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# ELECTRONIC DATA GENERATION AND DISPLAY SYSTEM

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## Abstract

The Electronic Data Generation and Display System (EDGADS) is a "field tested" paperless technical manual system. The authoring provides subject matter experts the option of developing procedureware from digital or hardcopy inputs of technical information from text, graphics, pictures, and recorded media (video, audio, etc.).

The display system provides multi-window presentations of graphics, pictures, animations, and action sequences with text and audio overlays on a high resolution color CRT and monochrome portable displays.

The database management system allows direct access via hierarchical menus, keyword name, ID number, voice command or touch screen pictoral of the item (ICON). It contains operations and maintenance technical information at three levels of intelligence for a total system.

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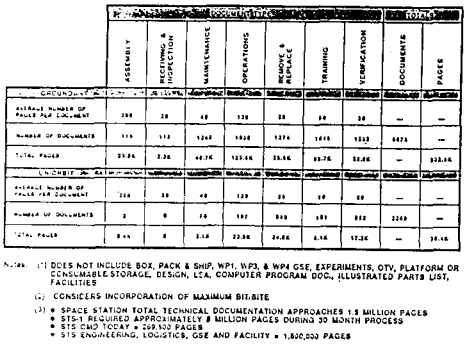
In 1985, the Kennedy Space Center Space Station Logistics Systems Office selected BAO (Boeing Aerospace Operations) to analyze, assess and develop the technical data and documentation system requirements to support O&M (Operations and Maintenance) activities for Space Station on-orbit and ground operations. Our analysis of on-going related programs revealed that traditional paper-intensive O&M technical documentation techniques are expensive, time consuming to produce and maintain, and difficult to use in a micro-G environment. It was projected (as shown in ***Figure 1***) that the Space Station Program technical information would exceed 1.5 million pages and require more than 75 thousand pages to provide autonomous support for on-orbit activities. The characteristics of a paper documentation system is, at best, cumbersome. It requires: (1) space in the operations area, (2) time consuming accessibility and update procedures, (3) multi-page reference trails, and (4) high cost to acquire and place in orbit.

Example: It would cost 44 million 1985 dollars to deliver the 75 thousand page file system to low earth orbit.

**Figure 1**
**HARD COPY TECHNICAL DOCUMENTATION REQUIREMENTS SUMMARY**



The unweildly behavior and the inherent characteristics of paper are intolerable in intra-vehicular activities and impossible in extra-vehicular activities.

These initial analysis of the space station technical documentation investigations concluded:

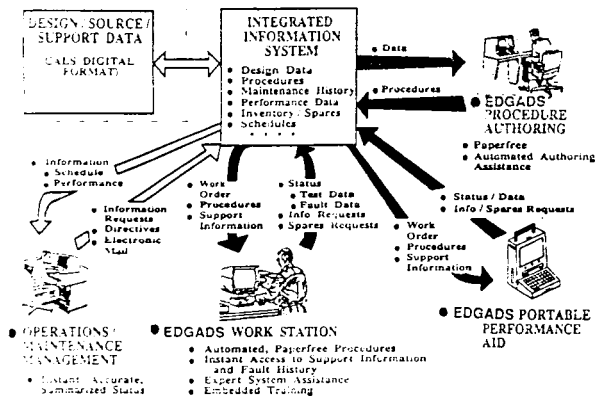
- o An end-to-end "paperless" ETDS (Electronic Technical Documentation System) eliminates these undesirable inherent characteristics.

- o Current technology and existing hardware could support the requirements for developing and demonstrating the feasibility of a paperless technical information system.

## ETDS CONCEPT

The BAO concept (shown in ***Figure 2***) for the Space Station Program ETDS is to electronically acquire, author, compress, integrate and interface various forms of technical information from design, manufacturing and product support data bases for use in supporting operations and maintenance activities. The process will utilize computer-based digital, audio, video, laser and other electronic devices to provide the operator/user hands-free or eyes free selection and use of O&M technical information without the need for generating voluminous technical procedures and/or manuals in paper format. The ETDS is comprised of two major components: (1) a TIAS (Technical Information Acquisition Standard, and (2) an EDGADS (Electronic Data Generation and Display System) hardware and software suite.

**Figure 2**
**INTEGRATED INFORMATION SYSTEM**




## I. Technical Information Acquisition Standard

The TIAS serves as a guide for prescribing and managing the digitized formats, media, content, and automated interchange of technical information between designers, authors, editors and consumers to support space station operations, maintenance, logistics support, verification, validation, and training functions. It incorporates applicable industry and government accepted standards and provides for handling non-digitized data. It presents explicit examples of User Video Displays developed from digitized formats (arrangements) of design and manufacturer source materials. Draft Version 4 was submitted to NASA KSC SS-LSO for staffing on 4/10/88.

## II. Electronic Data Generation and Display System

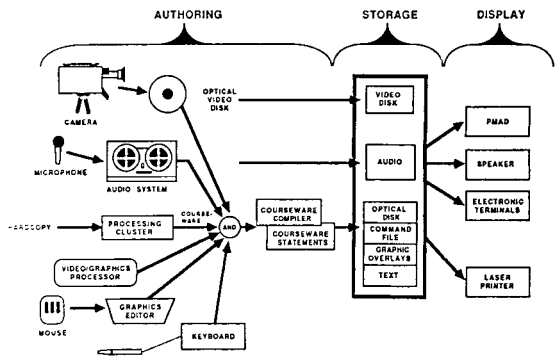
The approach for developing the EDGADS is shown in ***Figure 3***.

EDGADS is defined by the following requirements:

AUTHORING SYSTEM

The authoring system will provide computer aided authoring of technical information by subject matter experts from hardcopy (text, graphics, pictures) and recorded media (video, audio).

**Figure 3**
**EDGADS APPROACH**




**ORIGINAL PAGE IS OF POOR QUALITY**

DISPLAY SYSTEM

The display system will provide multi-window presentations of graphics, pictures, animations, action sequences with text statements and audio overlays on high resolution color CRT. It will include a print option and a monochrome portable device.

STORAGE SYSTEM

The storage system will be an Optical disk (WORM) drive controlled by work station and transparent to input/output hardware.

DATA BASE MANAGEMENT SYSTEM

The DBMS will be structured to allow direct access via hierarchial menus, keyword, name, ID number, voice command or touchscreen pictoral of the item.

It will contain operations and maintenance information at three levels of intelligence for a total system.

APPLICATIONS SOFTWARE

The applications software will provide for the following:

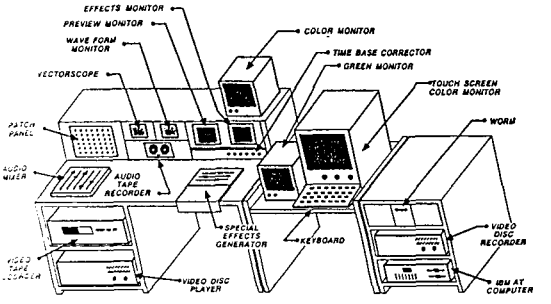
a) Automated data presentations
b) Switching between operations instructions and related maintenance instructions
c) Sequence termination and restart at same point
d) Maintaining date, time and personnel ID log
e) Intelligence level selection and change at anytime
f) QA control functions
g) Out-of-sequence branching.

EDGADS user requirements:

- o Hands-free operation
- o Immediate access to Support Data Bases
- o Automatic verification of Support Test Equipment
- o Authenticates users
- o Prevents accidental deletion of base-line data (WORM)
- o Allows authorized amendments to accommodate unique or field required modifications (change management)
- o Allows authorized amendments to accommodate unique or field required modifications (change management)
- o Automatic update of historical and logistics support files
- o Date, time and personnel ID log by task or procedural step (print on demand)
- o Allows user to develop new or special test routines
- o Contains all processing and control forms
- o Includes embedded User's Guide.

In February of 1986, Boeing Aerospace agreed to supplement the funding of an on-going IR&D project (PBA-502) to develop a proof of concept demonstration on an operational system to prove feasibility of the EDGADS implementation aspects. Part of the Product Support Development Station hardware (as shown in ***Figure 4*** ) and software was modified and dedicated to this effort. The project was designated as BIDS (Boeing Intelligent Data System).

**Figure 4**
**BIDS DEVELOPMENT STATION**




## BIDS IR&D Project Objectives

The overall objectives of the Boeing Intelligent Data System (BIDS) project for 1986 were to:

1. Develop the EDGADS conceptual design to perform computer based authoring, storage and presentation functions for technical data to support operations, maintenance, training and inventory management activities for Space Station and other related DOD programs.

2. Integrate a concept demonstrator consisting of the BAC Training Equipment Systems (TES), baseline Computer Based Instructional (CBI) delivery station.

3. Procure, develop and integrate the various hardware and software elements to support a demonstration.

4. Develop and demonstrate typical subsystem maintenance scenarios which will reflect a new documentation and support concept for the Space Station program.

5. Provide support for demonstrations and meetings.

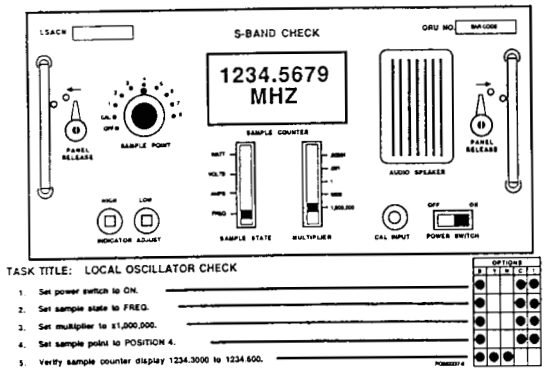
6. Document activities of above tasks.

All of these objectives were met.

## EDGADS Proof of Concept Demonstration

The EDGADS conceptual design was successfully demonstrated to NASA, Navy and AF personnel on June 3, 1986 in the BCAC 757 Trainer Simulator Facility. The demonstration was a paperless audio and video presentation of the 757 procedural steps to provide a moderately trained technician to perform the functions for resolving a malfunction in the 757 right engine generator system and return it to proper operation. A video documentary of the demonstration is available for VHS viewing on request.

**Figure 5**
**EDGADS DISPLAY**



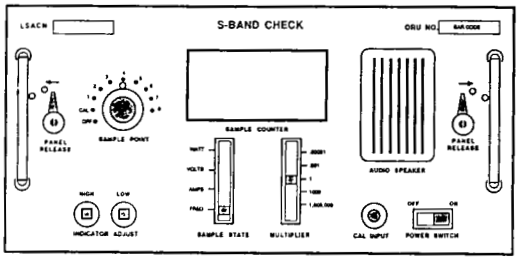



## ETDS End-to-End Paperless Procedure Development

The end-to-end paperless procedure development, as shown in *Figure 2*, was simulated by providing examples of engineering source data and a composite of the user's desired display format to the EDGADS author. These examples are shown in Figures 5, 6 and 7. When the ETDS is implemented, the EDGADS procedure authoring station could acquire these files electronically. The **EDGADS Display** (as shown in *Figure 5)* is a combination of the **EDGADS Input File** *(shown in Figure 6)* and the **Local Oscillator Check** elements of the other **Input File** *(Figure 7)*. It also provides the author explicit instructions for implementing the user requirements for satisfying the qualification testing protocols, QA actions and operator interface techniques.

The most significant of these instructions involves the "options" matrix which is explained as follows:

**Figure 6**
**EDGADS INPUT**




### Options Matrix Codes

B - executes a browse capability

Y - indicated actions were successful

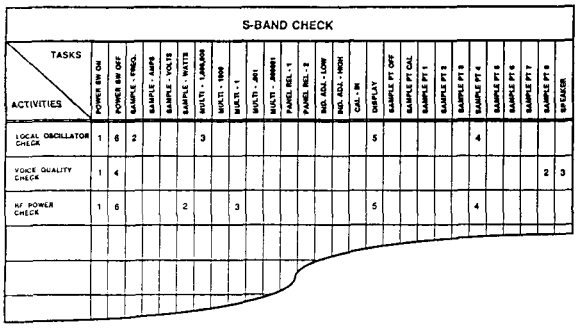
N - indicated action not successful; automatically branches to trouble-shooting menu; must be cleared to continue

C - indicates action complete; proceeds to next step

I - indicated action incomplete; can browse, quit, or do other task out of sequence; flags control system that test is incomplete.

The front panel drawing was manipulated to produce the O&M user displays for performing the selected tasks/activities as desired. The highlighted/ animated frames are maintained in the O&M grahics file and can be accessed by **LSACN, ORU No., NOUN NAME** as indicated on the drawing.

**Figure 7**
**EDGADS INPUT**




## IUS Ground Power Control Rack Demonstration

Although the 757 demonstration proved the feasibility of the EDGADS concept, it did not address the ramifications of a real NASA/DOD operational environment; such as, quality verification, contractual delivery requirements, monitoring protocols, configuration management (procedure), and performance authorization. Therefore, it was decided to utilize the Air Force Eastern Launch Site (ELS) Inertial Upper Stage (IUS) off-line facility to demonstrate the paperless concept in the operational environment on the Ground Power Control Rack.

The Ground Power Control Rack (GPCR) provides power at the various voltage levels required for operating and calibrating the IUS flight systems during assembly and certification testing at the ELS.

## IUS GPCR Demonstration Features

- o Operates with both base and portable computers
- o Accepts keyboard, voice and touch inputs
- o Displays test document accompanied by video, graphic and audio aids
- o Verifies (barcode) personnel and equipment
- o Automatically logs all test data
  - o Test progress (time, date, status, etc. for each step)
  - o Equipment use
  - o Required buy-off/signatures
  - o Pickups, UER's, etc.
- o Retrieves and displays
  - o Drawings ("A" size in demo)
  - o Specifications
  - o Historical data (related UER's, test logs, etc.)

Although the entire procedure was automated, only selected segments were performed in four demonstration sessions which were viewed by Air Force (uniform and civilian), Navy civilians, and NASA personnel.

The Demonstration Scenario included: a brief introduction to the **CH**eck-out **E**xecutive **S**ystem (CHEX); System Startup sequence; general notes from IRSO; AC Function Power Test and 28V DC FPT; Browse Test Log; Go Out-of-Sequence to Wrap Around Test; simulate a fault and fill out a Pickup; view related specifications; begin repeat of WRAP Test; perform clean-up sequence and "print" buy-off sheet.

The video documentary of the as-run demonstration clearly shows the superiority of paperless prompting. It also requires 40% less time to perform and eliminates 80% of the pre-test and post-test activities imposed by paper-driven systems.