Lawrence Berkeley National Laboratory
Recent Work

Title
USING A COMPUTER-AIDED DRAFTING SYSTEM TO AID IN ENGINEERING AND FABRICATION

Permalink
https://escholarship.org/uc/item/9qd78197

Authors
Millaud, J.
Goulding, F.
Salz, P.

Publication Date
1985-05-01

eScholarship.org Powered by the California Digital Library
University of California

LBL-19692
c.2

Lawrence Berkeley Laboratory

UNIVERSITY OF CALIFORNIA

RECEIVED
LAWRENCE
BERKELEY LABORATORY
NOV 20 1985
LIBRARY AND
DOCUMENTS SECTION

Engineering Division

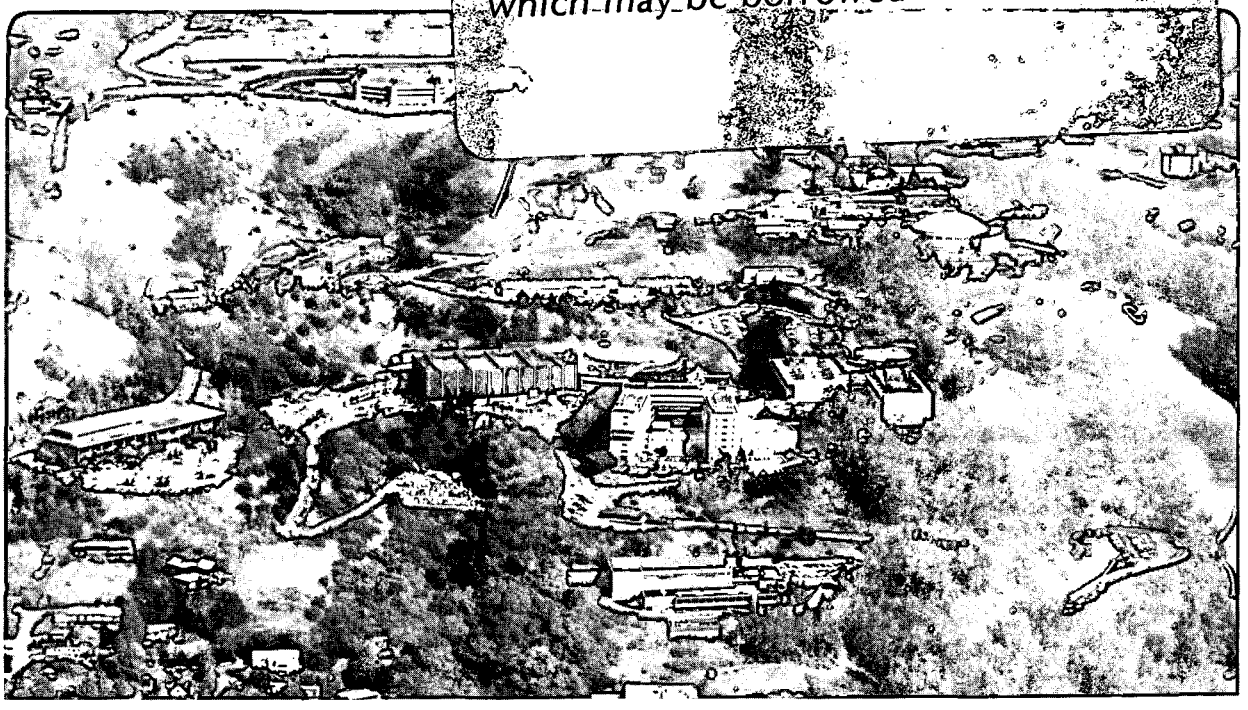
Presented at the 4th DOE Workshop on Computer Aided Engineering, New York, NY, October 10-11, 1985

USING A COMPUTER-AIDED DRAFTING SYSTEM TO AID IN ENGINEERING AND FABRICATION

J. Millaud, F. Goulding, and P. Salz

May 1985

TWO-WEEK LOAN COPY
This is a Library Circulating Copy
which may be borrowed for two weeks.



LBL-19692
c.2

Prepared for the U.S. Department of Energy under Contract DE-AC03-76SF00098

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

USING A COMPUTER-AIDED DRAFTING SYSTEM TO AID IN ENGINEERING AND FABRICATION*

J. Millaud, F. Goulding, P. Salz

Lawrence Berkeley Laboratory
University of California, Berkeley
Berkeley, California USA 94720

SUMMARY

The generation of schematics and artwork on CAD workstations yields a large amount of numeric data that can be used in many ways. Standard by-products are connection lists, photoplot files and drill files.

Using open-ended software allows for more information to be retrieved and used for various purposes in engineering and fabrication.

HISTORICAL BACKGROUND

The Lawrence Berkeley Laboratory's systematic effort in CAD for electronics began in 1980 with a schematics capture package designed by F.S. Goulding. By the autumn of 1982 two HP9845Cs operating under EGS 45 were purchased for the drafting group. Although they were quite slow by today's standards, these systems clearly pinpointed the advantages of open-ended software. The increasing needs (Fig. 1) led to the purchase of three HP200-36Cs and, more recently, of an HP 320, all operating under EGS 200. This software package is faster and far more sophisticated than the previous one while retaining its open endedness and data structure.

In June of 1985 bi-directional graphics file transfers between an IBM PC-based schematics entry package and EGS 200 were successfully organized through the writing of a translator. The ultimate goal of integrating engineering--that is, the ability to move files from the engineer's desk to fabrication shops in a fast, efficient and reliable way through different software--was one major step closer (Fig. 2).

IMPROVEMENTS ADDED TO THE EXISTING SOFTWARE

The EGS 200 provides the usual tools of graphics editors as well as standard post processors such as:

- Photoplot files generation
- N.C. Drill files generation
- Material listing
- Connection list files

A less common feature is its open endedness. Drawing files can be converted in ASCII representations and, conversely, ASCII files structured along the lines of the Graphics Editor command can be entered in the Graphics Editor environment. Exploiting this open endedness through the combination of post and preprocessing of files has provided a large number of opportunities:

- Linkage between engineering and drafting through the automatic creation of drawing files from calculated data.
- Graphic translation of drawing files to and from other drafting packages
- Drafting aids.
- Engineering aids.
- Fabrication aids.

These programs have been written in BASIC, but those most frequently used will be rewritten in Pascal and integrated in the drafting software package for easier use.

DRAFTING AIDS

Automatic lines clearances. Physical layers on a printed circuit board correspond to the combination of logical layers. Lines that must be cleared (ground clearance is a good example) can be extracted from the drawing file, new wider lines can be created using the vertices position information from the original lines. The clearance is, consequently, run exactly over the lines to be cleared.

Schematics parts generation. Creating schematic parts is the process of coyping a drawing, usually from an IC data book. This tedious process involves, in addtion to the drafting of the geometry of the part, the entry and positioning of special attributes such as physical and logical ports. It is relatively error prone. The entire drafting of schematics parts has been eliminated by a preprocessor that prompts the user to provide in specific sequences the list of pin numbers, pin functions, and that directly creates a command file. Errors are essentially eliminated and only cosmetic touches may be required before installation of the part in the library.

Extra large or dense artwork or high density wire wrap boards. The basic EG 200 system limits boards to 32" x 32" and density is generally limited by available RAM or the ability to store the corresponding file on floppies (≈700 kbytes). Both limitations have been overcome by designing the layout in sections and recomposing them with the appropriate offsets prior to post-processing (photoplot, N.C. Drill, wire wrap). Artwork size is only limited by photoplotter size, and density by system storage.

Specialized patterns. If a drawing can be described as the result of calculations, then it can be drawn automatically in a matter of minutes. Similar results may in some case be attainable through the direct use of MACROS in the Graphics Editor.

ENGINEERING AIDS

The direct path between calculations and drafting allows results of simulations to be entered into the Graphics Editor environment and thence directly to fabrication. Conversely, it is possible to write software that will use layout file data to provide information on the electronic performance of the layout. This concept has been implemented in a program written to generate the codes necessary to drive a semi-automatic wire wrap machine. It:

a) Compares the schematics connection list and the layout file;

b) Generates symbolic position information that can be replayed to both the schematic file(s) and the layout file.

c) Maps actual equipotentials on the screen, calculates their total length and warns the user of possible design problems.

Using the graphics editor dynamic tracking capability, it is possible to assess the effect of displacing parts. Such tools can be expanded at minimal cost to almost any technology (multiwire, printed circuit, etc.).

Fabrication Aids

Generation of wire-wrap or multiwire codes using the parts placement file and the schematics connection testing. Almost any two axis N.C. machines can be driven from post-processed files. Routing of boards and engraving have been demonstrated.

Automatic loading of components can be implemented in minimal time. Presently, loading listings can be provided either through part type or geographical sequencing.

Ordering forms could be filled automatically from material listings.

An untapped but promising application is in quality assurance for printed circuits using photoplot files or N.C. drill files as the source of data.

Particular attention has been given to file transfer between the drafting environment and the production environment (LBL's or outside vendors' fabrication shops). Modem transfer has been retained as the most economical vehicle. Special interfaces have been written to render the transfer almost transparent to the users.

SYSTEM INTEGRATION

Computer Integrated Engineering, that is the existence of a continuous path from the engineer's desk to the fabrication shop, started with the recognition that:

a) Engineers need a schematics entry package and simulation tools, but they should be minimally involved in artwork or layout generation and fabrication; and

b) Almost any engineer's desk is presently equipped with a personal computer. The IBM PC represents the largest percentage of these PC's.

The primary candidate for the engineer's desk CAD package had to be a schematic entry package operating on IBM's PCs, XTs, ATs or compatibles and capable of either direct drawing file compatibility or bidirectional transferability to the central CAD workstations. CASE's Technology schematics' entry package file structure was translatable into HPs EGS 200 and vice versa thanks to the open endedness of both software. A translator has been written. Parts created under EGS 200 can be transferred to the CASE Technology libraries and drawings completed under CASE Technology's software can be transferred to EGS 200. In both directions graphics files are transferred not connection lists. The advantages of such a translator and its importance relative to system structuration are listed on Fig. 3.

CONCLUSIONS

LBL's electronic drafting started with limited power and low-price workstations. Efforts have been concentrated into shortening and speeding up the design-to-fabrication path--a major component, although too often underestimated in projects' development costs.

Using open-ended software has resulted in the development of major aids to drafting, engineering and fabrication while permitting a smooth and coherent structuration of integrated engineering.

ACKNOWLEDGMENT

Reference to a company or product name does not imply approval or recommendation of the product by the University of California or the U. S. Department of Energy to the exclusion of others that may be suitable. This work was supported by the U.S. Dept. of Energy under Contract No. DE-AC03-76SF00098.

We are especially thankful to Fred Kirsten for his many suggestions, to Goffril Obegi and Anita Whichard for their enthusiasm in writing the codes for the bi-directional translator, and the entire drafting group for their eagerness in trying new tools and methods and making them successful.

A C T I V I T I E S

* SCHEMATICS

* P.C. ARTWORK

* DETECTOR ARTWORK

* LIGHT MECHANICAL

* PRESENTATION

Figure 1

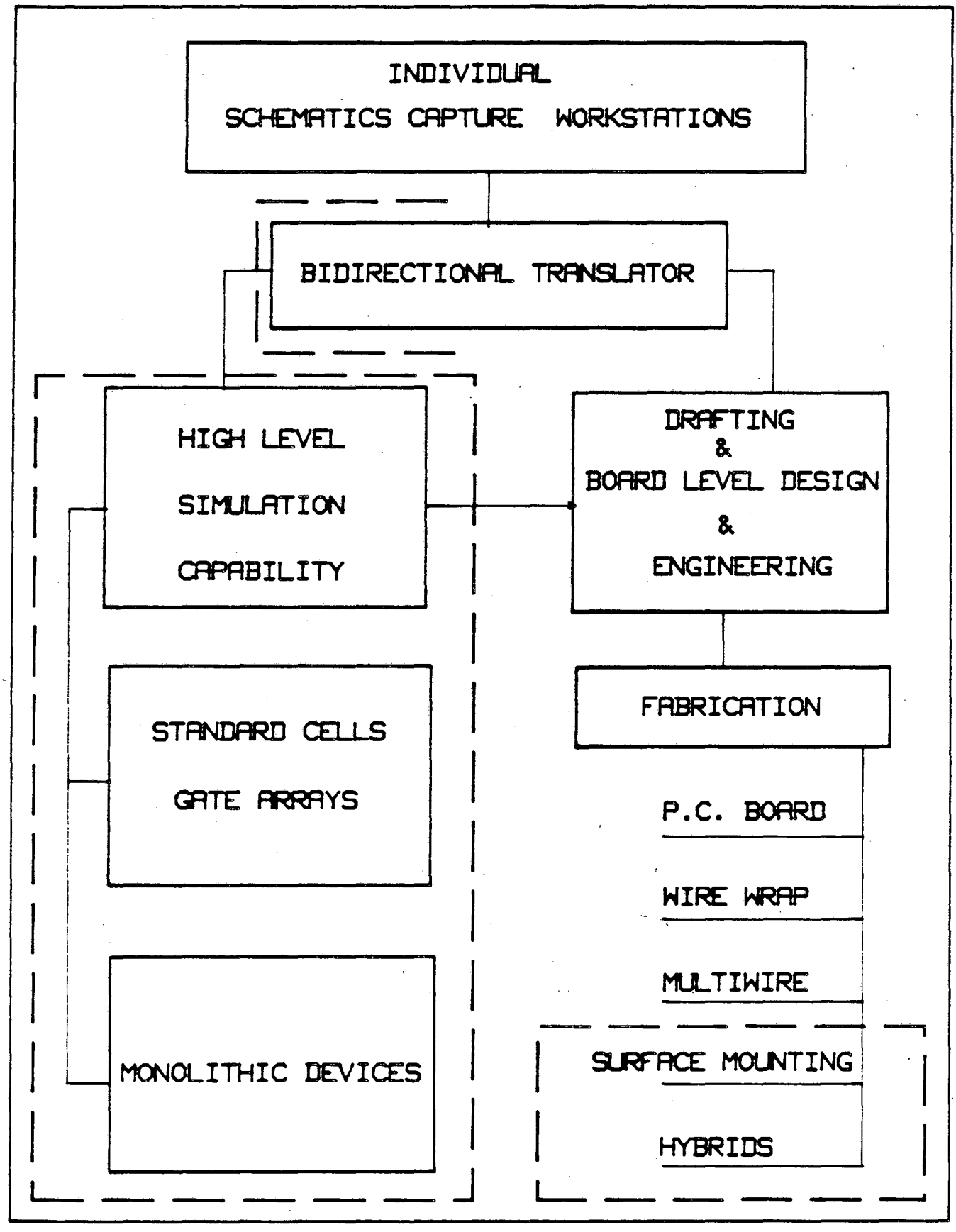

INDIVIDUAL
SCHEMATICS CAPTURE WORKSTATIONS
BIDIRECTIONAL TRANSLATOR
HIGH LEVEL
SIMULATION
CAPABILITY
DRAFTING
&
BOARD LEVEL DESIGN
&
ENGINEERING
STANDARD CELLS
GATE ARRAYS
FABRICATION
P.C. BOARD
WIRE WRAP
MULTIWIRE
MONOLITHIC DEVICES
SURFACE MOUNTING
HYBRIDS

Figure 2

INTEGRATING ENGINEERING

* CONTINUOUS PATH FROM ENGINEERING TO FABRICATION.
* DE FACTO STANDARDIZATION OF PARTS.
* COMMON ARCHIVAL FORMAT FOR DRAFTING.
* ELIMINATION OF SCHEMATICS REDRAWING AND ASSOCIATED RISK OF ERRORS.
* ACCELERATED BUILD UP OF A LAB WIDE MASTER LIBRARY.
* ACCESS TO FACILITIES OF THE CENTRAL DRAFTING GROUP.
* MORE EFFICIENT USE OF THE NUMEROUS PC, XT, AT OR COMPATIBLES.

Figure 3

This report was done with support from the Department of Energy. Any conclusions or opinions expressed in this report represent solely those of the author(s) and not necessarily those of The Regents of the University of California, the Lawrence Berkeley Laboratory or the Department of Energy.

Reference to a company or product name does not imply approval or recommendation of the product by the University of California or the U.S. Department of Energy to the exclusion of others that may be suitable.

TECHNICAL INFORMATION DEPARTMENT
LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA 94720