DEVELOPMENT OF ENGINEERING APPLICATION PACKAGES FOR INTERACTIVE DESIGN OF ELECTRONIC SYSTEMS

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ABSTRACT

Application Packages provide an efficient and convenient means of using the Advanced Design System (ADS), a computer-based graphic system, in various design activities like hybrid microelectronic circuit layout, printed circuit board layout, cabinet and front panel layout, etc., which are associated with electronic systems engineering. Each Package is tailored to a specific design activity, thereby considerably simplifying its use. Moreover, the Packages are sufficiently similar that a user familiar with one can learn to apply any other rapidly. This paper describes the concepts and technical details of Application Packages, and the scheme used for their development is presented. Examples of presently available Packages are also given.

MISE AU POINT DE PROGRAMMES-PRODUITS D'APPLICATION TECHNIQUE POUR LA CONCEPTION DE SYSTÈMES ÉLECTRONIQUES À ACTION RÉCIPROQUE

ABRÉGÉ

Les programmes-produits d'application offrent un moyen efficace et opportun d'utiliser l'ADS (Advanced Design System), un système graphique par ordinateur, dans diverses activités de conception comme la disposition des circuits micro-électriques hybrides, la disposition des circuits imprimés sur planchettes, la disposition des coffrets électroniques. Chaque programme-produit est spécialement prévu pour une activité de conception particulière, simplifiant ainsi considérablement son utilisation. De plus, les programmes-produits sont assez semblables de sorte que l'utilisateur familier avec l'un d'eux peut rapidement apprendre à se servir d'un autre. Le présent mémoire décrit les notions et spécifications techniques relatives aux programmes-produits d'application ainsi que la méthodologie de la mise au point. Des exemples de programmes-produits disponibles actuellement sont donnés également.

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INTRODUCTION

Experience with the Advanced Design System (ADS) at
Chalk River Nuclear Laboratories over the last two years
has shown that using Application Packages tailored to
various design activities in electronic systems enginee-
ring improves the efficiency of the overall design
process.

Presently, about twenty designers use ADS as a tool
in their daily work. Full-time operators are not
employed, thereby eliminating an additional designer/
operator interface in the design process. Application
Packages have simplified the operation of ADS such that
designers can readily apply the system to a broad range
of design activities.

THE ADVANCED DESIGN SYSTEM (ADS)

The Advanced Design System* consists of three major
parts: a Computer-Aided Design (CAD) Subsystem, Artwork
Generation Equipment and a link to external computing
facilities.

The CAD Subsystem is centered around a PDP-11/15
computer controlling two Editing/Digitizing Stations and
other peripherals, see Figure 1. The Artwork Generation
Equipment consists of a photoplotter and a pen-plotter,
both sharing a controller. The link to external compu-
ting facilities is under development.

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* The Advanced Design System is an interactive computer-
  based graphic system supplied by Applicon Inc. to AECL
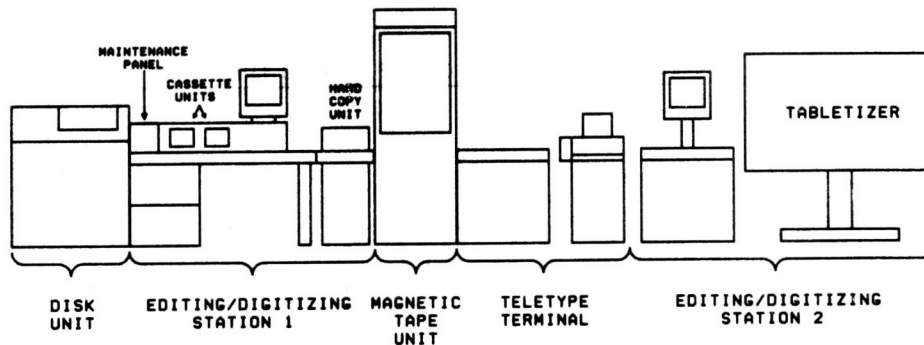 specifications. For further details see references 1
  and 2.

FIGURE 1: The CAD Subsystem of ADS

The system is designed to manipulate graphic enti-
ties called "components". These components can be as
simple as a line, or can be built up to, for example, a
highly detailed representation of a mechanical part.
Components are designed to suit a given application and
are stored in a "library". They can be called up from
the library and added to a "conceptual drawing table" to
create a drawing, which is displayed on the screen. The
drawing table is a composite of sixteen "transparent
sheets" or levels. Components are defined on any combin-
ation of levels.

The user enters commands for adding or manipulating
components by drawing symbols on a tablet, i.e. by using
the tablet as a "sketchpad". This means of entering
graphic data provides a "natural" person/machine inter-
face, which is a key feature of ADS.

The system can be "taught" to recognize tablet
symbols and macro commands. Macro commands are entered
from a keyboard, and are typically concatenations of
basic system commands. Information about command symbols
and macros is stored in a "dictionary", which is tailored
to suit each application.

Finished drawings can be produced on either plotter.
For archival purposes, drawings are stored on cassettes
or magnetic tapes.

APPLICATION PACKAGE

An Application Package consists of a master file
containing a library of graphic components and a dic-
tionary of commands developed for a specific design
activity. A design activity is defined as any one of the
major steps or partitions in the design sequence for an

electronic system. Each Application Package aids the
designer by:

1. integrating design and documentation
   procedures;

2. reducing errors by eliminating repetitious
   design and drafting;

3. making effective use of the "natural" person/
   machine interface of ADS; and

4. taking advantage of the "drawing gain" feature
   of ADS.

Each package possesses two important character-
istics:

1. Specificity: components and commands developed
   for each Package are highly tuned to the speci-
   fic needs of the application, thus making the
   corresponding design process simple and
   efficient; and

2. Commonality: procedures associated with using
   one Package are similar to those required for
   any other, thereby encouraging the user to
   easily and rapidly apply ADS to different
   design activities.

Each Package is developed by a Design Team made up
of members of the ADS staff, and a designer who is thor-
oughly familiar with a given design activity. Once the
Package is complete and fully documented, it is released
for general use.

EXAMPLES OF APPLICATION PACKAGES

The following are examples of Application Packages
in current use:

Application Package for Thick Film Hybrid
Microelectronic Circuit Layout:

Design of a hybrid circuit involves generating masks
for layouts of resistors, conductors and insulators.
This Package includes components representing chips,
resistors, etc.. Various layers of a thick-film circuit
are depicted by different levels. Masks necessary for
production are generated directly on the photoplotter.
Engineering documentation associated with the circuit
assembly, e.g. subassembly drawings, wire-bonding
diagrams, etc., are derived automatically from the lay-
out, achieving "drawing gain". Availability of up-to-

date documentation is thus considerably improved. Figure 2(a) shows a typical thick-film circuit mask.

Application Package for Printed Circuit Board (PCB) Layout

This Package provides fixed-width, stretchable components on two levels to depict the copper conductors of a double-sided PCB, see Figure 2(b). Components representing integrated circuit packages, resistors, transistors, etc. have connector pads, drilling template holes and subassembly details on different levels. The drilling template and subassembly drawings of a PCB are therefore automatically derived from the finished copperwork - another example of "drawing gain".

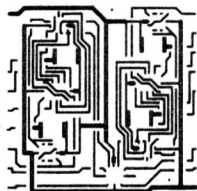## Application Package for Electronic Circuit Schematics

A broad range of components representing standard symbols for resistors, transistors, logic gates, flip-flops, etc. are defined in this Package to help generate electronic circuit schematics rapidly. Since components are easily manipulated, even major revisions are considerably simplified.

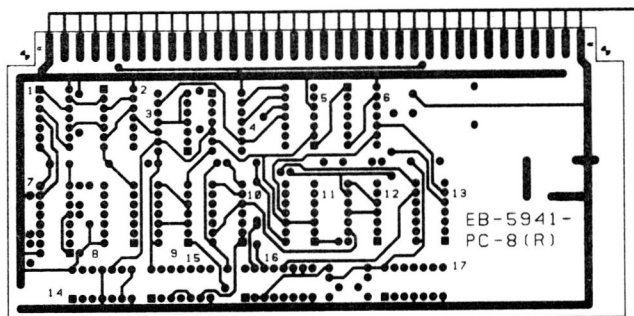## Application Package for Cabinet and Front Panel Layout

This Package facilitates the layout of cabinets, front panels, and associated equipment for electronic data acquisition and control systems. It offers a wide variety of pre-defined components, thereby eliminating repetitious drafting. To take advantage of "drawing gain", many of the components have front, rear and plan views defined on different levels. As a result, the rear and plan views can be derived automatically from the layout of the front view. This Package is also of significant help to designers for major modifications to the layouts can be readily made. Figure 2(c) shows the front view of a typical cabinet layout.

Application Package for Hybrid Computer Schematics

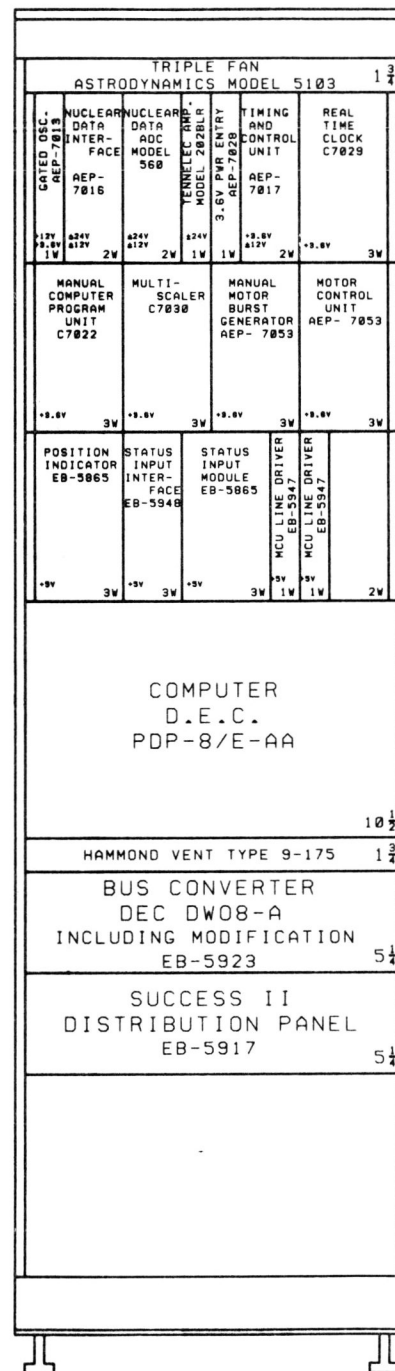Hybrid computer schematics for dynamic simulations can be generated rapidly using this Package, since all the necessary hybrid computer symbols are included. Once a schematic is fully designed on ADS, the user can get plots of the complete schematic, a "scaled" schematic (i.e. a schematic with scaling factors and gains, but no device numbers) or a "blank master" (i.e. a schematic without scaling factors or device numbers).

a) Hybrid Microelectronic
Circuit Conductor Mask

TRIPLE FAN
ASTRODYNAMICS MODEL 5103 1¾

GATED OSC. AEP-7013	NUCLEAR DATA INTER-FACE AEP-7016	NUCLEAR DATA ADC MODEL 560	TENNELEC AMP. MODEL 202BLR	3.6V PWR ENTRY AEP-7028	TIMING AND CONTROL UNIT AEP-7017	REAL TIME CLOCK C7029
+12V +9.8V 1W	±24V ±12V 2W	±24V ±12V 2W	±24V 1W	1W	+9.8V +12V 2W	+9.8V 3W

MANUAL COMPUTER PROGRAM UNIT C7022	MULTI-SCALER C7030	MANUAL MOTOR BURST GENERATOR AEP- 7053	MOTOR CONTROL UNIT AEP- 7053
+9.8V 3W	+9.8V 3W	+9.8V 3W	+9.8V 3W

POSITION INDICATOR EB-5865	STATUS INPUT INTER-FACE EB-5948	STATUS INPUT MODULE EB-5865	MCU LINE DRIVER EB-5947	MCU LINE DRIVER EB-5947	
+9V 3W	+5V 3W	+5V 3W	+5V 1W	+5V 1W	2W

COMPUTER
D.E.C.
PDP-8/E-AA

10½

HAMMOND VENT TYPE 9-175 1¾

BUS CONVERTER
DEC DW08-A
INCLUDING MODIFICATION
EB-5923 5¼

SUCCESS II
DISTRIBUTION PANEL
EB-5917 5¼

EB-5941-PC-8(R)

b) Printed Circuit Board
Copperwork

c) Front View of a
Cabinet Layout

FIGURE 2: Typical Outputs from Application Packages

CONCLUSIONS

Experience has shown that the added convenience offered by Application Packages has contributed to the wider acceptance of computer aids by designers. The results are notable, e.g. repetitious drafting has been reduced, generation of some engineering drawings has been automated, and the availability of up-to-date documentation has improved. An additional benefit of the designers operating ADS directly has been their contribution to the further improvement of the Packages.

REFERENCES

1. G. Yan, "Implementation of Design Aids in Electronics in a Nuclear Research and Development Establishment", 3rd Man-Computer Communications Seminar, Ottawa, May 1973.

2. R.R. Shah, G. Yan, "Application of Electronic Aids in Engineering Design", AECL Research and Development in Engineering, Winter 1974.