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DECUS NO.	8-351
TITLE	COMBIN LOADER
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COMPANY	University of California Berkeley, California
DATE	August 1970
SOURCE LANGUAGE	PAL

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COMBIN LOADER

DECUS Program Library Write-up

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1. INTRODUCTION

ComBIN is an extended utility loader for BIN and RIM format binary punched tapes. Functions include all standard BIN loader features, optional "autostart" (load-and-run) in any memory field, automatic selection of high or low speed input and prohibition of any attempt to load over itself wherever it resides.

ComBIN may be resident on any page of any memory field. It will load programs into any region of memory outside its own page. Either BIN or RIM tapes may be loaded by starting at the appropriate address; the same functions apply to both formats except that naturally no checksum checking or autostart is possible with RIM tapes.

The autostart function is the same as in other loaders such as "BIN Mk 4" (DECUS 5/8-48) with the addition of field selection; the starting address is indicated on the tape by an origin setting immediately preceding the checksum, the memory field used being the one most recently selected by a field setting. Such tapes are easily produced by any standard assembler or by the BIN punch routine. Autostart can be inhibited by setting the right-hand switch register bit down.

Either the high or low speed reader can be used, the correct one being activated automatically. Either "2000" code leader or blank tape may be initially over the reader head.

ComBIN is supplied as a tape in "ARK" format which is read by a 9-instruction initial loader (10 instructions for the ASR33 reader). It normally loads into the top page of memory, but the same tape may be used to put ComBIN on any desired page.

2. USING THE LOADER

The ComBIN loader is assumed to be already resident in the top page of field 0. If it is not already in core, see Section 3.3 and 3.4. For use with more than one field (4K) of memory, refer to Section 4.1.

2.1. Loading BIN Format Tapes

1. Put the tape to be loaded in the reader. The high speed reader should be used if available, otherwise the teletype reader. Either leader-code (channel 8 punched) or blank tape should be over the reading head.

2. Set the switch register to 7777, i.e., set the three "DATA FIELD" and three "INST FIELD" switches down, and all twelve "SWITCH REGISTER" switches up. (Also see Section 4.2 when using more than one field of memory.)
3. Press the "LOAD ADDRESS" switch. This sets starting address 7777 in the program counter.
4. Press "START". The tape should then begin reading in, and should stop on trailer-code (channel 8 punched) at the end of the punched program data. Subsequent action is described in the next section.

2.2. Actions Following Loading

A tape without an autostart address will cause a halt with the program counter at 7777. If it has been read correctly the accumulator will contain zero.

Any difference between the checksum accumulated during reading and that punched at the end of the tape appears as a non-zero value in the accumulator when the loader halts. Another attempt to read the tape may be made simply by moving it back to the beginning and pressing "CONTINUE". If it shows the same error a second time, the tape is faulty -- another error with a different value probably indicates reader problems.

If the tape has an autostart address (Section 5.1) a correct load will normally result in an automatic jump to this address. This jump may be suppressed by setting the rightmost bit (bit 11) of the switch register down after pressing "LOAD ADDRESS" (step 3 above); the loader will then halt at 7777 as for a non-autostart tape. If a checksum error occurs the loader always halts.

2.3. Loading RIM Format Tapes

The procedure to be followed for loading RIM tapes is the same as that for BIN tapes (Section 2.1) except that the starting address set up in step 2 is different.

1. Put the RIM tape to be loaded in the reader.
2. Set the switch register to 7770, i.e., put the "DATA FIELD" and "INST FIELD" switches down, set the leftmost nine "SWITCH REGISTER" switches up, and the rightmost three down. (See Section 4.2 for use with more than one field of memory.)
3. Press "LOAD ADDRESS".
4. Press "START".

The tape will read in, and stop on trailer-code at the end of the program data. RIM tapes have no checksum, so the loader will halt at 7777 with the accumulator non-zero. It is not possible to load more RIM tapes by pressing "CONTINUE"; the RIM loader section must be started at 7770 each time.

2.4. Loader Self-Protection

If a BIN or RIM tape attempts to load into the page occupied by the loader itself, the program immediately comes to a "permanent" halt at 7757; pressing "CONTINUE" at this point will have no effect. Other tapes can be loaded by restarting in the normal way.

3. CORE REQUIREMENTS AND INITIAL LOADING PROCEDURE

3.1. Core Space Occupied by the Loader

The loader may reside on any one page of any memory field; unless there are special requirements this is normally the last page. The loader occupies almost the whole page, although the first six locations on the page are actually free for other uses if desired; they cannot, of course, be loaded directly.

3.2. "ARK" Format Initial Loader

For initially loading into core, ComBIN is provided as a tape in "ARK" format. This is read in by a short initial loader deposited in the first locations of page zero.

3.3. Initial Loading Procedure (High-Speed Tape Reader)

For loading into more than 4K of memory see Section 4.3.

1. Put the "ARK" format tape in the reader with blank tape over the reading head.

2. Deposit the 9-instruction initial loader given in Table 1 into memory using the console switches as follows:

Set 0000 in the switch register; press "LOAD ADDRESS"

Set the first instruction (6014) in the switch register; lift the "DEPOSIT" key

Set the next instruction in the switches and lift "DEPOSIT"; repeat this step until all values in the table have been deposited in memory.

3. Set a starting address of 0000. (Set the switch register to 0000; press "LOAD ADDRESS".)

4. Press "START". The tape will read in and stop at the end of data with the program counter at 7777.

The ComBIN loader is now ready for use.

3.4. Initial Loading from the Teletype Reader

The steps to be followed are similar to 3.3 above, except that the initial loader in Table 2 should be used. Note that the starting address for this is 0001.

4. USE WITH EXTENDED MEMORY OPTION

4.1. Loading BIN and RIM Tapes in Extended Memory

When extra 4K memory banks are installed, the "DATA FIELD" and "INSTRUCTION FIELD" switches are activated and must always be set to the desired fields at the time the loader starting address -- 7777 or 7770 -- is set (see step 2 in Sections 2.1 and 2.3).

The INSTRUCTION FIELD must be that in which the loader resides. The DATA FIELD switches select the field into which loading will begin, but BIN program tapes may have characters which change to other fields during loading.

The self-protection feature only affects the page in which the loader actually resides. Equivalent pages in other fields are not protected.

4.2. Initial Loading of ComBIN into a Field Other Than Zero

The initial "ARK" loader (Sections 3.3 and 3.4) must be run in page 0 of the bank in which ComBIN is to reside. In other words, both INSTRUCTION FIELD and DATA FIELD switches must be set to this field before beginning to key the initial loader into memory, and must remain so until loading is complete.

5. OTHER NOTES

5.1. Autostart Tapes

An autostart BIN program tape is one in which the last item before the checksum is an origin setting. When such a tape is read by ComBIN, it will jump to the address specified by this origin in the currently selected DATA FIELD -- unless a checksum error has occurred, or autostart is inhibited by bit 11 of the switch register being down.

An autostart tape may be produced using the PALIII or other assembler, simply by immediately preceding the terminating dollar sign by the desired origin setting. The BIN punch program (Digital 8-5-U) will also produce such a tape if a final block is added in which the "initial

address" is the desired starting address and the "final address" is one less than the initial address.

5.2. Residence in other Core Pages

When developing special operating systems and so on, which may need to occupy the last page of core, it is often convenient to have a loader elsewhere in memory. ComBIN will operate in any page without modification. The initial loader may be used to deposit it in the required place by changing the initial value placed in the auto-index pointer location (location 10 for the high speed reader, 12 for the low speed); this should be set to the address of the first location on the desired page minus two; e.g., to load into locations 5600-5777, set the pointer location to 5576. The only other difference is that the tape will not stop at the end of loading, and must be halted manually.

5.3. Disc Monitor

The HFL disc monitor system DIRE has a ComBIN loader in locations 5600-5777. Starting address for BIN tapes is 5777, for RIM tapes 5770.

5.4. Useful Locations

The checksum accumulated during reading the tape is held in location 7775. The deposit-location pointer is location 7774; this holds the address of the location which would be loaded next -- or the starting address of an autostart program.

5.5. "ARK" Loader Operation

This is probably the shortest loader that can directly load arbitrary data words into any block of memory; it thus differs from the "bootstrap" loaders such as "HELP", which must first overlay themselves with a more comprehensive routine. "ARK" is very quick to key in, but is slower than HELP when the teletype reader is used. The system was originated by Brian J. Mercer of Imperial College, London.

12-bit words are read off the tape as groups of four characters. The first character of each group has channel 7 punched, and the 6 most significant bits of the word in channels 1 to 6; the following characters each contain a further two bits of the word. The advantage of this format is that the word can be assembled simply by an "RTL" instruction; when the link is set (by the channel 7 punch of the first character being shifted into it) assembly is complete. Complete words are deposited in successive locations using an auto-index register.

When the loader is keyed into memory, the auto-index register is set so that the first location loaded will be itself, and so the first word it reads from the tape sets the beginning of the block of memory to be filled. If one wants to load the tape into a different area of memory, all that is necessary is to preload the auto-index with the

desired block initial address minus two -- allowing one location to be filled with the unrequired address from tape, and one other because the auto-index is incremented before depositing.

In general, there is no way for the loader to detect the end of the data, but because the last location loaded is normally the top one of the field -- 7777 -- further data will wrap around and begin to fill up from location 0. This behavior is used to overlay the ARK loader with a jump to the halt in ComBIN at 7776, so that tape reading stops and ComBIN is immediately ready to use.

TABLE 1 - 'ARK' MINIMUM LOADER
 ***** FOR INITIAL STORAGE OF COMBIN

HIGH SPEED READER VERSION

Core loc:	Load with:	
0000	6014	RFC
0001	6011	RSF
0002	5001	JMP .-1
0003	7106	CLL RTL
0004	6016	RRB
0005	7430	SZL
0006	3410	DCA I 10
0007	5001	JMP 1
0010	0007	.-1

SA=0000
 START ON BLANK LEADER

TABLE 2 - 'ARK' MINIMUM LOADER

LOW SPEED VERSION

Core loc:	Load with:	
0001	6031	KSF
0002	5001	JMP .-1
0003	7106	CLL RTL
0004	3036	DCA 36
0005	6036	KRB
0006	1036	TAD 36
0007	7430	SZL
0010	3412	DCA I 12
0011	5001	JMP 1
0012	0011	.-1

SA=0001
 START ON BLANK LEADER

1. 3 /COMBIN LOADER
 1. 4 /PETER GOODEVE - AUGUST 1970
 1. 5 /HUMAN FACTORS LAB
 1. 6 /UNIVERSITY OF CALIFORNIA, BERKELEY

1. 8 /ORIGIN SETTING
 1. 9
 1. 10 7600 LDPAGE=7600

1. 12 7607 *LDPAGE+7

1. 14 07607 0000 ORGSW, 0
 1. 15
 1. 16 07610 0000 TOPHAF, 0

1. 18 07611 0000 BEGG, 0
 1. 19 07612 4246 JMS READ /GET CHAR
 1. 20 07613 7106 CLL RTL
 1. 21 07614 7006 RTL
 1. 22 07615 7500 SMA /CHAN 8 PUNCHED?
 1. 23 07616 3246 DCA HOLD /NO - STORE SHIFTED VALUE
 1. 24 07617 5611 JMP I BEGG /YES - LEAVE IN AC

1. 26 07620 4246 JMS READ
 1. 27 07621 1356 RUBOUT, TAD KM376
 1. 28 07622 7750 SPA SNA CLA
 1. 29 07623 5220 JMP .-3
 1. 30 07624 5212 JMP BEGG+1

1. 32 07625 1210 END, TAD TOPHAF /FORM TAPE CHKSUM
 1. 33 07626 7106 CLL RTL
 1. 34 07627 1337 TAD WORD2
 1. 35 07630 7041 RIMBIN, CIA
 1. 36 07631 1375 TAD CKSUM /COMPARE WITH CHARS READ
 1. 37 07632 7450 SNA /DO THEY AGREE?
 1. 38 07633 2207 ISZ ORGSW /YES - IS THIS AUTOSTART?
 1. 39 07634 5376 JMP STOP /NO

1. 41
 1. 42 07635 7604 EXIT, LAS /AUTOSTART TAPE
 1. 43 07636 7010 PAR
 1. 44 07637 7520 SNL CLA /SR 11 UP?
 1. 45 07640 5376 JMP STOP /NO
 1. 46 07641 1373 TAD IFLD
 1. 47 07642 6214 RDF /SET INST FIELD
 1. 48 07643 3244 DCA .+1 /TO DATA FIELD
 1. 49 07644 6202 CIF
 1. 50 07645 5774 JMP I ORIG /AND JUMP TO START

1	52		HOLD,		
1	53	07646	0000 READ,	0	
1	54	07647	0031	KSF	
1	55	07650	5355	JMP TRYHI	
1	56	07651	0036	KRB	
1	57	07652	3354	DCA CHAR	
1	58	07653	1354	TAD CHAR	
1	59	07654	5646	JMP I READ	
1	60	07655	6011 TRYHI,	RSF	
1	61	07656	5247	JMP READ+1	
1	62	07657	6016	RRB RFC	
1	63	07660	5252	JMP READ+4	
1	65	07661	0000 PROT,	0	
1	66	07662	3210	DCA TOPHAF	/HOLD DATA VALUE
	67	07663	1374	TAD ORIG	
1	68	07664	0274	AND M7600	/FIND CURRENT DATA PAGE
1	69	07665	6214	RDF	/COMBINE WITH DATA FIELD
1	70	07666	1355	TAD THISPG	/COMPARE WITH LEADER PAGE
1	71	07667	7650	SNA CLA	/SAME?
1	72	07670	5356	JMP CLANG	/YES - HOLLER
1	73	07671	1210	TAD TOPHAF	
1	74	07672	3774	DCA I ORIG	
1	75	07673	5661	JMP I PROT	
1	77		M7600,		
1	78	07674	7600 BEGIN,	7600 /CLA	
1	79	07675	1310	TAD CIALOC	/SET FOR BIN TAPES
1	80	07676	3230 BEGIN2,	DCA RIMBIN	
1	81	07677	6032	KCC	/INITIALIZE DEVICES
1	82	07700	6014	RFC	
1	83	07701	4211	JMS BEGG	/LEADER LOOP
1	84	07702	1354	TAD CHAR	/AC NON-ZERO IF CHAN 8
1	85	07703	7770	SZL SPA SNA CLA	/CHAN 8 PUNCHED OR BLANK?
1	86	07704	5301	JMP .-3	/YES - STILL LEADER
1	87				
1	88	07705	1211 PRSET,	TAD BEGG	/PICK UP SR ENTRY
1	89	07706	0274	AND M7600	/CONVERT TO PAGE
1	90	07707	6224	RIF	/COMBINE WITH INST FIELD
1	91	07710	7041 CIALOC,	CIA	
1	92	07711	3355	DCA THISPG	/PAGE PROTECT MARKER
1	93				
1	94	07712	3375 GO,	DCA CKSUM	
1	95	07713	1246	TAD HOLD	/VALUE FROM LAST BEGG
1	96	07714	7510	SPA	/IF FIELD SETTING, NO 2ND CHAR
1	97	07715	5322	JMP ONECHR	/SO SET WORD2 TO CDF
1	98	07716	3210	DCA TOPHAF	/OTHERWISE PUT AWAY WORKING VALUES
1	99	07717	1354	TAD CHAR	
1	100	07720	3352	DCA WORD1	
1	101	07721	4246	JMS READ	/SECOND CHAR
1	102	07722	3337 ONECHR,	DCA WORD2	
1	103	07723	4211	JMS BEGG	/LOOK AHEAD
1	104	07724	7450	SNA	/SPECIAL (BIT 8)?
1	105	07725	5337	JMP ONWD	/NO

1.	106	07726	7104	BIT8,	CLL RAL	
1.	107	07727	7550		SNA CLA	/TRAILER?
1.	108	07730	5225		JMP END	/YES
1.	109	07731	1354		TAD CHAR	/NO
1.	110	07732	1356		TAD KM376	/RUBOUT?
1.	111	07733	7540		SMA SZA	
1.	112	07734	5221		JMP RUBOUT	/YES - IGNORE UNTIL NEXT ONE
1.	113	07735	1367		TAD KFLD	/CONVERT TO FIELD SETTING
1.	114	07736	3246		DCA HOLD	
1.	115			ONWD,		
1.	116	07737	0000	WORD2,	0	
1.	117	07740	1337		TAD WORD2	
1.	118	07741	7710		SPA CLA	/WAS IT FIELD SETTING?
1.	119	07742	5313		JMP GO+1	/YES - SKIP THE REST OF SEG
1.	120	07743	1210		TAD TOPHAF	
1.	121	07744	7106		CLL RTL	/TOP 6 BITS + ORIG MARK
1.	122	07745	1337		TAD WORD2	/AND BOTTOM 6
1.	123	07746	7430		SZL	/ORIGIN?
1.	124	07747	5360		JMP SETORG	/YES
1.	125	07750	4261	FILL,	JMS PROT	/DEPOSIT DATA POINT (IF ALLOWED)
1.	126	07751	2374		ISZ ORIG	/BUMP POINTER
1.	127	07752	0000	WORD1,	0	/AND X'
1.	128	07753	5362		JMP CHEX	
1.	130					
1.	131	07754	0000	CHAR,	0	
1.	132	07755	0000	THISPG,	0	
1.	134			CLANG,		
1.	135	07756	7402	KM376,	HLT	
1.	136	07757	5356		JMP .-1	
1.	138	07760	3374	SETORG,	DCA ORIG	
1.	139	07761	7240		CLA CMA	
1.	140					
1.	141	07762	3207	CHEX,	DCA ORGSW	
1.	142	07763	1352		TAD WOPD1	/FORM CHKSUM
1.	143	07764	1337		TAD WORD2	
1.	144	07765	1375		TAD CKSUM	
1.	145	07766	5312		JMP GO	
1.	146					
1.	147	07767	6277	KFLD,	6277	
1.	149	07770	7200	RIM,	CLA	
1.	150	07771	1350		TAD FILL	/SET FOR RIM TAPES
1.	151	07772	5276		JMP BEGIN2	
1.	153	07773	6202	IFLD,	CIF	
1.	155	07774	0000	ORIG,	0	
1.	156					
1.	157	07775	0000	CKSUM,	0	

1. 159 07776 7402 STOP, HLT
 1. 160 07777 5274. JMP BEGIN
 1. 161
 1. 162. \$

BEGG	7611	18/01*	24/01	30/01	83/01	88/01	103/01
BEGIN	7674	78/01*	160/01				
BEGIN2	7676	80/01*	151/01				
BIT8	7726	106/01*					
CHAR	7754	57/01	58/01	84/01	99/01	109/01	131/01*
CHEX	7762	128/01	141/01*				
CIALOC	7710	79/01	91/01*				
CKSUM	7775	36/01	94/01	144/01	157/01*		
CLANG	7756	72/01	134/01*				
END	7625	32/01*	108/01				
EXIT	7635	42/01*					
FILL	7750	125/01*	150/01				
GO	7712	94/01*	119/01	145/01			
HOLD	7646	23/01	52/01*	95/01	114/01		
IFLD	7773	46/01	153/01*				
KFLD	7767	113/01	147/01*				
KM376	7756	27/01	110/01	135/01*			
LDPAGE	7600	10/01*	12/01				
M7600	7674	68/01	77/01*	89/01			
ONECHR	7722	97/01	102/01*				
ONWD	7737	105/01	115/01*				
ORGSW	7607	14/01*	38/01	141/01			
ORIG	7774	50/01	67/01	74/01	126/01	138/01	155/01*
PROT	7661	65/01*	75/01	125/01			
PRTSET	7705	88/01*					
READ	7646	19/01	26/01	53/01*	59/01	61/01	63/01
RIF	6224	1/01*	90/01				101/01
RIM	7770	149/01*					
RINBIN	7630	35/01*	80/01				
RUBOUT	7621	27/01*	112/01				
SETORG	7760	124/01	138/01*				
STOP	7776	39/01	45/01	159/01*			
THISPG	7755	70/01	92/01	132/01*			
TOPHAF	7610	16/01*	32/01	66/01	73/01	98/01	120/01
TRYHI	7655	55/01	60/01*				
WORD1	7752	100/01	127/01*	142/01			
WORD2	7737	34/01	102/01	116/01*	117/01	122/01	143/01

