

COMPUTER-AIDED CATV SYSTEM DESIGN

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ABSTRACT

Cox Cable Communications's Design and Drafting Department is equipped with four microcomputer systems to aid in the design of CATV systems. The computers perform all calculations involved in design of Bill of Materials, freeing the system designer to concentrate on routing, amplifier placement, and cost effectiveness. Computer-aided system design is faster, more accurate, and less costly than design produced with non-computer methods.

INTRODUCTION

In companies like Cox Cable that choose to develop large quantities of system design in-house, less than maximum production from the design staff can mean costly construction delays due to lack of maps and Bill of Materials.

A proficient designer, using a computer, can produce in excess of 15 miles of raw design (unpowered/no B.O.M.) in a normal work day. Non-computer-aided methods of design cannot compare in production speed.

Accuracy in system design is imperative. Designing with a simple calculator requires repeated entry of data such as input and output levels, cable losses, and insertion losses. Minimizing the number of keyboard entries will reduce the possibility of keyboard entry errors. Computer-aided system design requires a minimum of keyboard entries. A computer, using custom programming, will instantly calculate all losses and new levels as each span measurement or device selection is entered.

HARDWARE

Cox Cable Communications, Inc. (CCCI) has chosen Wang Laboratories Model 2200 computers for use in system design. While other computer manufacturer's equipment can duplicate most if not all the features incorporated in the Wang 2200 systems, Wang offers excellent dependability at a comparatively low price.

CCCI currently uses four 2200 systems in the Design Department. All four systems are multiplexed to a dual diskette drive and a 120 character per second 7x9 dot matrix printer.

The dual diskette drive provides 524, 288 bytes of off line storage of programs and data. Disk based storage is preferred to cassette tape based storage. Disk systems have a much faster transfer rate than cassette tape systems, and disk provides direct access to stored data. In contrast, data is stored and loaded sequentially on cassette tape systems.

The Wang 2200 series of computers are 8-bit word length machines. The language (BASIC) and its compiler are stored in ROM (42.5K). Storage and transfer code is ASCII.

Each CCCI computer is equipped with 16K (16,384 bytes) of Random Access Memory (RAM). Seven hundred bytes of RAM are required to interface RAM and ROM, leaving 15,686 bytes of user-available RAM.

CCCI's Wang computers are equipped with several features that have proven to be invaluable both in the writing of programs and in actual design.

16 User Defined Special Function Keys. The 16 Special Function Keys allow single key stroke access to any of 32 custom sub-routines. All active and passive CATV devices are selected using one of the Special Function keys for both Design and Bill of Materials.

Separate Numeric Keypad. All four CCCI computer keyboards are equipped with calculator format numeric keypads. This simplifies entry of numeric data (such as span footages) and minimizes entry errors.

Programmable Audio Signal. A 960 Mz beep tone may be program-activated on all four computers. This beep tone serves as an alarm to alert a designer that an entry error has been made or some pre-assigned design parameter has been exceeded.

Edit Capability. Computers that are not equipped with edit functions force a programmer to re-enter an entire line of program text if an error is made while entering the line. With edit capability, the programmer is only required to correct the specific error.

The Wang 2200 system's program language is BASIC (Beginner's All Purpose Symbolic Instruction Code). BASIC is the most common higher level computer language which uses many close-to-English key words. It is the simplest of all computer languages to learn.

SOFTWARE

An effective computer-aided CATV design program must meet the following criteria:

1. All cable losses, insertion losses, and operating levels must be stored in memory and accessed under program control.
2. A single program must function for design of both trunk and feeder.
3. Operation of the program should be simple enough that a person not familiar with computer hardware or computer programming can nonetheless be an effective CATV system designer.
4. Bill of Materials should be compiled in a step after completion of raw design. Attempting to compile Bill of Materials as a part of the design process only serves to slow the designer and lessen the accuracy of the completed Bill of Materials. If necessary, a designer must be able to go back over previously completed work and make changes without concern for previously "SAVED" materials.
5. The computer should function as a "TOOL" for the designer. Decisions regarding placement of amplifiers and cable routing are still best left to the human designer.

DESIGN

Figure 1 is a simplified flow chart for CCCI's CATV design program. To conserve memory, the design program is actually two programs chained together.

Program "DES-1" assigns the following design parameters to the proper array variables for subsequent use in the primary design program ("DES-2"):

1. All cable losses for both high and low design frequencies. (1.000 in. Trunk, .750 in. Trunk, .500 in. Feeder,

and .412 in. Feeder)

2. All operating levels for both Trunk and Feeder amplifiers.
3. All directional tap values and insertion losses.
4. All passive device losses.

The designer is given the option of changing any or all levels or losses to meet different job requirements. (In practice all major system designs have a disk dedicated for that system's levels and losses.) If no changes are desired, the computer will load program "DES-2" over "DES-1". All variables assigned in program "DES-1" remain in memory for use in "DES-2".

No attempt is made to compile Bill of Materials while designing for reason previously mentioned. Compiling the Bill of Materials is the final step in the design process.

All active and passive devices are selected with a user defined Special Function Key. The Special Function Keys access subroutines (smaller programs within a larger program) which assign the selected active device output levels or subtract the selected passive device insertion losses.

The designer is free to move from Feeder to Trunk or from Trunk to Feeder at will. The numbers 1, 2, 3, 4, and 5 are used by the program as code numbers. By entering the proper number, the designer may select Bridger outputs (1, 2, 3, or 4) or Trunk output (5).

The design program is written to be interactive. The designer enters strand footages or selects devices in response to CRT-displayed prompts.

Note: All references within the design program flow chart (Figure 1) to "Print" are CRT displays.

BILL OF MATERIALS

The Bill of Materials for completed design is compiled as a final step in the design process using the programs shown in the simplified flow charts in Figures 2 and 3.

The Compiling Program (Figure 2) is used to total all cable, passive devices, active devices, and connectors for a single map or power supply.

The numbers 1, 2, 3, or 4 are used as code numbers by the program, allowing

the Bill of Materials Clerk to change cable sizes at will. (1 for 1.000 Trunk, 2 for .750 Trunk, 3 for .500 Feeder, and 4 for .412 Feeder.)

All active and passive devices are counted with a single key stroke using the proper user-defined Special Function Key.

Connectors are counted automatically under program control. Connector size is determined by the selected cable size. Connector quantity is equal to the number of connectors required for the selected device.

When all devices and cable for the map or power supply have been entered, the Bill of Materials Clerk will obtain a printout of the totals.

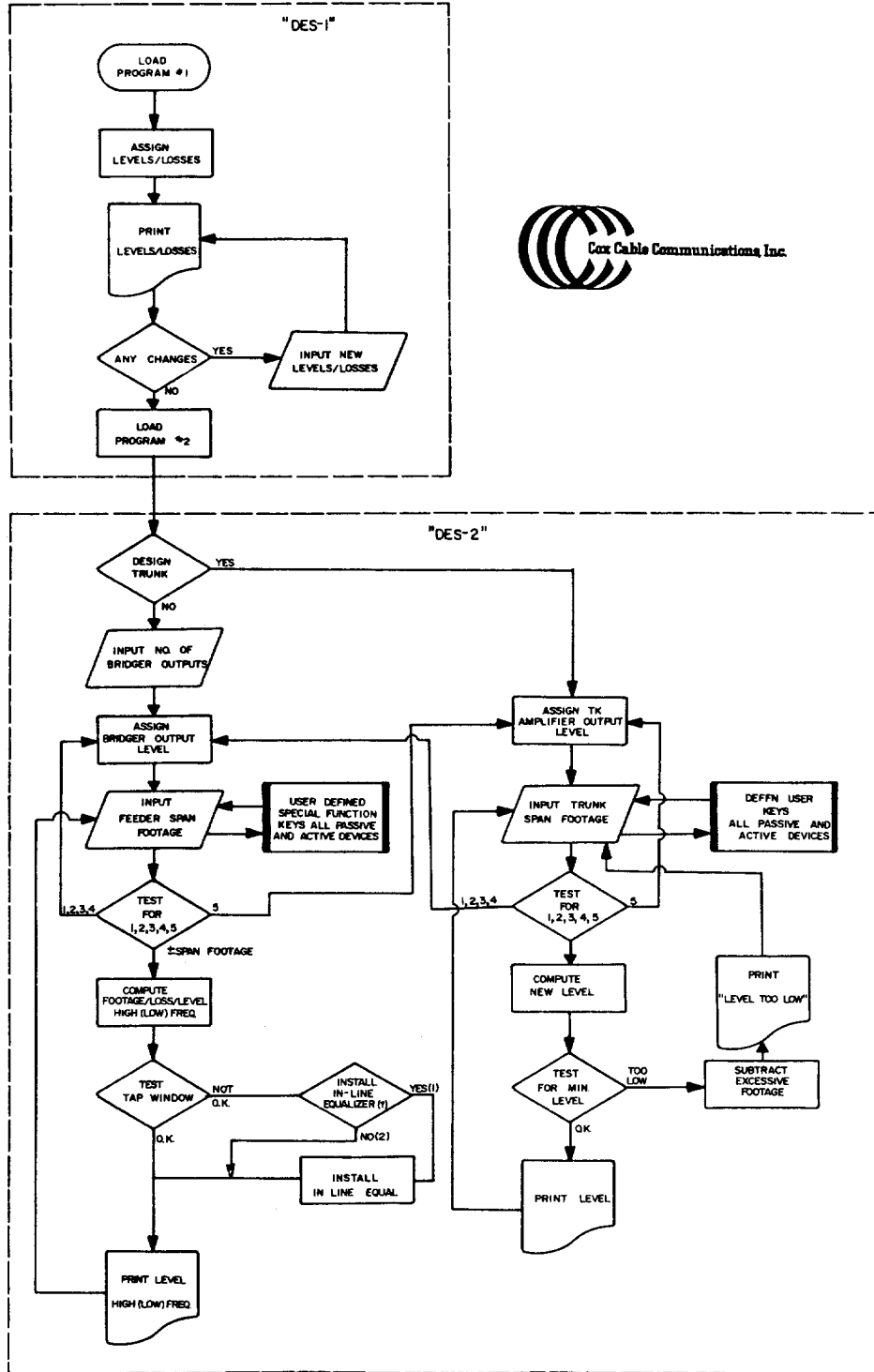
The Printout Programs (Figure 3) are loaded under program control. The Individual Map Printout program section provides the printout for the material counted with the Compiling Program. Figure 4 is a sample printout of a single map or power supply.

When the printout of the single map or power supply totals is completed, the totals are added to the cumulative total stored off line on disk. The updated cumulative totals are resaved on the disk and the Cumulative B.O.M. Printout program is loaded.

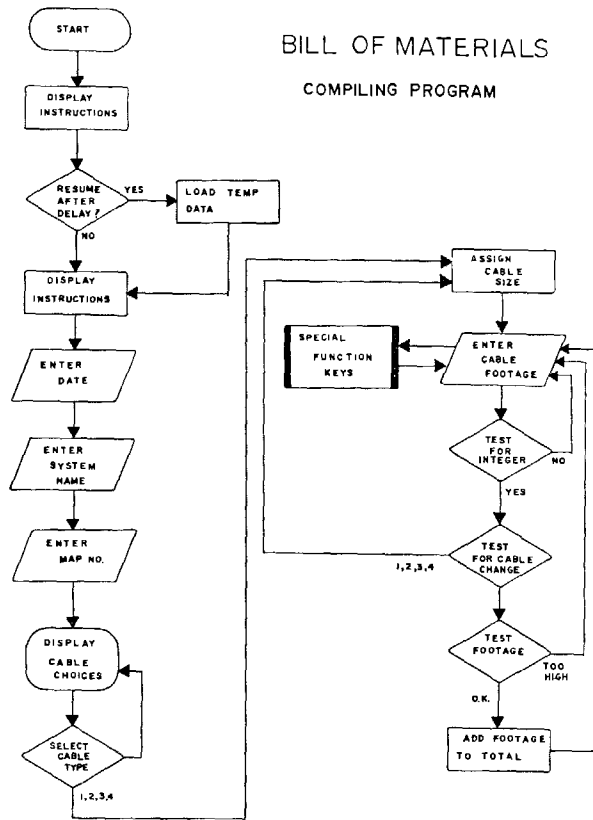
The Cumulative B.O.M. Printout program will print out an updated total of all material counted. This printout also includes the cost of each item, the extended costs, and total per mile costs for Cable, Directional Taps, and Electronics. Figure 5 is a sample Cumulative Bill of Materials printout.

SUMMARY

Using computer-aided methods, Cox Cable Communications, Inc. continues to develop all new system design in-house. The overall cost savings is significant, however equally important is the control over production obtained by not relying on outside sources for system design.

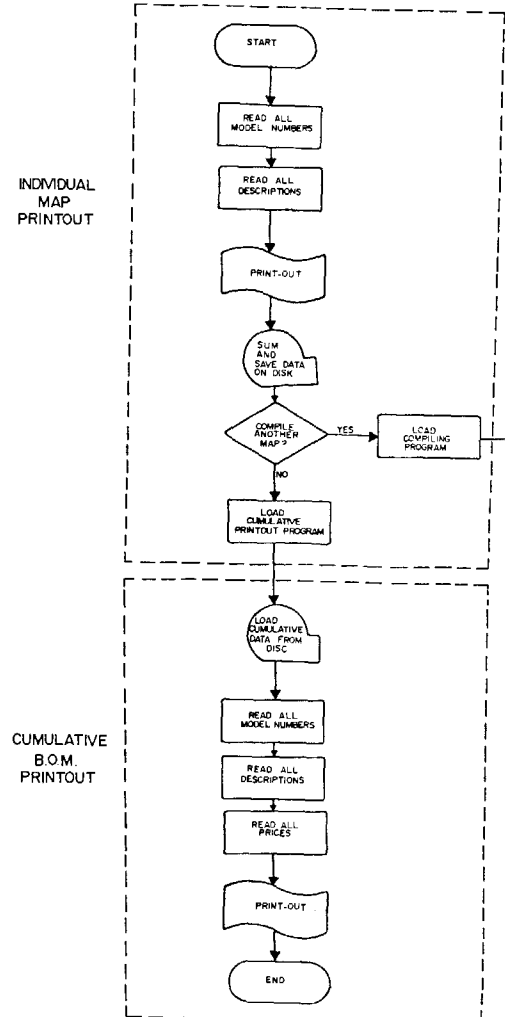


CATV DESIGN PROGRAM
WANG 2200
FIGURE 1



(Figure 2)

BILL OF MATERIALS PRINTOUT PROGRAMS



(Figure 3)

((RLA)) COX CABLE COMMUNICATIONS INC.
BILL OF MATERIALS
 ANYTOWN, USA 3/27/79 MAP NO OR POWER SUPPLY

ACTIVE DEVICES / ASSOCIATED EQUIPMENT

MODEL	DESCRIPTION	QTY	MODEL	DESCRIPTION	QTY
5-2-TC10R	TK/GR - ACC/ASC	0	5-2-E300-0	TK EQUALIZER	0
5-2-TDR	TK/GR - MAN	0	5-2-E300-5	TK EQUALIZER	0
5-2-TC1R	TK - ACC/ASC	0	5-2-E300-8	TK EQUALIZER	0
5-2-TR	TK - MAN	0	5-2-E300-11	TK EQUALIZER	0
5-2-0BR	INT/TERM BR	0	5-2-E300-14	TK EQUALIZER	0
			5-2-E300-17	TK EQUALIZER	0
			5-2-E300-20	TK EQUALIZER	0
5-S1	FEEDER MAKER	0	5-EE300-0	L.E. EQUALIZER	0
5-S2	FEEDER MAKER	0	5-EE300-5	L.E. EQUALIZER	0
5-S3	FEEDER MAKER	0	5-EE300-8	L.E. EQUALIZER	0
5-S4	FEEDER MAKER	0	5-EE300-11	L.E. EQUALIZER	0
			5-EE300-14	L.E. EQUALIZER	0
			5-EE300-17	L.E. EQUALIZER	0
			5-EE300-20	L.E. EQUALIZER	0
5-LE/34	LINE EXTENDER	0			

DIRECTIONAL TAPS

MODEL	QTY	MODEL	QTY	MODEL	QTY
3732/2	0	3735/4	0		
3729/2	0	3732/4	0		
3726/2	0	3729/4	0	3833/8	0
3723/2	0	3726/4	0	3830/8	0
3720/2	0	3723/4	0	3827/8	0
3717/2	0	3720/4	0	3824/8	0
3714/2	0	3717/4	0	3821/8	0
3711/2	0	3714/4	0	3818/8	0
3708/2	0	3711/4	0	3815/8	0
3704/2	0	3708/4	0	3811-T/8	0
TOTAL 2'S	0	TOTAL 4'S	0	TOTAL 8'S	0

TOTAL TAPS 0
 TAPS/MILE

PASSIVES, CABLE, CONNECTORS

MODEL	DESCRIPTION	QTY	MODEL	DESCRIPTION	QTY
			1.000	P-III CABLE	0
4-TFC-3	2-WAY SPLITTER	0	.750	P-III CABLE	0
4-TFC-8	DIP COUPLER	0	.500	P-III CABLE	0
4-TFC-12	DIR COUPLER	0	.412	P-III CABLE	0
4-TFC-377	3-WAY SPLITTER	0	EFI-1000	CONN.	0
FFE-8	IN-LINE EQUAL.	0	EFI-750	CONN.	0
625-TR8	TERMINATOR	0	EMI-500	CONN. (NFT)	0
ETE-625R	ADAPTER	0	EMI-412	CONN. (F/T)	0

STRAND MILES 0 FD/TK RATIO LE/MILE
 DIST MILES 0 TK AMPS/MILE
 TRUNK MILES 0 ACTIVES/MILE

(Figure 4)

((RLA)) ANYTOWN, USA
BILL OF MATERIALS/COST SHEET
 COX CABLE COMMUNICATIONS INC. 3/27/79

MILES- 0

TAP	QTY	UNIT COST	EXT COST	MODEL	DESCRIPTION	QTY	UNIT COST	EXT COST
				5-2-TC10R	TK/BR-ACC/ASC	0	0	0
				5-2-TDR	TK/BR-MAN	0	0	0
				5-2-TC1R	TK-ACC/ASC	0	0	0
				5-2-TR	TK-MAN	0	0	0
				5-2-0BR	INT/TERM BR	0	0	0
3732/2	0	0	0	5-2-E300-0	TK EQUALIZER	0	0	0
3729/2	0	0	0	5-2-E300-5	TK EQUALIZER	0	0	0
3726/2	0	0	0	5-2-E300-8	TK EQUALIZER	0	0	0
3723/2	0	0	0	5-2-E300-11	TK EQUALIZER	0	0	0
3720/2	0	0	0	5-2-E300-14	TK EQUALIZER	0	0	0
3717/2	0	0	0	5-2-E300-17	TK EQUALIZER	0	0	0
3714/2	0	0	0	5-2-E300-20	TK EQUALIZER	0	0	0
3711/2	0	0	0					
3708/2	0	0	0	5-S1	FEEDER MAKER	0	0	0
3704/2	0	0	0	5-S2	FEEDER MAKER	0	0	0
				5-S3	FEEDER MAKER	0	0	0
				5-S4	FEEDER MAKER	0	0	0
				TOTAL FFT-2'S-	0			
3735/4	0	0	0	5-LE/34	LINE EXTENDER	0	0	0
3732/4	0	0	0					
3729/4	0	0	0	5-EE300-0	L.E. EQUALIZER	0	0	0
3726/4	0	0	0	5-EE300-5	L.E. EQUALIZER	0	0	0
3723/4	0	0	0	5-EE300-8	L.E. EQUALIZER	0	0	0
3720/4	0	0	0	5-EE300-11	L.E. EQUALIZER	0	0	0
3717/4	0	0	0	5-EE300-14	L.E. EQUALIZER	0	0	0
3714/4	0	0	0	5-EE300-17	L.E. EQUALIZER	0	0	0
3711/4	0	0	0	5-EE300-20	L.E. EQUALIZER	0	0	0
3708/4	0	0	0					
				TOTAL FFT-4'S-	0			
3836/8	0	0	0	4-TFC-3	2-WAY SPLITTER	0	0	0
3833/8	0	0	0	4-TFC-8	DIR COUPLER	0	0	0
3830/8	0	0	0	4-TFC-12	DIR COUPLER	0	0	0
3827/8	0	0	0	4-TFC-377	3-WAY SPLITTER	0	0	0
3824/8	0	0	0	1.000	P-III CABLE	0	0	0
3821/8	0	0	0	.750	P-III CABLE	0	0	0
3818/8	0	0	0	.500	P-III CABLE	0	0	0
3815/8	0	0	0	.412	P-III CABLE	0	0	0
				EFI-1.000	CONNECTOR	0	0	0
				EFI-750	CONNECTOR	0	0	0
				EMI-500	CONNECTOR	0	0	0
				EMI-412	CONNECTOR	0	0	0
				EMI-500	CONN. (F/T)	0	0	0
				EMI-412	CONN. (F/T)	0	0	0
				TOTAL FFT-8'S-	0			
				ETE-625R	ADAPTER	0	0	0
				625-TR8	TERMINATOR	0	0	0
				FFE-8	IN-LINE EQUAL.	0	0	0
					POWER SUPPLY	0	0	0
				4-LPI	POWER COMBINER	0	0	0
				TOTAL TAPS-	0			
				TAPS/MILE -				
				TK AMPS PER MILE-	STRAND MILES-	0	TAPS COST/MILE-	0
				LE'S PER MILE-	TRUNK MILES-	0	CABLE COST/MILE-	
				ACTIVES PER MILE-	FEEDER MILES-	0	ELECTRONICS COST/MILE-	
				FD/TK RATIO-				

(Figure 5)