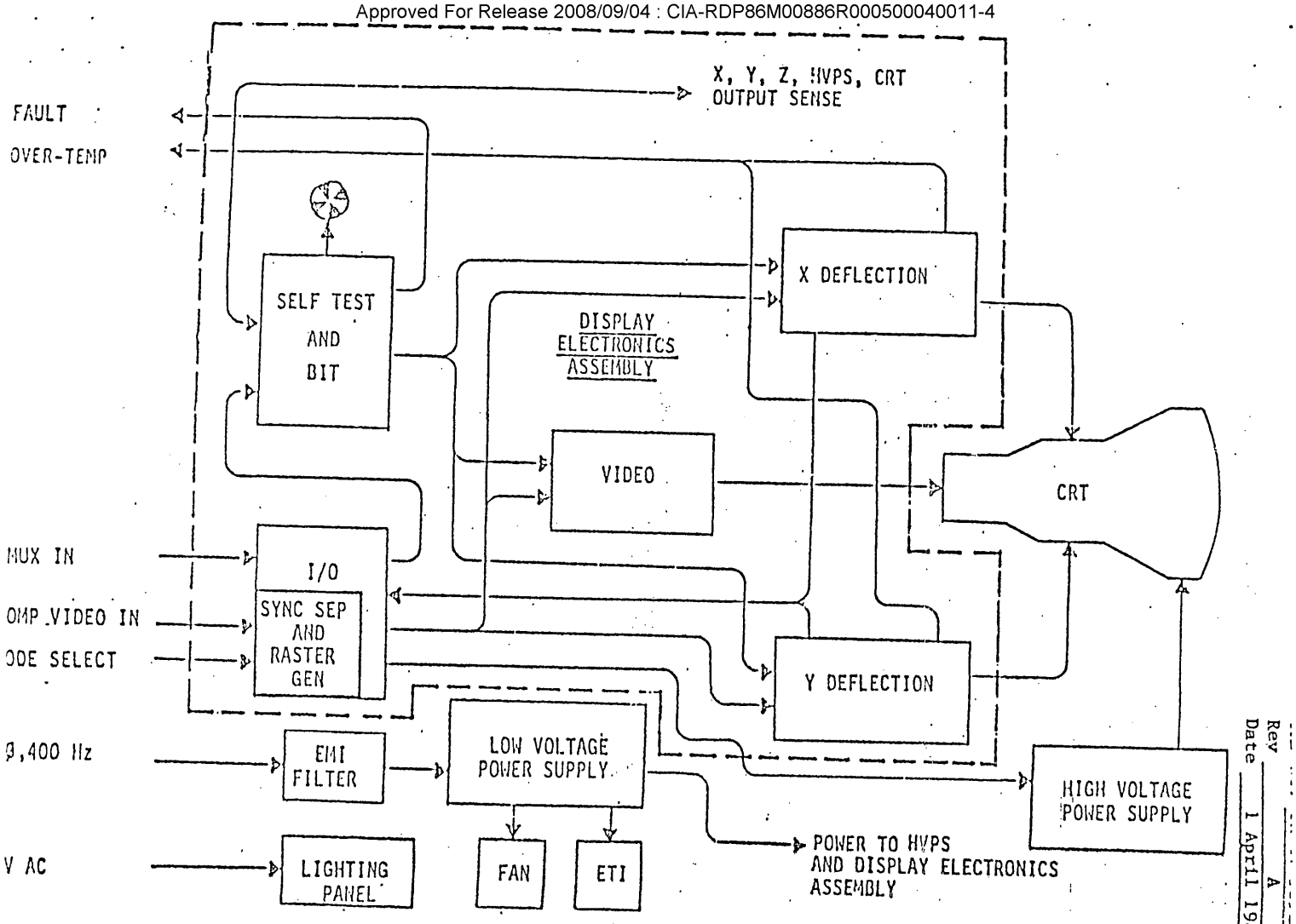


Figure 6. Converter-Display - Block Diagram

FEATURES OF MAINTENANCE AND TROUBLESHOOTING EXPERT SYSTEM

1) MIXED INITIATIVE

2) ANALOG OR DIGITAL

3) COST OF TEST, SET-UP AND RISK ARE TAKEN INTO ACCOUNT

4) DYNAMIC MODEL OF BELIEFS

- EVIDENTIAL REASONING
- NON-MONOTONIC REASONING
- ADAPTIVE TROUBLESHOOTING TREE
- FORWARD AND BACKWARD REASONING

5) HEURISTIC SEARCH

6) NEXT BEST TEST

7) FUNCTIONALITY BEING ADDED

8) LEARNING FEATURE TO BE ADDED

- STATISTICS
- AUTOMATIC DEDUCTION OF QUALITATIVE RULES
- CADCAM

9) AUTOMATIC RULE GENERATION

INVERSE SYNTHETIC APERTURE RADAR

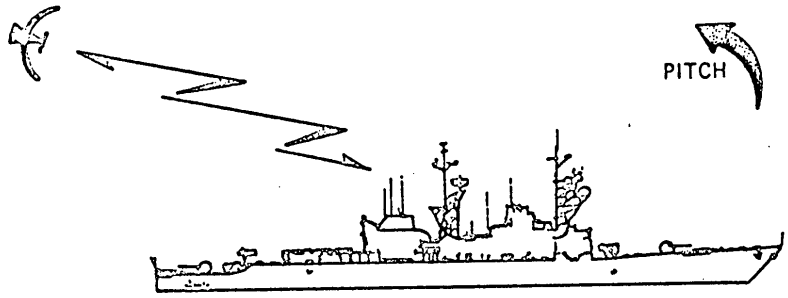
A TWO-DIMENSIONAL RADAR IMAGE CONSTRUCTED FROM DOPPLER RETURNS CAUSED BY THE MOTION OF THE TARGET

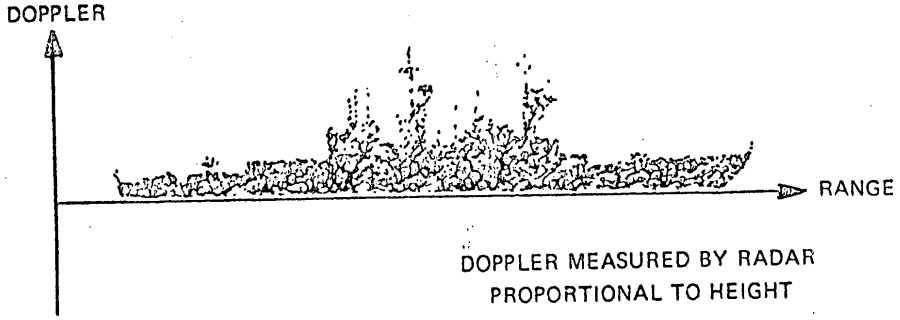
- POORER QUALITY THAN A VISUAL IMAGE
- NOISY
- REFLECTION INTENSITIES VARY GREATLY, EVEN FROM SIMILAR VIEWING ANGLES
- SHIP ORIENTATION AND CROSS-RANGE SCALE IN THE IMAGE ARE UNKNOWN

THIS IMAGE RECOGNITION PROBLEM IS NOT WELL-SUITED FOR TRADITIONAL STATISTICAL PATTERN RECOGNITION TECHNIQUES

UNCLASSIFIED

RANGE/DOPPLER PITCH CONCEPT





UNCLASSIFIED

WHAT IS NEEDED

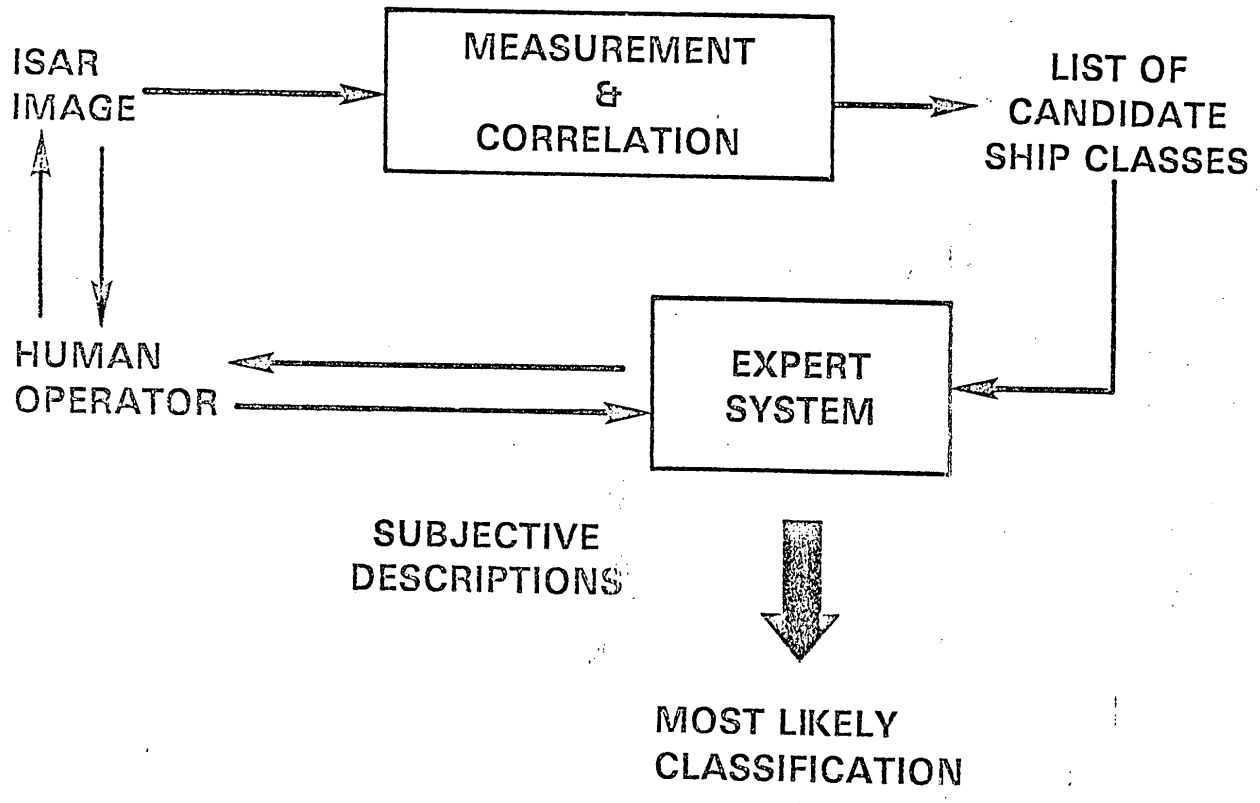
- ALLOW FOR AUTOMATIC PROCESSING WHEN PRACTICAL AND APPROPRIATE
- MAKE USE OF THE OPERATOR'S JUDGEMENTS AND PATTERN RECOGNITION CAPABILITIES
- CAPTURE THE KNOWLEDGE AND REASONING ABOUT ALTERNATIVE CLASSIFICATIONS THAT IS CHARACTERISTIC OF AN EXPERT ANALYST
- SHOW PROMISE OF NEAR-TERM TRANSITION TO THE FLEET

UNRESOLVED ISSUES

- TESTED ONLY ON HIGH QUALITY, HIGH RESOLUTION IMAGES
- USES ONLY A SINGLE STATIC FRAME OF IMAGERY
- CAN IT DISTINGUISH AMONG SIMILAR SHIP CLASSES?
- DOES NOT ALLOW FOR USER QUERIES, OBSERVATIONS, ETC.

IS IT PRACTICAL FOR THE OPERATIONAL NAVY?

ISAR IMAGE CLASSIFICATION SYSTEM



Excerpts From An Actual Classification Trial

isaraid – Thu Dec 1 13:18:57 1983

Welcome to the ISAR image interpretation aid
(NCARAI)

—Enter command: question
>>Enter the image name or t: image84
>>Enter the class name or t: *

Do you wish to see the results of each question ? y

To what degree do you believe that
(profile-has-isolated-directors-fwd-of-bridge-with-a-linear-taper) ?* -3

I neither suspect nor doubt the possibility of ForestSherman, Bainbridge, Sverdlov, Coontz, Leahy, Belknap, Truxtun, California or Virginia
I doubt that image84 could be LongBeach

To what degree do you believe that
(profile-has-a-gap-between-aft-mast-and-aft-superstructure-block) ?* 5

I strongly suspect that image84 is Coontz
I doubt that image84 could be ForestSherman, Sverdlov, Leahy, Belknap, Truxtun, California or Virginia
I strongly doubt that image84 is Bainbridge or LongBeach

To what degree do you believe that
(profile-has-isolated-directors-on-aft-superstructure-block) ?* 5

I strongly suspect that image84 is Coontz
I slightly doubt that image84 could be California
I doubt that image84 could be Leahy, Belknap, Truxtun or Virginia
I strongly doubt that image84 is ForestSherman, Bainbridge, Sverdlov or LongBeach

---

To what degree do you believe that
(profile-mast-heights-are-equal) ?* -4

I strongly suspect that image84 is Coontz
I slightly doubt that image84 could be California
I doubt that image84 could be Leahy
I strongly doubt that image84 is ForestSherman, Bainbridge, Sverdlov, LongBeach, Belknap, Truxtun or Virginia

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To what degree do you believe that
(profile-aft-mast-is-on-top-of-aft-superstructure-block) ?* **-5**

I strongly suspect that image84 is Coontz
I doubt that image84 could be Leahy
I strongly doubt that image84 is ForestSherman, Bainbridge, Sverdlov, LongBeach, Belknap, Truxtun, California or Virginia

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To what degree do you believe that
(profile-deck-is-level-with-no-offsets) ?* **2**

I strongly suspect that image84 is Coontz
I strongly doubt that image84 is ForestSherman, Bainbridge, Sverdlov, LongBeach, Leahy, Belknap, Truxtun, California or Virginia

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No more askable questions about image84
*** Summary of hypotheses about ***
image84

Coontz	4.999936
California	-4.841409
Leahy	-5.000000
Truxtun	-5.000000
Belknap	-5.000000
Virginia	-5.000000
Sverdlov	-5.000000
Bainbridge	-5.000000
ForestSherman	-5.000000
LongBeach	-5.000000

I strongly suspect that image84 is Coontz
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RESULTS

- EXTENSIVELY TESTED
  - 101 TOTAL IMAGES OF THE CHOSEN SHIP CLASSES
    - 52 PLAN VIEWS
    - 49 PROFILE VIEWS
  - 18 IMAGES OF SHIPS NOT IN THE DATA BASE
- "SUCCESS" RATE OF 84%
  - IN 85 OF THE 101 TRIALS, THE SHIP CLASS RANKED 1st BY THE EXPERT SYSTEM WAS THE CORRECT CLASSIFICATION
- CONSISTENTLY USEFUL DISCRIMINATIONS
  - CORRECT TRIALS:
    - AVG CONFIDENCE IN TOP RANKED CLASS 1.692
    - AVG CONFIDENCE IN 2nd RANKED CLASS −2.383
    - THIS MEANS THE SYSTEM USUALLY COMES UP WITH ONLY ONE PLAUSIBLE CLASSIFICATION
  - INCORRECT TRIALS:
    - AVG CONFIDENCE IN TOP RANKED CLASS −0.161
    - AVG CONFIDENCE IN 2nd RANKED CLASS −0.990
    - A FEW CLASSES, USUALLY INCLUDING THE CORRECT ONE, ARE CLUSTERED TOGETHER AS ALTERNATIVE CLASSIFICATIONS

KNOWLEDGE-BASED MULTI-SENSOR INFORMATION INTEGRATION (MSII)

PURPOSE —

INVESTIGATE AND DEMONSTRATE HOW ARTIFICIAL INTELLIGENCE (AI) TECHNIQUES CAN BE USED TO IMPROVE THE INTEGRATION OF INFORMATION FROM DIVERSE SENSORS IN SUPPORT OF NAVY COMMAND & CONTROL OPERATIONS IN ELECTRONIC WARFARE (BOTH AT THE PLATFORM AND THE BATTLE GROUP LEVEL)

RELEVANT AI TECHNIQUES —

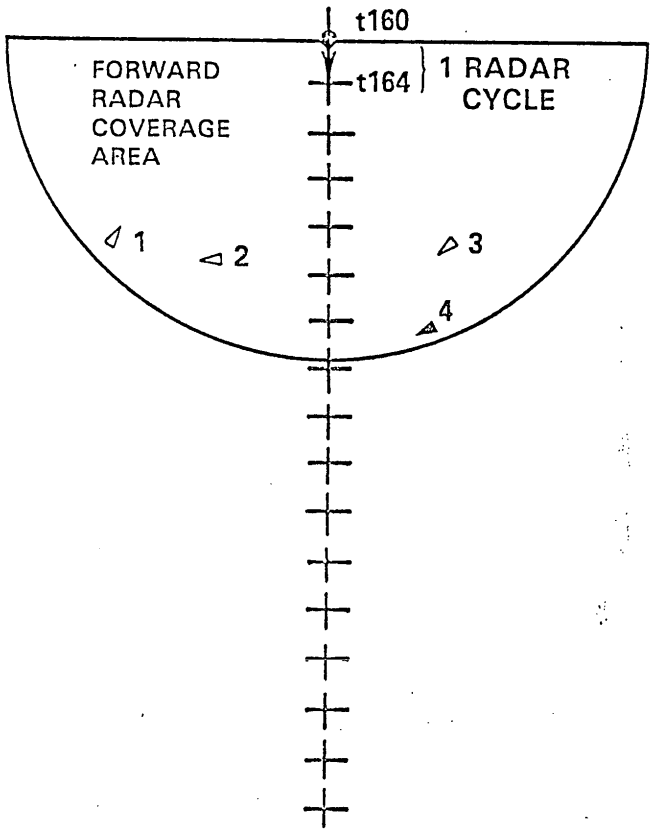
- EXPERT SYSTEMS DEVELOPMENT — CAPTURING AND EMULATING DECISION-MAKING EXPERTISE/KNOWLEDGE USED BY NAVY EXPERTS
- KNOWLEDGE REPRESENTATION AND UTILIZATION — STRUCTURING AND PROPAGATING HUMAN EXPERTISE/KNOWLEDGE IN A COMPUTATIONAL NETWORK
- DISTRIBUTED PROBLEM SOLVING — COMMUNICATING AMONG CO-OPERATIVE EXPERT SYSTEMS TO PROVIDE THE BEST DECISION SUPPORT POSSIBLE

KNOWLEDGE-BASED MULTISENSOR INFORMATION INTEGRATION

APPROACH –

- COMBINE ALGORITHMIC METHODS WITH AI TECHNIQUES
- CAPTURE PROCESSES THAT HUMANS USE TO REASON IN THIS NOISY, NON-ANALYTICAL ENVIRONMENT
- EXPLOIT EXPERT SYSTEMS AND DISTRIBUTED PROBLEM SOLVING TECHNOLOGIES
- EMPLOY AN INCREMENTAL APPROACH TO SYSTEM DEVELOPMENT
  - DESIGN ARCHITECTURE
  - TEST WITH SIMULATED DATA
  - IMPROVE THROUGH SYSTEM EVALUATION AND USER FEEDBACK
  - TEST WITH FIELD/EXERCISE DATA

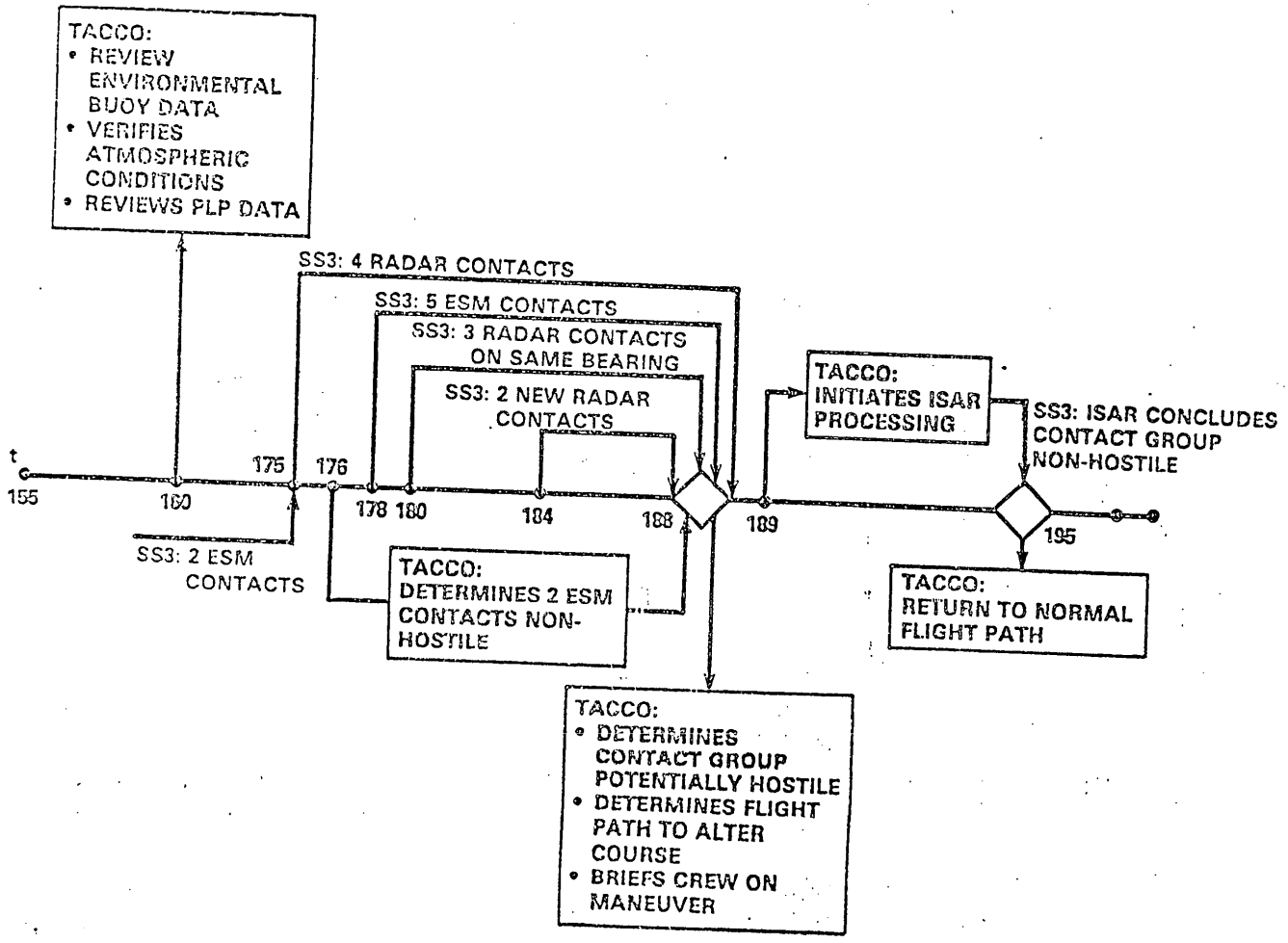
ASUW SCENARIO: SEARCH SEGMENT
(t155 — t210)
t = 160



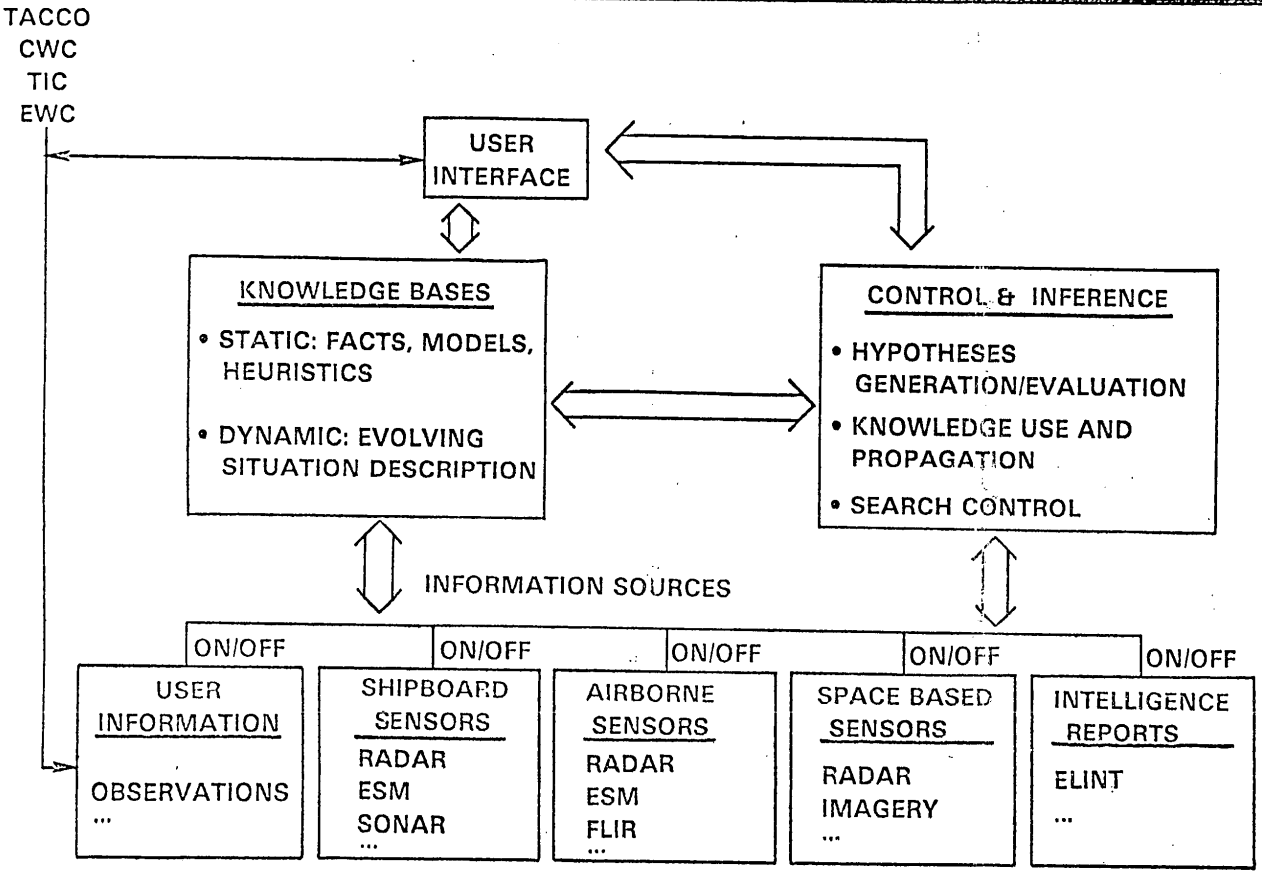
- P-3 POSITION
- POSSIBLY HOSTILE SHIP
- FRIENDLY SHIP
- 50 NM

- BEGIN FIRST LEG OF SEARCH
- SS3 REPORTS ESM CONTACTS (1,2,3,4)
- SS3 REPORTS RADAR CONTACTS (1,2,3,4)
- TACCO DETERMINES CONTACTS (1,2,3) TO BE NON-HOSTILE

ASUW SCENARIO EVENT TIMELINE
(MAJOR EVENTS LEADING TO ISAR MANEUVER)



SYSTEM ARCHITECTURE FOR ORGANIZATION OF KNOWLEDGE-BASED MSII SPECIALISTS



EXAMPLE OF ACTION RULES

THREAT ASSESSMENT RULE - (ASW)

IF (1) there is ESM contact gained on a hostile aircraft,
(2) there is ESM contact gained on an enemy submarine,
(3) both ESM contacts are on the same bearing,
(4) there has been radio communication between the two targets in the past 15 minutes,

THEN it is very likely (.9) that the submarine is launching an immediate attack.

SENSOR MANEUVER RULE - (ASUW:search)

IF (1) there are 3 or more ESM contacts,
(2) they are all on the same bearing,
(3) RADAR contacts are associated with the ESM contacts,
(4) contacts can not be determined to be non-hostile,

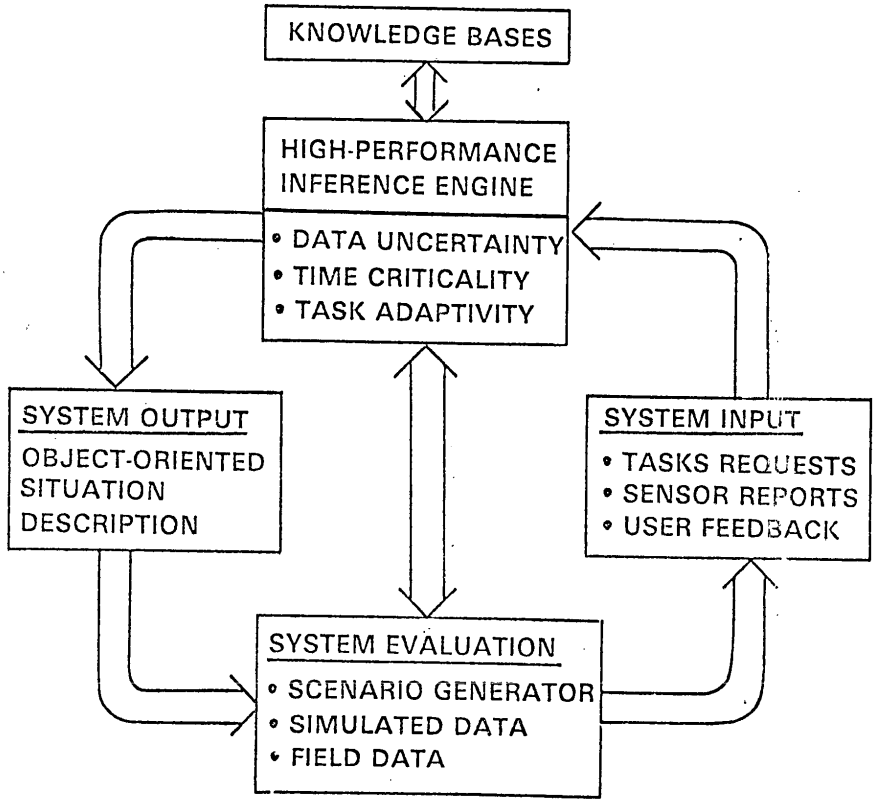
THEN (1) establish a flight path at the periphery of the SAM range of the potentially hostile vessels,
(2) initiate ISAR processing,

TARGET ENGAGEMENT RULE - (ASUW:attack)

IF (1) the location of the escorted supply ship has been confirmed by ESM, RADAR, and ISAR,
(2) the position of the P-3 aircraft has been dropped below the convoy's radar line-of-sight,
(3) the flight path to position the attack axis has been established,
(4) no other hostile forces are known in the area,

THEN the TACCO is advised of the readiness for launching both a Harpoon and a LOFAR buoy

EXPERIMENTAL DESIGN METHODOLOGY FOR ORGANIZATION OF KNOWLEDGE-BASED MSII SPECIALISTS



MSII - A KNOWLEDGE-BASED SYSTEM TO SUPPORT DIVERSE P-3 MISSIONS

SINGLE-PLATFORM MISSIONS

ANTISUBMARINE WARFARE
ANTISURFACE WARFARE
MINE LAYING

BATTLE-GROUP MISSIONS

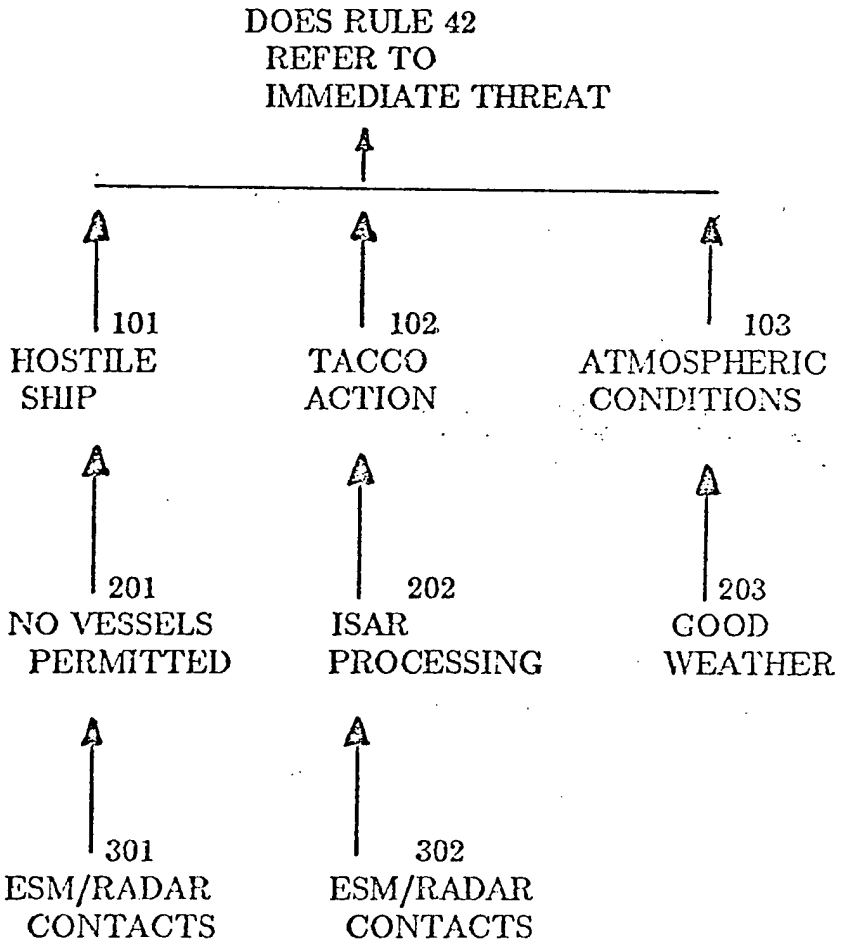
SURVEILLANCE
CONVOY PROTECTION
OVER-THE-HORIZON TARGETING

GENERIC FUNCTIONS

SITUATION DESCRIPTION
THREAT ASSESSMENT
RESOURCE ALLOCATION
MISSION PLANNING

THE REASONING USED TO INFER THAT RULE 42 MENTIONS IMMEDIATE THREAT

INVOCATION OF THE INFERENCE ENGINE



A RULE WHICH CAN BE INFERRED TO MENTION IMMEDIATE THREAT

RULE 42

IF (1) earlier ESM and RADAR contacts have associated the direction of the target movement with that of an anticipated convoy,

(2) there have not been ESM contacts in the past hour,

(3) good weather is forecast for the target area,

THEN it is likely (.6) that the target is contemplating hostile actions.

POTENTIAL AREAS FOR JOINT NAVELEX/NRL PROGRAMS

- TROUBLESHOOTING AND TRAINING OF ELECTRONIC EQUIPMENT
- MULTISENSOR INFORMATION AND ASSESSMENT FOR SURVEILLANCE
- TARGET CLASSIFICATION FOR ACOUSTICS AND NON-ACOUSTICS
- BATTLE GROUP LEVEL MANAGEMENT AND ASSESSMENT

RESEARCH ISSUES FOR MSI MANAGEMENT AND ASSESSMENT APPLICATION

- TIME CRITICAL HIGH LEVEL INFERENCING MECHANISM
- INTEGRATION OF INFORMATION FROM DIVERSE SOURCES TO FORM A COHERENT SITUATION DESCRIPTION
- EFFECTIVE TIME CRITICAL MAN-MACHINE INTERFACES
- KNOWLEDGE ACQUISITION TECHNIQUES TO CAPTURE HUMAN ANALYSTS EXPERTISE

OBJECTIVES OF MSI MANAGEMENT AND ASSESSMENT APPLICATION

* EXTEND AI CONCEPTS AND TECHNIQUES TO

  - CAPTURE HUMAN EXPERTISE
  - MAKE HIGH/LEVEL INFERENCES
  - INTEGRATE DIVERSE DATA FORMS

* DEMONSTRATE THE EFFECTIVENESS OF EXPERT SYSTEMS IN TIME CRITICAL AND HIGH DATA RATE SITUATIONS

* DEVELOP HIGH SPEED NATURAL LANGUAGE INTERFACES AND REAL TIME SIGNAL INTERPRETERS

* PROVIDE INFORMATION INTEGRATION AND FRIENDLY DISPLAYS THAT PROVIDE REASONING AND ASSESSMENT FOR THE BATTLE GROUP COMPOSITE WARFARE COMMANDER

* USE AI/EXPERT SYSTEMS TECHNOLOGY ON NAVAL TACTICAL DECISION MAKING

* PROVIDE GENERIC APPROACH TO ENSURE APPLICATIONS FOR THE ARMY, AIR FORCE AND OTHER NAVAL SCENARIOS