An Integrated ECAD Library System for Standard Part Management in a Heterogeneous ECAD Environment

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〈Abstract〉

In this study, we propose an *integrated CAD(Computer Aided Design) library database* in a heterogeneous commercial ECAD(Electronic CAD) environment. To effectively solve engineering problems focused on *BOM* data extraction we use a software system called *schematic capture* and company-wide standard electronic part information loaded on different commercial *ECADs* We unify many commercial *ECADs* into one *schematic capture* and a variety of PCB(Printed Circuit Board) design tools. For this purpose we develope a model for linking *CAD symbol library* with *company-wide standard part information*. We also develope a schematic design data conversion scheme and show how to extract *PBA level BOM* data using our customized *schematic capture*. This system is being operated in an X-Window based engineering work station and commercial RDBMS base.

Keywords: *Integrated CAD library database, BOM(Bill of Material), Company-wide standard part information, ECADs(Electronic CAD system), Schematic capture, PBA(Print Board Assembly), CAD symbol library*

1. Introduction

There has been a growing need for a corporate-wide EDB (Engineering Database) system that integrates all technical management information — product design information, draft information, part order information, and technical documents — such that they can be used and maintained consistently throughout the manufacturing process from product development and production to sales and after-service.

At SEC(Samsung Electronics Corporation), we are currently using a variety of ECAD tools, each of which has libraries and operating methods that are incompatible. Therefore, it is impossible to exchange CAD. data among them, and BOM data is manually extracted from the heteroseneors ECAD systems after the CAD operation. However, problems arise from the generation of the BOM data, first, there is the reliability problem due to the human errors in extracting the data from ECAD, and second, generation of BOM

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data is not prompt enough to be useful(i.e. Update delay may result in inconsistency problem when outdated BOM data are propagated to the production line or purchasing division). In order to build an integrated design information system environment that solves the above mentioned problems, the followings should be established:

—A single schematic capture and an integrated CAD library should be built, and schematic diagrams generated from the single schematic capture in designing the PCB in each ECAD tool should be used. —BOM data should be extracted directly from the schematic diagram. Also, capability to generate part related information (BOM list, part cost, etc.) should be implanted within a single schematic capture.

We are able to apply the single schematic capture developed by SEC for linking the symbol library with standard electronic part information(i.e We could not apply any of the existing commercial schematic captures because they could not be customized for our needs). In this paper, we present the system development environment and show the link process between the symbol library and the standard electronic part information. We then present an integrated CAD library database and the data conversion process needed for designing the PCB in each of commercial ECADs (CADSTAR and VISULA in particular).

We also present the standard electronic part search module using logical symbol data which is linked with standard electronic part information. Lastly, we present the process of generating the BOM data from within the schematic capture.

2. System Development Environments

1) Hardware Used

—HP9000/865s(for DATA SERVER)

—HP9000/300s, 400s, and 700s(for EDB clients)

—X-Terminal(17″ Color, for EDB clients also)

2) Software Used

—X-Window 11/R4, OSF/Motif 1.1

—C-Language

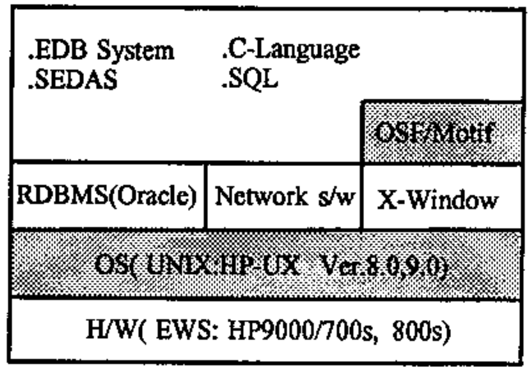
—ORACLE RDBMS Ver.6.0.30

· SQL*PLUS

· SQL*Net

· SQL*Connect

· Pro*C



3) Network Base

Ethernet of TCP/IP Base

4) Electronic Design Automation System

SEDAS(Samsung Design Automation System) is used for a dedicated schematic capture and symbol editor. Three submodules are as follows;

—SENET : Schematic Editor

—SESYM : Logical Symbol Editor

—SELIB : Physical Symbol Editor

3. PCB Design Flow View through Standard Part Management Information Link

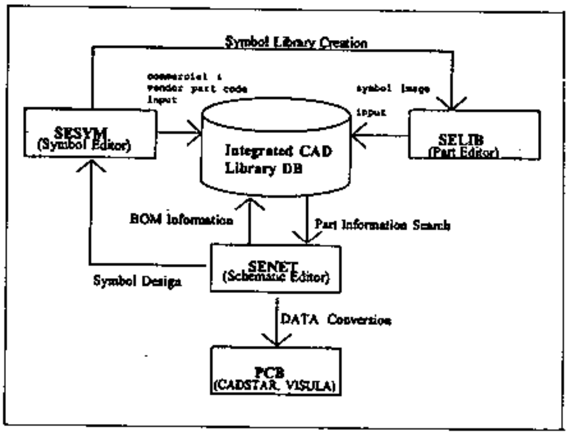
We develope the general PCB design steps with our customized ECAD environment as follows:

· First, input logical symbols and the corresponding physical symbols(or PCB design) into the integrated CAD library DB using two editors(SESYM, SELIB)

· Second, enable the schematic process by calling library DB from SENET.

· Third, when the schematic process is finished, support the continuous PCB process on other hardware and CAD software platforms by generating PCB output file from CADSTAR or VISULA as an alternative to SENET storage method.

Figure 1 demonstrates a flow diagram for the steps described above.



⟨Figure 1⟩ PCB Design Flow for other Commercial ECAD

4. Job Flow View for the Part Information in SEC

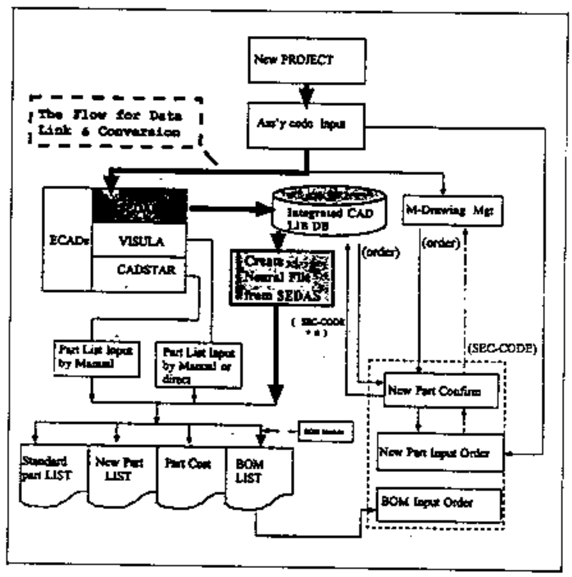
This flow shows steps from the project order to the generation of part information. We focus on the part information out of SEC project development steps. And this shows a customized scheme; the applied SEDAS tool, other commercial ECAD tools(CADSTAR and VISULA), and integrated CAD library database.

VISULA maintains a CAD library DB, and when SEC standard part information is input to this DB, a neutral file of standard format is generated, and it becomes possible to generate BOM data using a separate BOM generation module.

However, when a new(non-standard) part is introduced, it becomes impossible to make the connection to SEC integrated CAD library DB to incoporate the SEC temporary part code. In that case, it is necessary to link the existing BOM module with the new part processing module. Therefore, it is inevitable to resort to manual creation of BOM data.

The situation is worse with CADSTAR because CADSTAR does not even maintain a CAD library DB. Therefore, manual creation of BOM data is also inevitable with CADSTAR.

Figure 2 shows two design flows going from ECAD to the generation of BOM data. One is going from either VISULA or CADSTAR and the other is going from our SEDAS. We will describe the latter design flow indicated in the figure as a thick line.



⟨Figure 2⟩ Job Flow View for a dedicated coporate system

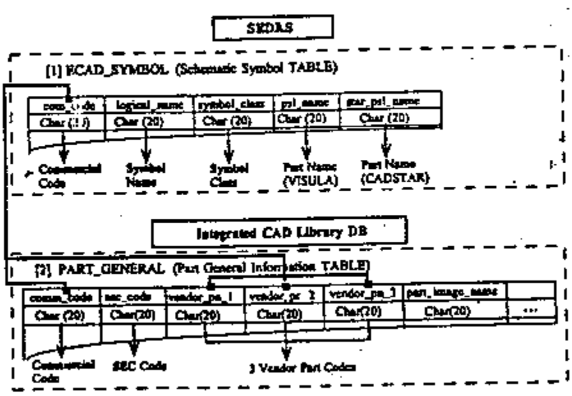
5. Logical Symbol Link with Standard Part Management Information

PCB design starts from the schematic design. For the schematic design, logical symbol should be created and input by SESYM(symbol editor) for the first time. Most commercial ECAD tools design symbols independently by their own graphic symbol and property data. But if the circuit designer can search the standard part information in corporate level while he designs, the design efficiency would be maximized. In this respect, it is required to link logical symbol data with the corporate standard part information. Accordingly, in this study, this link is realized by preparing the neutral table, ECAD—SYMBOL, in the integrated CAD library DB. Figure 3 shows above link by two DB table connections.

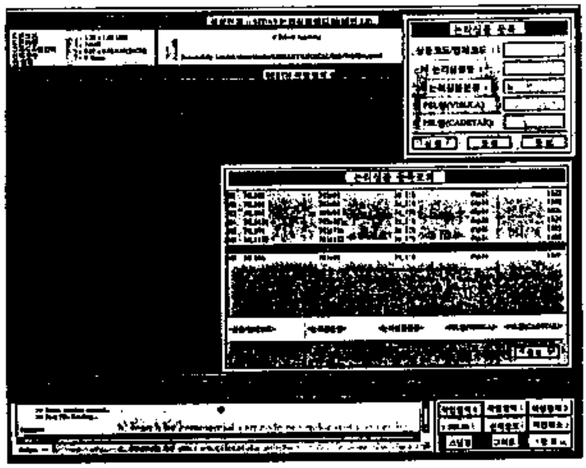
The real action for linking logical symbol with the SEC standard part information is triggered by selecting the UI (User Interface) menu for the logical symbol input. The key value for the link is the part commercial code(if available) or vendor part codes, if it doesn't have the part commercial code.

In case of vendor part code, three vendor part codes are considered for the appropriate part selection scope in design stage.

Finally, the corporate standard management information is fetched by the SEC code, which is internally connected to the commercial code field and the three vendor part code fields in DB table, PART—GENERAL.
Figure 3 shows above descriptions and Figure 4 represents how to implement it in our application.



〈Figure 3〉 Logical Symbol Link with Standard Part Management Information by DB Tables



〈Figure 4〉 UI for logical symbol input to link with standard part Information in SESYM

6. Neutral File Generation for BOM through Standard Part Management Information

6.1 Search Routine for Standard Part Management Information

This search routine uses the result of linking CAD symbol data with standard part information. Hence, in schematic design(SENET), the graphic symbol image is called by selecting a standard part through this search menu screen. Because the symbol selected from the search routine has the corporate standard part management information along with its CAD data internally, BOM data for each board level can be extracted easily after the schematic design is completed.

Figure 5 shows a corporate standard part management information and its logical symbols.

1) Basically it has top-down part class structure of depth 3.

Depth 1	Depth 2	Depth 3
IC	Logic IC	TTL series (code range:871) MOS series (code range:873) …
	Linear IC	Amplifier series (code range:881) Comparator series (code range:881) …
TR	BJT series (code range:891) FET series (code range:891) …	
…		

2) This gives 4 search paths for user applications

a. search by SEC CODE input

b. search by commercial part code or vendor part number input

c. search by part specification input.

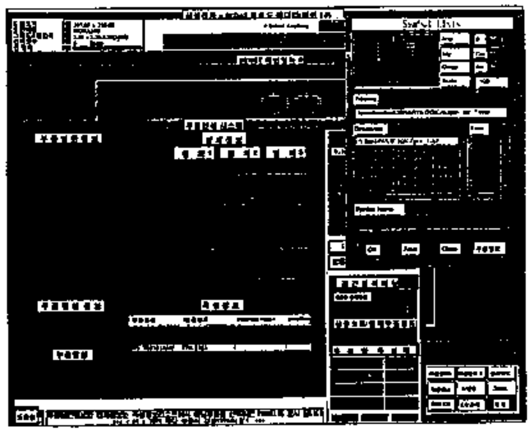
d. search all for a part class selected.

6.2 Neutral File Generation for BOM

In order to minimize the production lead time and maximize the purchasing efficiency of corporate standard parts, BOM data should be generated in EVT(Engineering Validation Test) stage, just after the neutral file for BOM data of a schematic diagram is created directly from SENET through linking ECAD symbol data with corporate standard part management information. Also, this flow replaces manual coding for BOM data generation(Figure 1 : Flow for CADSTAR or VISULA part list manual input).

Table 1 shows a sample neutral file for BOM data generation and Table 2 presents its output file, BOM file.

Table 2 shows the part hierarchy that represents the



⟨Figure 5⟩ UI Screen for the standard part information search in SENET

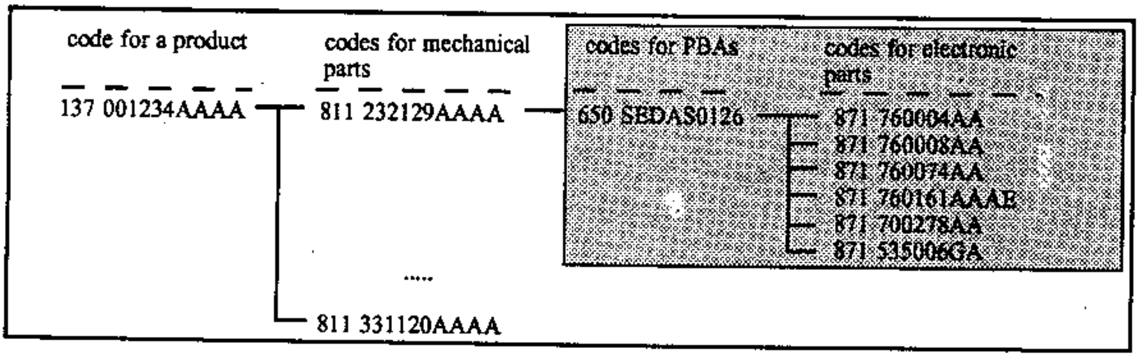
Table 1:A sample Neutral File for BOM

[.PTS] FILE

871 760004AA:1:U1:DIP,14,300MIL,HEX,
871 760008AA:1:U2:DIP,14,300MIL,QUAD,
871 760074AA:1:U3:DIP,14,300MIL,DUAL,
871 760161AAAE:1:U4:DIP,16,300MIL,SINGLE,
871 700278AA:1:U5,U6:DIP,14,300MIL,SINGLE,
913 535006GA:1:U7,U8,U9,U10:10%,1W,SIDE,-,25TURN,-,25TRN,5.59X12.7X12.

Table 2: A generated sample BOM File from the sample Neutral File in Table 1

L	PBA CODE	SEC CODE	SEP	QUANTITY	REF.CODE	DSN	E	S	DSNS	DSNE	MAN	DL	INP.D
1	SEDAS0126	871 760004AA	1	00001.00000	U1		Y		930126	930226	A45458		999999
1	SEDAS0126	871 760008AA	1	00001.00000	U2		Y		930126	930226	A45458		999999
1	SEDAS0126	871 760074AA	1	00001.00000	U3		Y		930126	930226	A45458		999999
1	SEDAS0126	871 760161AAAE	1	00001.00000	U4		Y		930126	930226	A45458		999999
1	SEDAS0126	871 700278AA	1	00002.00000	U5,U6		Y		930126	930226	A45458		999999
1	SEDAS0126	871 535006GA	1	00004.00000	U7,U8,U9,U10		Y		930126	930226	A45458		999999



relationship between a PBA(i.e. hierarchy level 0; this isn't shown in this table but we designed to have this PBA assigned to level 0 when we make a BOM structure) for a top assembly and its sub-SEC codes for child parts(i.e. hierarchy level 1). In this paper, we show a PBA level BOM rather than a complete BOM(i.e. a complete BOM structue should be comprised of both mechanical parts and electronic parts). Our whole BOM structure unifies the two isolated BOM constructions, the product level BOM construction and the PBA level BOM construction(the isolation of these two BOM construction was enevitably due to our development environment). So we first focus on a BOM structure for electonic parts(i.e. a PBA level; it is seen to be a subassembly for mechanical components of a product) and finally designed to send this to material management section to construct a complete BOM structure. Our role here is to construct a BOM structure of PBA level(shaded area in the hierarchical part tree below).

7. Data Conversion for Compatibility with Commercial PCB tools

For the compatibility with other commercial PCB design tools, common physical symbol library is constructed in database by saving graphic data of physical symbol created by SELIB, one of threemodules of SEDAS, into the data format of two commercial PCB design tools: CADSTAR and VISULA.

Data conversion flow is as follows (This flow is described in Figure 6):

—CADSTAR I/F:

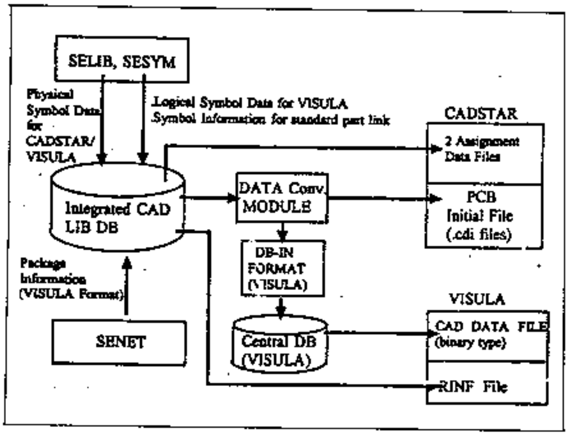
- input logical symbol informations {symbol name, symbol class, commercial code or vendor part number for standard part for data link} into the integrated CAD library DB(in SESYM).
- input physical graphic symbol data into the integrated CAD library DB(in SELIB)
- create a catalog file for CADSTAR {catalog.star}(in SENET).
- extract three initial files for PCB design {comp.cdi, part.cdi, conn.cdi} by executing autogate.
- create output file, sheet—name. CDI for PCB design from 3 { .cdi } files and 2 assignment files{as.dat, sedas—ass.dat}.

—VISULA I/F:

- input logical symbol informations {symbol name, symbol class, commercial code or vendor part number for standard part for data link} into integrated CAD library DB (in SESYM).
- input physical symbol graphic data into the integrated CAD library DB(in SELIB).
- input logical graphic symbol data into the integrated CAD library DB(in SESYM).
- create a catalog file {catalog.vis} for VISULA(in SENET).
- extract RINF file {sheet—name.frs} by executing autogate.
- create PACKAGE {Net List(connection Information),

Library Names} information for VISULA format.

- extract DB—IN—FORMAT file for PCB design for VISULA from the integrated CAD library DB(in SENET).
- input DB—IN—FORMAT file VISULA LIB DB by VISULA LIB tool, and convert it to binary data file by VISULA LIB tool.
- finally, design a PCB with 2 data files {binary data file and RINF file}.



〈Figure 6〉 CAD data conversion flow for the interface with commercial PCB Design tools (CADSTAR, VISULA)

8. Conclusion

This study shows the process that extracts BOM data directly from a schematic diagram designed by our customized schematic capture, SEDAS, in a PBA level, and also presents the effective approach to design PCB in the heterogeneous commercial ECAD tools from this schematic diagram. For that purpose, an integrated CAD library DB is proposed. The integrated CAD library DB is composed of two kinds of data; the link between ECAD symbol library and corporate standard part information and the schematic data conversion from our customized schematic capture to other commercial ECAD tools(CADSTAR and VISULA in paticular) for PCB design.

Table 3 shows two proposed benefits in a global manner. For future studies, back annotation from the PCB designed by other commercial ECAD tools to our customized schematic capture should be solved so that the customized system we propose in this paper may be for accommodating the PCB information modified in other ECAD tools back to the original ECAD tools. This is an essential process in a manner of keeping the consistancy between schematic design data and its PCB data when design changes occur in a PCB.

Table 3:Proposed Benefits

Benefits	Contents
Tangible Benefits	· can save the time for part specific jobs; part list generation and part cost calculations (50%). · can save the purchasing cost and delivery time for parts. · can reduce unnecessary material stocks(50%). · can save the time for technical documenta ton efforts(70%).
Intangible Benefits	· can share real time information among heterogeneous ECADs · can minimize the product development time · can have the standardization of ECADs · can reduce the buying cost of ECAD tools

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