



Interactive Support of Maintenance

Prof. Asim Smailagic
Carnegie Mellon University
ICES and ECE
asim@cs.cmu.edu



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Overview

- **Introduction**
- **CMU Wearable Computers**
- **Interactive Electronic Technical Manuals (IETMs)**
- **Real-time Collaboration with a Remote Expert Helpdesk**
- **Context-Aware Maintenance**
- **Field Experience and Evaluation**
- **Summary and Future Directions**

Exploratory Systems Design

2001

2000

1999

1998

1997

1996

1995

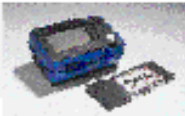
1994

1993


1992

1991

Itsy/Cue
Wireless Communication and Low Power Innovation




Metronaut
Navigation + Information




ISSAC
Speech Interface Assistant


Frogman
Underwater Maintenance




Navigator 1
Navigation Assistant



Wu-Man 2
Navigation Assistant



Wu-Man 1
Manufacturing



Customer Driven Systems Design

Spot
Research Platform



IBM Wearable Smart Modules
Aircraft Maintenance
Language Translation



Mocca
Mobile Work Assistant

TIA-0
Maintenance



OSCAR
Plant Operation Assistant

MIA
Bridge Inspection

TIA-P
Language Translator
F-15 Maintenance
C-130 Maintenance




Navigator 2
Aircraft Maintenance

Wu-Man 3
Vehicle Maintenance




Visionary Design and Research


Tactile Display




Sprout
Wireless Communicator



Streetware
Fashionable Computers




Design for Wearability
Wearable Shape Research




Folio
Foldable Display

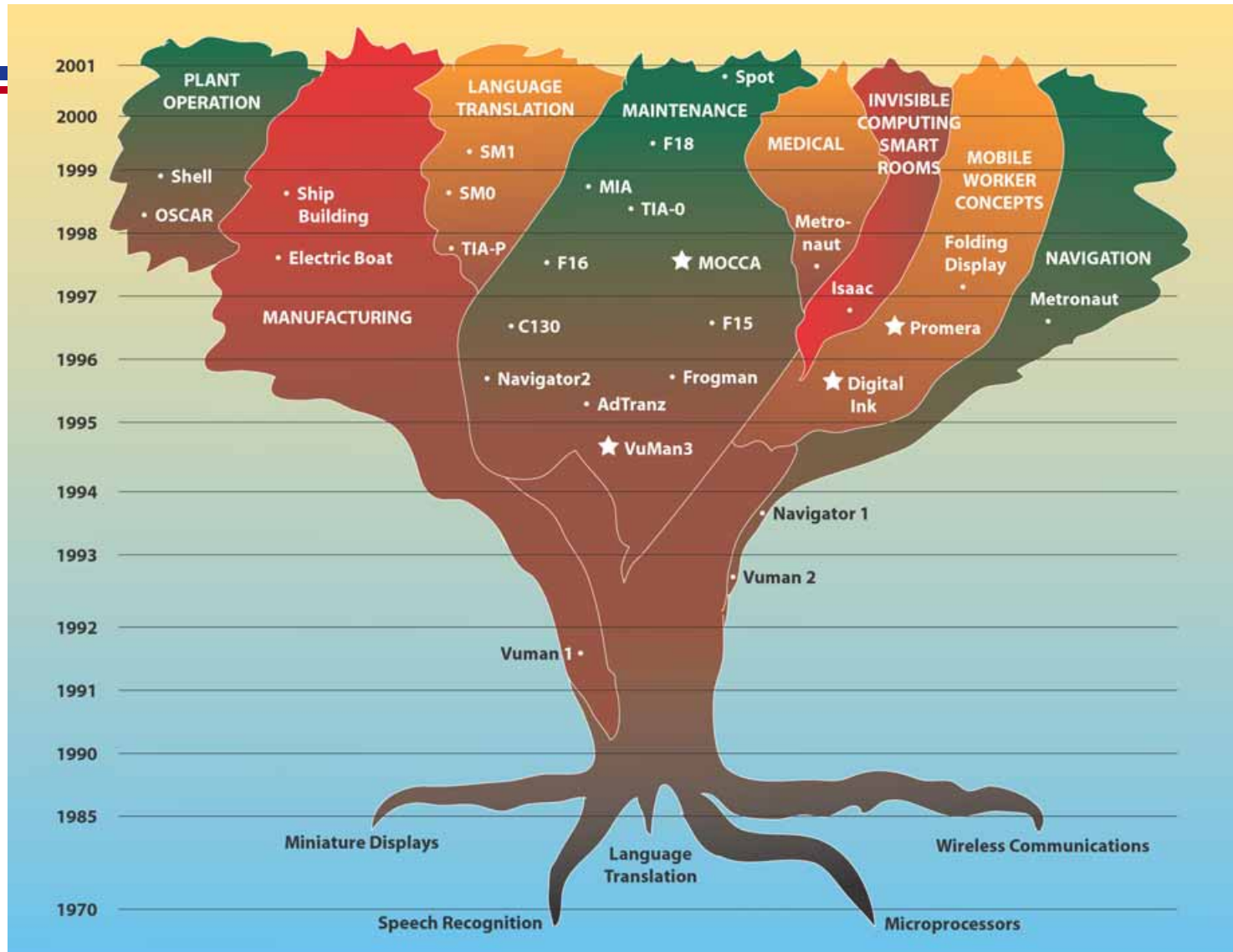
Promera
Handheld camera/projector



Digital Ink
Digital Pen Computer



Family Tree of CMU Wearable Computers (by Operational Delivery Dates and Application Areas)



Wearable and Handheld Computers



VuMan 3



Navigator 2



TIA-P



MoCCA

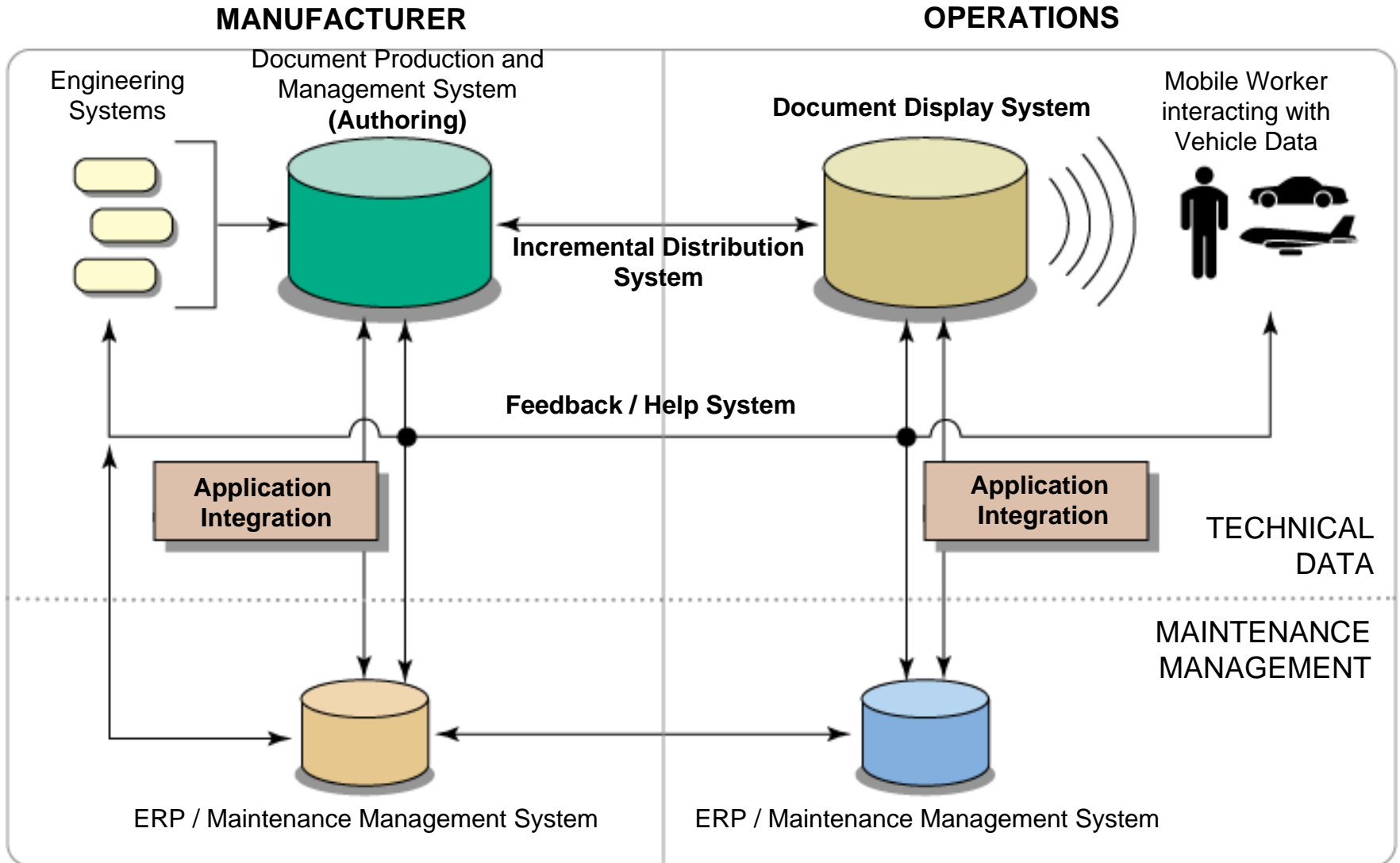


Spot

Overall Objectives

- **Provide performance enhancing systems (PESs) for Front Line Workers**
 - » Integration of enterprise information presented in worker's context
 - » Employ user-centered development approach
- **Assist sponsors in addressing important operational issues**
 - » Historic Carnegie Mellon/Boeing work: aircraft wiring manufacture, KC-135 inspections, F-15 depot overhaul, F/A-18 maintenance

Enterprise Concept of Objectives



User's Major Concerns

- **Accurate and updated technical information**
- **Being able to get help (contact others easily)**
- **Controlling sign-on/off**
- **Enabling improved collaboration with co-workers**
- **Flexibility to start/stop task and know where you are and what's next**
- **Having information access with their hands free**
- **Interfacing to legacy systems they must use, e.g., parts ordering**
- **Privacy about own training/work performance**
- **Reliability and durability of hardware/computers**
- **Seeing evidence that on-line access to documents is more efficient than paper**

Issues in Wearable Computing

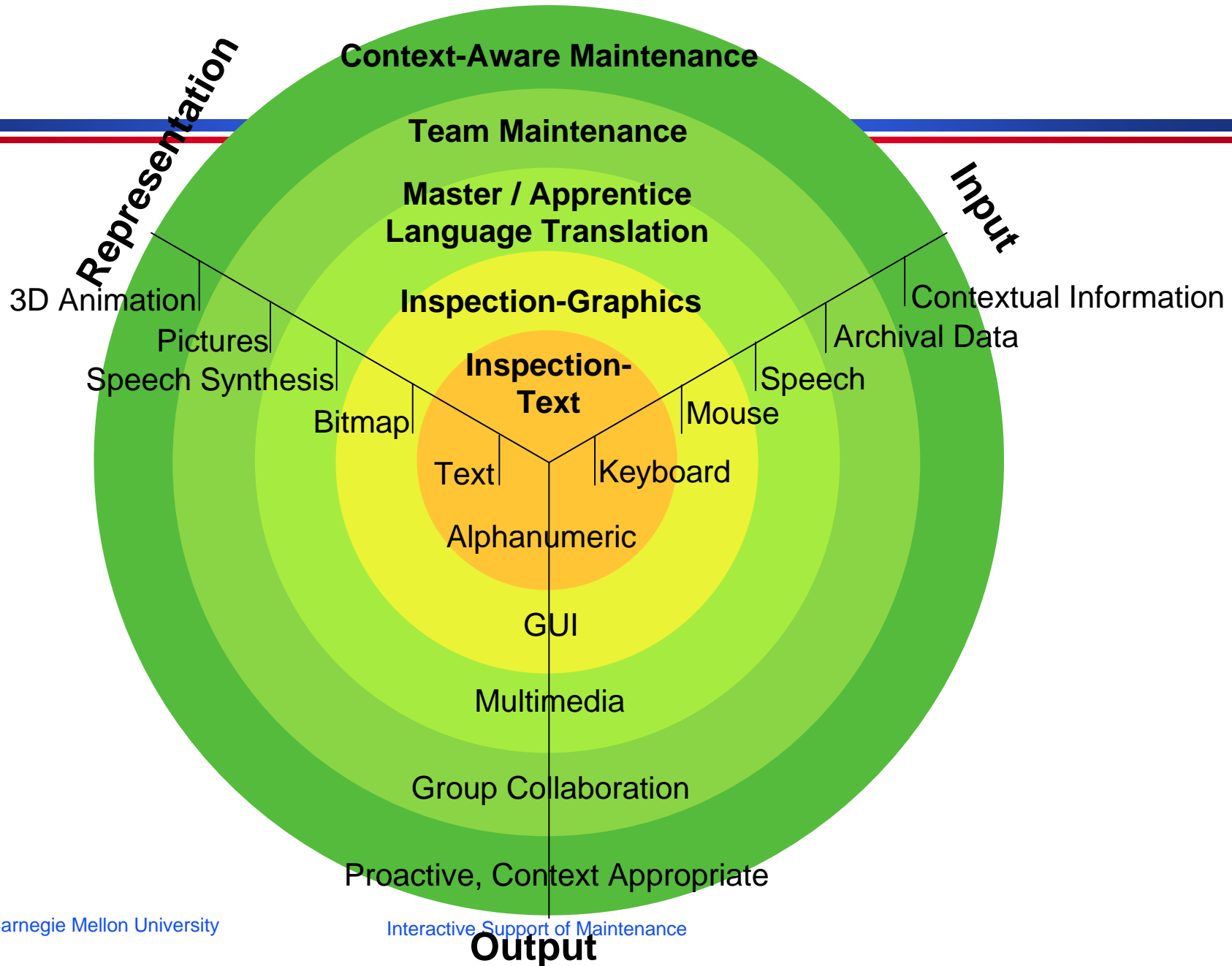
We identified four design principles for mobile systems:

- **User interface models**
 - » What is the appropriate set of metaphors for providing mobile access to information?
- **Input/output modalities**
 - » Room for new, easy-to-use input devices such as the CMU dial.
- **Matched capabilities with application requirements**
 - » Interface design and evaluation should focus on the most effective means for information access.
- **Quick interface evaluation methodology**
 - » Human computer interface evaluation results should be available for iterative system design and prototyping.

Four User Interface Models

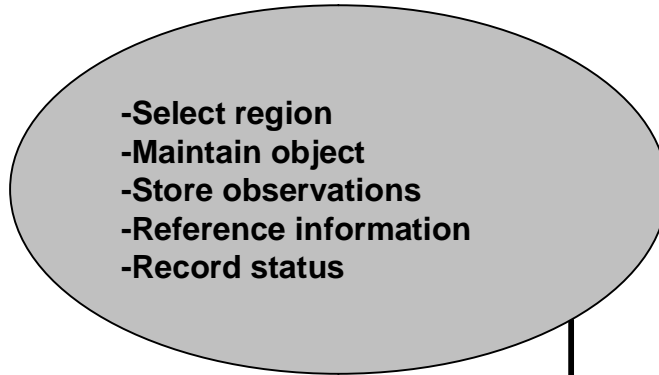
- **Each model with their unique user interface, input/output modality, and capability.**
 - » **Procedures – Text and Graphics**
 - » **Master/Apprentice Help Desk**
 - » **Team Maintenance/Collaboration**
 - » **Context Aware Collaboration – Proactive Synthetic Assistant**

User Interface - Control and Rendering

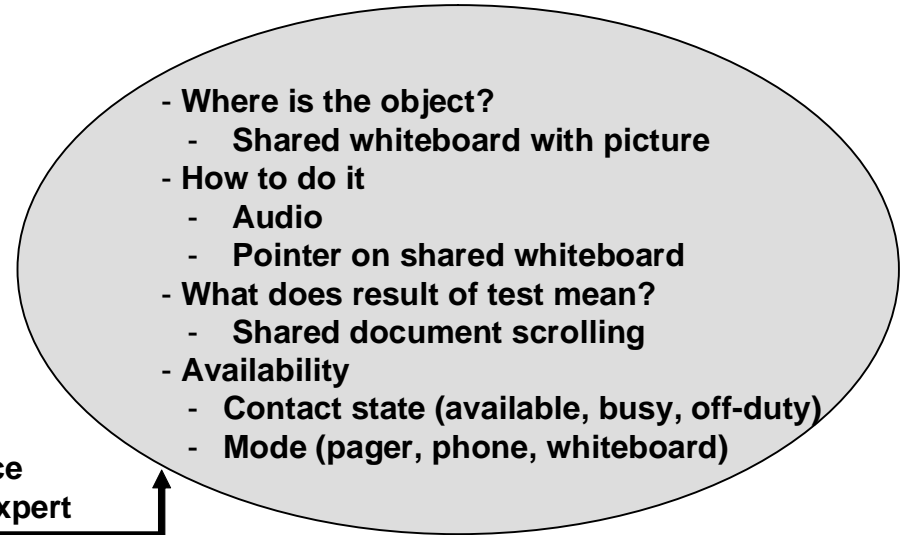


State Diagram for Problem Solving Capabilities

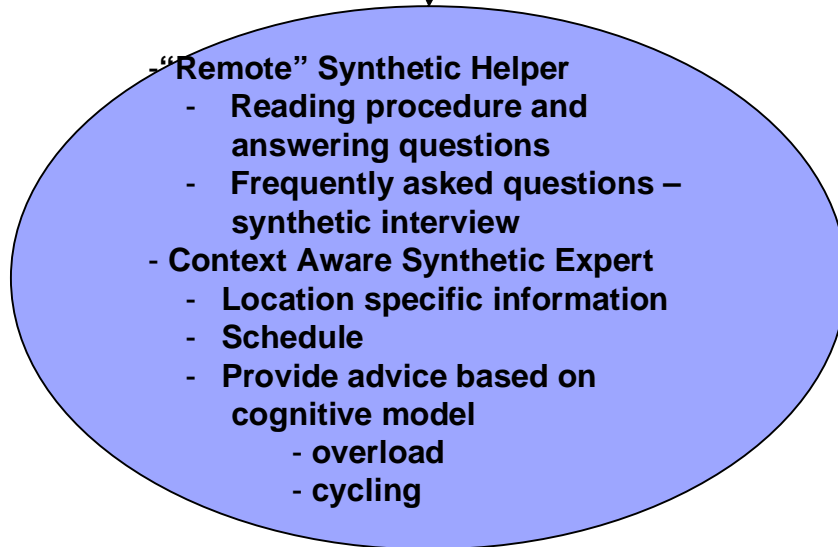
Static/Prestored Procedures



Synchronous

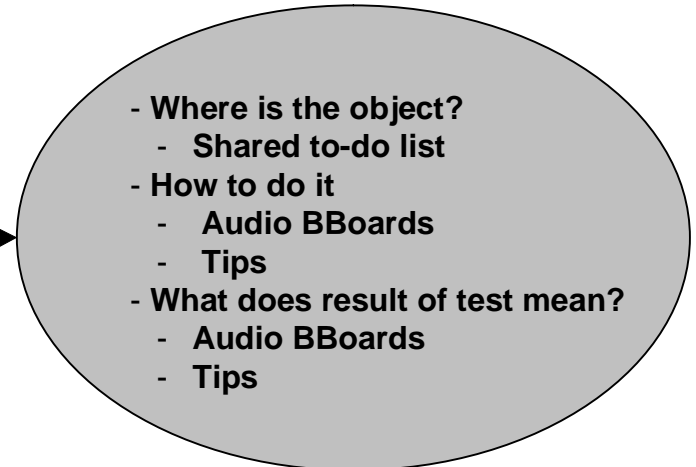


Proactive Assistant



Reference
a Human Expert


Asynchronous



Procedures – Text and Graphics

- **Procedures. Maintenance and plant operation applications are characterized by a large volume of information that varies slowly.**
 - » For example even simple aircraft may have over 100,000 manual pages.
 - » One leading manufacturer produces over 70,000 trucks per year, representing over 20,000 different configurations.
- **A typical request consists of approximately ten pages of text and schematic drawings. Changes to the centralized information base can occur on a weekly basis.**

User Interface Screen

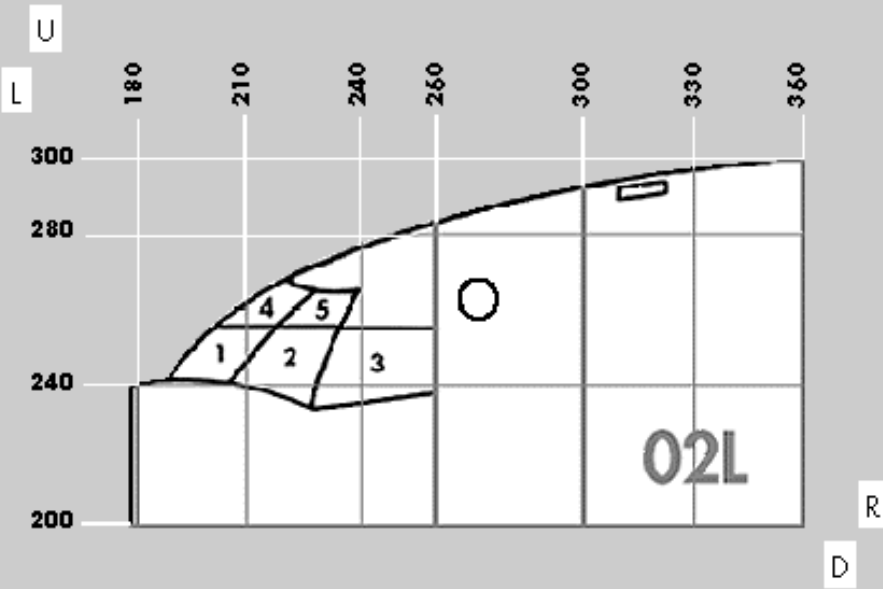
Select a defect location 14:38 E  F S

Aircraft Body Main Menu

Type of defect
Minor Major Critical

How-Mal
Corroded
Cracked
Dented
Deteriorated
Loose
Missing
Worn
Other...

Complete Remove



The diagram shows a cross-section of an aircraft body with a coordinate grid. The vertical axis (L) ranges from 200 to 300, and the horizontal axis (U) ranges from 180 to 360. A curved line represents the upper boundary of the body. Five numbered regions (1-5) are marked on the left side. A circle is located at approximately (260, 260). A rectangular defect marker is located at approximately (330, 290). The text '02L' is displayed in the lower right area of the diagram.

270 by 265 Skin Manual

Master/Apprentice Help Desk

- **There are times when one individual requires assistance from experienced personnel.**
- **Example of this is the “Help Desk” wherein an experienced person is contacted for audio and visual assistance.**

Master / Apprentice (Live Expert) Help Desk



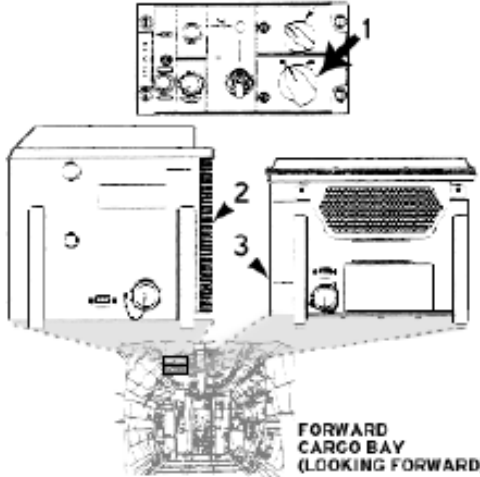
C-130 Help Desk

TO 1C-130H-2-34JG-40-4 - Microsoft Internet Explorer

1-1-2 INITIAL SKE TESTS



Mech.

- ▲ 5. Place **FREQ** switch to **A**
- ▲ **6. Place OFF/STBY/XMIT switch to STBY (1)** ▶
 - a. Blowers on SKE receiver-transmitter (2) and coder-decoder (3) operate.
 - Result Failed
- ▲ 7. Place **SKE ANT** selector switch to **TOP**



FORWARD CARGO BAY (LOOKING FORWARD)

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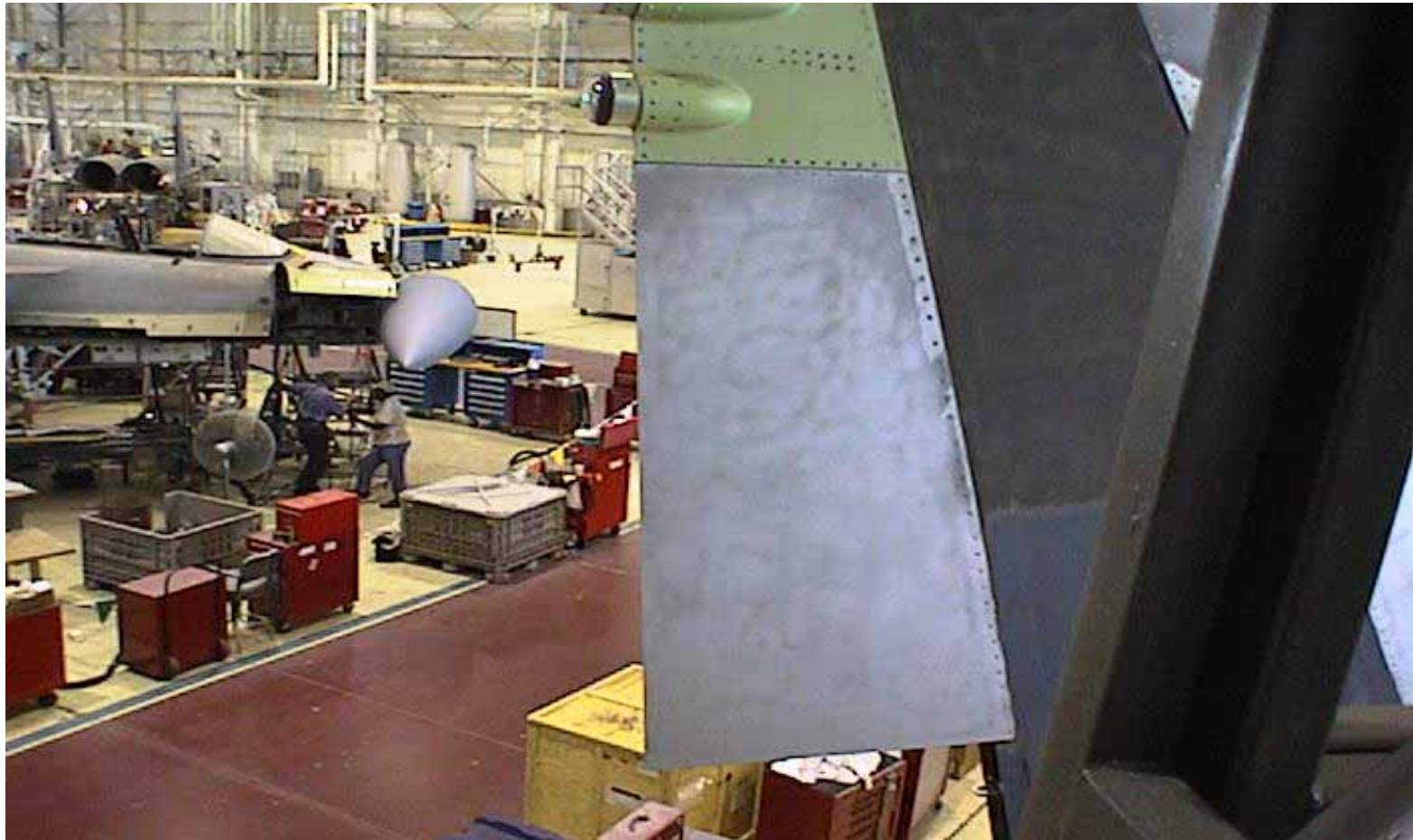


Integrated Technical Information for the Air Logistics Centers (ITI-ALC)

Technology Demonstration



F-15 Depot maintenance



ITI-ALC Technology Demonstration Architecture

