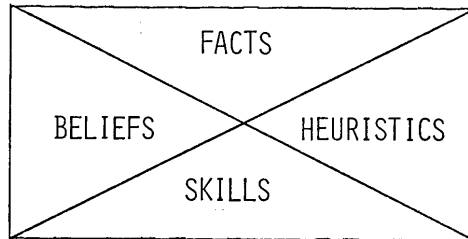


DRAFT

INTELLIGENT SYSTEMS RESEARCH



OFFICE OF RESEARCH AND DEVELOPMENT

PROCESSING AND ANALYSIS TECHNOLOGY GROUP

INFORMATION SYSTEMS RESEARCH DIVISION

MARCH 1982

(Classified Material Attached)

Output System
0260

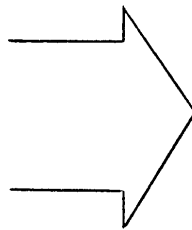
BRIEFING OBJECTIVES

- TO DESCRIBE THE TECHNOLOGY OF INTELLIGENT SYSTEMS
- TO EXPLAIN A NEW ORD PROGRAM FOR FY84
- TO RECEIVE FEEDBACK ON PROGRAM DIRECTION
- TO DISCUSS OPPORTUNITIES FOR JOINT PARTICIPATION

COMMON KNOWLEDGE-RELATED PROBLEMS

TYPICAL CIRCUMSTANCES

- PERSONNEL TURNOVER
- ENVIRONMENTAL CHANGES
- HIGH DATA VOLUMES
- UNCERTAINTY/INCOMPLETENESS
- COMPLEX MODELS
- RIGID SYSTEMS



POTENTIAL IMPACTS

- LOSS OF EXPERTISE
- COSTLY RETRAINING
- INFORMATION OVERLOAD
- INFORMATION UNDERLOAD
- LOWER PRODUCTIVITY
- HIGHER MAINTENANCE COSTS

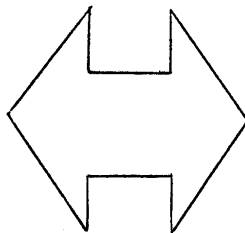
INFORMAL DEFINITION

AN INTELLIGENT SYSTEM IS A COMPUTERIZED SYSTEM WHICH ATTEMPTS TO EMULATE THE BEHAVIOR OF A HUMAN EXPERT IN SOLVING DIFFICULT PROBLEMS IN A SINGLE, WELL-DEFINED SUBJECT AREA. INTELLIGENT SYSTEMS COMBINE THE POWER OF THE COMPUTER TO CONSIDER MANY DETAILED ALTERNATIVES WITH THE WISDOM OF THE EXPERT TO DECIDE WHICH ALTERNATIVES ARE MOST LIKELY TO SUCCEED.

BENEFITS SOUGHT FROM INTELLIGENT SYSTEMS

GENERAL GOALS

- INSTITUTIONALIZE EXPERTISE
- REDUCE RETRAINING COSTS
- REDUCE USER CONFUSION
- IMPROVE PERSONAL PRODUCTIVITY
- SOLVE PREVIOUSLY UNTRACTABLE PROBLEMS
- CONTAIN SYSTEM LIFE CYCLE COSTS



SPECIFIC TECHNIQUES

- EXPERT SYSTEMS
- SELF-TUTORIAL SYSTEMS
- SYSTEM-ENHANCED QUERIES
- INTELLIGENT ASSISTANTS
- HEURISTIC SEARCH
- FLEXIBLE KNOWLEDGE REPRESENTATION

ASPECTS OF AN INTELLIGENT SYSTEM

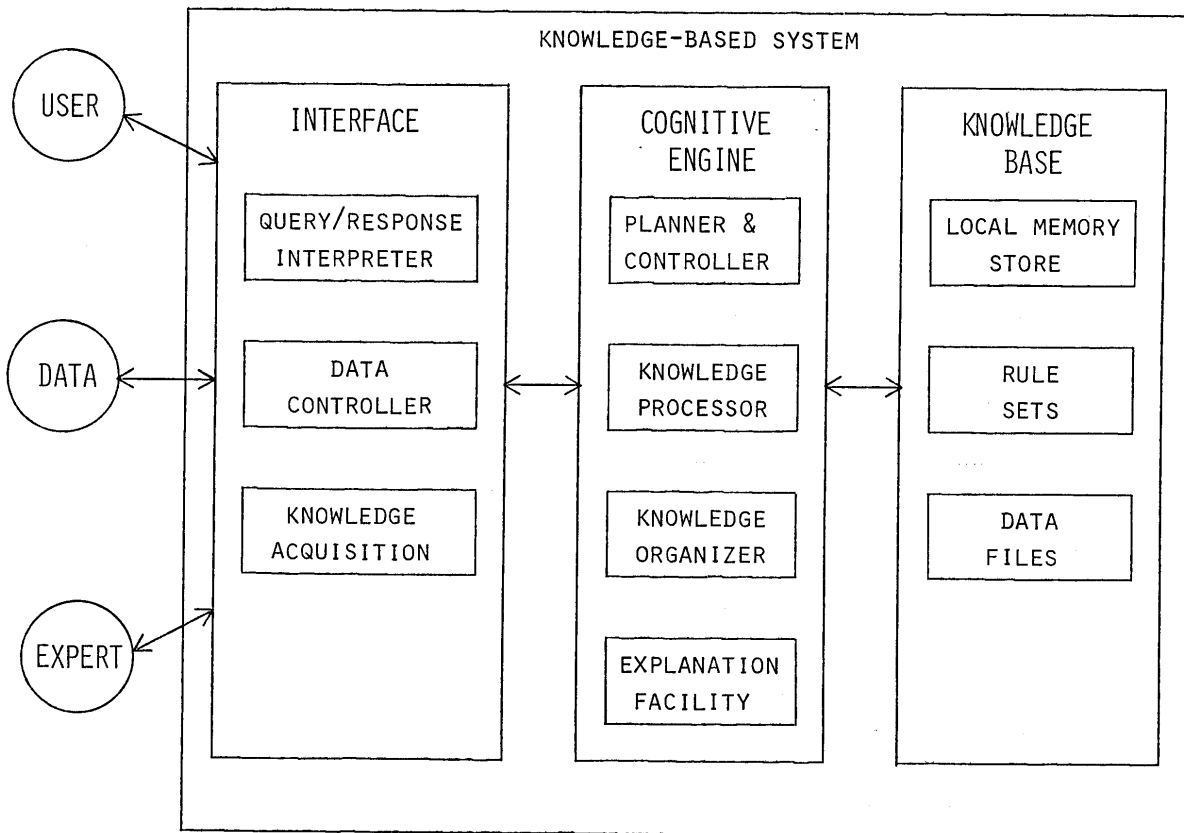
FUNCTIONS

- CORRECTLY INTERPRET PARTIALLY FORMED QUERIES
- MAKE INTELLIGENT INFERENCES WITH INCOMPLETE DATA
- ELIMINATE EXTRANEIOUS MATERIAL FROM RESPONSES
- EXPLAIN ITS BEHAVIOR TO SYSTEM USERS
- BE READILY MODIFIED TO ACCOMMODATE NEW KNOWLEDGE

CHARACTERISTICS

- SEPARATE KNOWLEDGE BASE FROM PROGRAM CODE
- APPLY LOGICAL RULES OF INFERENCE TO GIVEN FACTS
- ASSOCIATE CONFIDENCE FACTORS WITH DATA AND INFERENCES
- REPRESENT RULES IN EASILY UNDERSTOOD FORM
- MANIPULATE SYMBOLS INSTEAD OF CRUNCHING NUMBERS

KBS CONCEPTUAL DESIGN



SELECTED EXAMPLES OF SUCCESSFUL INTELLIGENT SYSTEMS

- DENDRAL - GENERATES PLAUSIBLE STRUCTURES OF ORGANIC MOLECULES FROM MASS SPECTRAL DATA - STANFORD
- MYCIN - DIAGNOSES BACTERIAL INFECTIONS IN THE BLOOD AND RECOMMENDS ANTIBIOTIC THERAPY - STANFORD
- PROSPECTOR - EVALUATES GEOLOGIC SITE SUITABILITY FOR MINERAL EXPLORATION - SRI
- MACSYMA - SOLVES PROBLEMS IN INTEGRAL CALCULUS AND OTHER DOMAINS OF HIGHER MATHEMATICS - MIT
- RI - DETERMINES HARDWARE CONFIGURATIONS FOR SALES ORDERS OF VAX COMPUTERS - DEC/CMU
- ACRONYM - LOCATES SPECIFIC OBJECTS IN VISUAL SCENES - STANFORD
- RITA - ACTS AS AN INTELLIGENT ASSISTANT TO FACILITATE ACCESS TO COMPUTER NETWORKS - RAND

GOAL-ORIENTED REASONING

GOAL: WHO IS THE GRANDMOTHER OF JENNIFER?

DATA:

- MICHELLE IS THE MOTHER OF JENNIFER
- CRAIG IS THE FATHER OF JENNIFER
- JOSIE IS THE MOTHER OF MICHELLE
- MILDRED IS THE MOTHER OF CRAIG

RULES:

- IF: X IS THE MOTHER OF Y AND
Y IS THE MOTHER OF Z
THEN: X IS THE GRANDMOTHER OF Z
- IF: X IS THE MOTHER OF Y AND
Y IS THE FATHER OF Z
THEN: X IS THE GRANDMOTHER OF Z

EXAMPLE RULES

R1 (VAX CONFIGURATION)

- IF: (1) THE CURRENT CONTEXT IS ASSIGNING DEVICES TO UNIBUS MODULES, AND
(2) THERE IS AN UNASSIGNED DUAL-PORT DISK DRIVE, AND
(3) THE TYPE OF CONTROLLER IT REQUIRES IS KNOWN, AND
(4) THERE ARE TWO SUCH CONTROLLERS, NEITHER OF WHICH HAS ANY DEVICES ASSIGNED TO IT, AND
(5) THE NUMBER OF DEVICES THAT THESE CONTROLLERS CAN SUPPORT IS KNOWN

- THEN: (1) ASSIGN THE DISK DRIVE TO EACH OF THE CONTROLLERS, AND
(2) NOTE THAT THE TWO CONTROLLERS HAVE BEEN ASSOCIATED AND THAT EACH SUPPORTS ONE DEVICE.

MYCIN (MEDICAL DIAGNOSIS)

- IF: (1) THE SITE OF THE CULTURE IS BLOOD, AND
(2) THE IDENTITY OF THE ORGANISM IS NOT KNOWN WITH CERTAINTY, AND
(3) THE STAIN OF THE ORGANISM IS GRAMNEG, AND
(4) THE MORPHOLOGY OF THE ORGANISM IS ROD, AND
(5) THE PATIENT HAS BEEN SERIOUSLY BURNED

- THEN: THERE IS WEAKLY SUGGESTIVE EVIDENCE (0,4) THAT THE IDENTITY OF THE ORGANISM IS PSEUDOMONAS.

POTENTIAL AGENCY APPLICATION AREAS

- LARGE-SCALE SIMULATION AND MODELING AIDS
- INTELLIGENT ASSISTANCE FOR ROUTINE PROCESSING
- FOCUSING SEARCHES THROUGH MASSIVE DATA FILES
- DIAGNOSIS OF SYSTEM FAILURES
- AUTOMATED AIDS FOR IMAGE UNDERSTANDING
- IMPROVED TECHNIQUES FOR UNDERSTANDING NATURAL LANGUAGE
- ENHANCED INTERFACES TO DATA BASE MANAGEMENT SYSTEMS
- COMPUTER-AIDED INSTRUCTION

SIGNIFICANT ISSUES IN KBS DEVELOPMENT

- KNOWLEDGE REPRESENTATION - RULES, FRAMES, PREDICATE CALCULUS, SEMANTIC NETWORKS, PROGRAMS
- KNOWLEDGE ACQUISITION - ELICITATION, REPRESENTATION, MULTI-SOURCE, EXPERT AVAILABILITY
- APPLICATION SELECTION - IDENTIFICATION, SELECTION CRITERIA, REASONABLE EXPECTATIONS, SUCCESS MEASUREMENT
- KNOWLEDGE ENGINEERING - PERSONNEL, TRAINING, TOOLS, TECHNIQUES, ORGANIZATIONAL ACCEPTANCE
- IMPLEMENTATION LANGUAGE - LISP DIALECTS, PROLOG, ROSIE, OPS-5, KAS, EMYCIN, TEIRESIAS, AGE
- COMPUTER RESOURCES - DEC (10/20/11/VAX), LISP MACHINES (SYMBOLICS, DOLPHIN, LMI), LARGE ADDRESS SPACE
- SYSTEM INTEGRATION - EXISTING DBMS, MODELS, VM, SAFE

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PREVIOUS/ONGOING ORD RESEARCH EFFORTS

- INTELLIGENCE APPLICATIONS STUDIES (AMRD) - BBN (1976), SRI (1980)
- IPANA (ISR/D) - LOGICON (1981)
- HYDROLOGY MODEL INTERFACE (AMRD) - SRI (1982)
- IMAGE UNDERSTANDING (IER/D) - HUGHES (1982)
- INTELLIGENCE COLLECTION (ACS) - ULTRASYSTEMS (C) (1982)
- OPEN SOURCE EXPLOITATION (ISR/D) - AI&DS (1982)

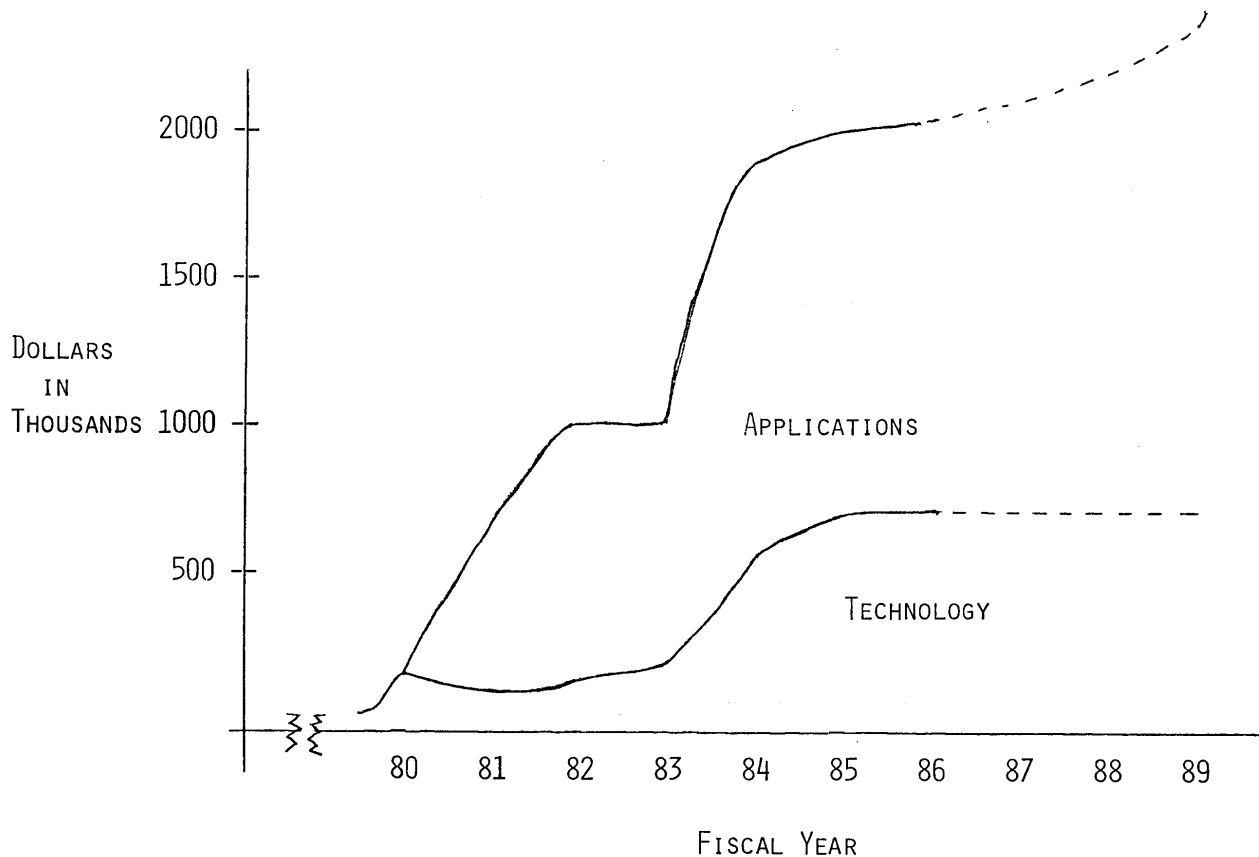
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PROPOSED/POTENTIAL ORD RESEARCH EFFORTS

- ENHANCED ACCESS TO DATA BASES (ISR)
- WHEAT MODEL DEVELOPMENT (AMR)
- KNOWLEDGE ELICITATION TOOLS (ISR)
- HARDWARE TROUBLESHOOTING (ISR)
- INTELLIGENCE PRODUCTION LAB (AMR)
- ORD TRAVEL PROCESSING (ISR)

SECRET

ORD INTELLIGENT SYSTEMS FUNDING PROFILE



SECRET

Declassified and Approved For Release 2012/12/14 : CIA-RDP95-00972R000100020004-5

ORD OBJECTIVES FOR INTELLIGENT SYSTEMS RESEARCH PROGRAM

- TO ASSIST INITIAL ORD APPLICATIONS OF KBS TECHNOLOGY
- TO DEMONSTRATE THE VALUE OF WIDER AGENCY APPLICATION
- TO ACQUIRE A SELECTION OF KNOWLEDGE ENGINEERING TOOLS
- TO DEVELOP A CADRE OF KBS EXPERTISE WITHIN THE AGENCY

MANAGEMENT ISSUES TO CONSIDER

BECAUSE:

- SIGNIFICANT APPLICATIONS REQUIRE SUBSTANTIAL EFFORT
- CHARACTERISTICS OF SUCCESSFUL APPLICATIONS ARE VAGUE
- KNOWLEDGE ENGINEERING IS A DIFFICULT ART
- KNOWLEDGE ENGINEERS ARE SCARCE
- KBS TECHNOLOGY IS CHANGING
- FEW KBS EXIST OUTSIDE A NARROW HARDWARE/SOFTWARE ENVIRONMENT

WE NEED TO:

- PLAN ADEQUATE RESOURCES
- EXPERIMENT WITH POTENTIAL APPLICATIONS
- ACQUIRE A SELECTION OF KNOWLEDGE ENGINEERING TOOLS
- DEVELOP IN-HOUSE EXPERTISE
- DEVELOP TECHNOLOGY "BUY-IN" STRATEGY
- DEVELOP IMPLEMENTATION/CONVERSION PLAN

ORD INTELLIGENT SYSTEMS RESEARCH STRATEGY

STUDY THE TECHNOLOGY

- OBTAIN FORMAL AND INFORMAL KNOWLEDGE ENGINEERING TRAINING
- TRACK KBS DEVELOPMENTS IN OTHER AGENCIES/COMPANIES
- PURSUE MULTIPLE KBS TECHNOLOGIES CONCURRENTLY

DEVELOP AGENCY APPLICATIONS

- INVOLVE MULTIPLE COMPONENTS OF ORD PLUS ODP, ASG, AND OTHERS
- EMPHASIZE PRACTICAL APPLICATION OF TECHNIQUES
- SELECT INITIAL APPLICATIONS CAREFULLY

ACQUIRE APPROPRIATE TOOLS

- DERIVE GENERAL TOOLS/TECHNIQUES FROM EACH APPLICATION
- BUILD UPON EXISTING TOOLS/SYSTEMS
- COLLECT/CONVERT TOOLS TO AGENCY COMPUTER ENVIRONMENT

PROPOSED ACTION STEPS

- HELP ORD ASSESS THE SIGNIFICANCE OF THIS TECHNOLOGY FOR THE AGENCY
- ASSIST ORD IN FORMULATING AN APPROPRIATE FY84 RESEARCH PROGRAM
- SUPPORT ORD BUDGET ACTION IN THIS AREA
- IDENTIFY A FOCAL POINT IN ODP FOR THIS TECHNOLOGY
- DETERMINE WHEN INTELLIGENT SYSTEMS SUPPORT SHOULD SHIFT FROM ORD TO ODP
- CONSIDER STAFFING AND TRAINING REQUIREMENTS TO BUILD IN-HOUSE EXPERTISE
- DETERMINE THE APPROPRIATE LEVEL OF ODP PARTICIPATION IN INTELLIGENT SYSTEM PROJECTS
- SUPPORT THE ACQUISITION AND USE OF INTELLIGENT SYSTEM TOOLS, SUCH AS INTERLISP AND PROLOG ON VM