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THE POTENTIAL OF PROGRAMMABLE CALCULATORS FOR PROCESSING SMALL BUSINESS SIMULATIONS

Kenneth R. Goosen, University of Arkansas at Little Rock

In the last 18 months Texas Instruments and Hewlett Packard have marketed programmable calculators which have tremendous programming capability. These calculators have the capability of storing programs on magnetic cards, thus eliminating the need to key-in programs each time an application is desired. The SR 52 and HP 97 both have 20 memory registers and 10 user-definable keys. Each calculator has 224 program storage locations. In addition to the standard CRT display for digital information, output may be obtained on a print unit. Each calculator contains programming features, such as conditional and unconditional branching; logical decision functions; subroutines, etc. Except for the limitations on amount of memory and printing capability these calculators have the capability to process scientific problems such as those processed on larger computers. Since the bases of all computerized business games are mathematical models, these calculators have the potential to process business simulations.

The purpose of this paper is to report on an experiment in which a simulation was processed on a Texas Instruments SR 52. The simulation, an absorption costing accounting model modified to include a demand function, was specially designed for the experiment. This simulation apart from its purpose to test the potential of programmable calculators was designed for use in managerial and cost accounting courses.

Absorption costing represents an important idea in these courses. In absorption costing, two variables determine net income: production and sales. A significant feature of the absorption costing model (also generally considered to be a major weakness) is that income can be increased merely by producing more units for inventory separate from demand. By producing for inventory fixed overhead can be absorbed into inventory.

The absorption costing simulation model used then was relatively simple in that it required the participants to make only two decisions: price and units manufactured. The complete model used is presented below:

$$I = P(Q^{s}) - \left[U^{bi}(C^{bi}) + Q^{p}(C^{ei}) + U^{ei}(C^{ei})\right] - E - O^{ua} \qquad (1)$$

I	= net income	Q^{p}	= quantity produced
P	= price	U^{ei}	= units of end. inv.
Q^{s}	= quantity sold	C^{ei}	= cost per unit-end. inv.
U^{bi}	= units-beg. inv.	E	= operating expenses
C^{bi}	= cost per unit-beg.inv.	O^{ua}	= underapplied overhead

In the equation, price and quantity manufactured are the independent variables; therefore, these variables represent the two decisions that must be made by the students. Values assigned to the other variables are the game parameters which are fixed during the play of the game.

In addition to the above equation the following equations were necessary in order to have an operational model:

$$Q^s = (P_o - P) \div k \quad (2)$$
$$F^{or} = F^m \div Q^n \quad (3)$$
$$U^{ei} = U^{bi} + (Q^P - Q^s) \quad (4)$$
$$C^{ei} = V^l + V^m + V^o + F^{or} \quad (5)$$
$$O^{ua} = F^m - [F^{or} (Q^P)] \quad (6)$$

P_o = price at zero demand
k = price change coefficient
F^{or} = fixed overhead rate
Q^n = normal prod. capacity
V^l = labor cost per product
V^m = material cost per product
V^o = variable overhead rate
F^m = fixed mfg. overhead

There is only one functional relationship in the game: quantity sold is a function only of price. Equation (2) expresses this relationship which is derived from the conventional revenue function: $R = PQ - k(Q^2)$. The programming of this model required 210 storage locations. The coding for the program is presented in Exhibit I. Since the SR 52 has 224 storage locations the capacity of the calculator was not fully utilized. However, if the model had required more than 224 storage locations a second magnetic card could have been used. Through careful programming larger models can be segmented and then linked. However, if many cards are required then processing a model can become rather cumbersome as only one card can be processed at a time. With the above model processing was very efficient in that a set of decisions was processed in less than 10 seconds. The program could be loaded and ready for use in less than 15 seconds.

The output from the programmable calculator can be either CRT display or paper tape from the print units. For purposes of the simulation experiment, display from the CRT would not have been very effective in that (1) processing would have to be stopped at each point where a game value is computed, and (2) that game value would have to be copied down by hand. The PC 100 print unit eliminates this delay in processing. The entire set of values can be printed within a few seconds. Spacing of the printed values can be programmed. The absence of alphabetic output was overcome by use of preprinted income statement formats. Paper output containing the computed game values was affixed to the preprinted forms. An example of the final output is illustrated in Exhibit II.

The simulation was used in the fall semester of 1976 at UALR in a class of 12 MBA students. The game results were obtained for four periods during a 75-minute class. The team decisions were immediately processed in the classroom on the SR 52 and attached PC 100 print unit. The students were divided into four teams of 3 students each. The students were told explicitly that the game was based on an absorption costing model. Furthermore, equation (1) was written on the blackboard. The students were given all values assigned to the parameters of the game with the exception of k. Additionally, the students did not know the exact nature of equation (2). Approximately six weeks earlier the students had been given two classroom lectures on absorption costing.

Since the students were supposedly quite knowledgeable about absorption costing and since the simulation was of a relatively simple nature, I was concerned that the exercise might not be of any learning benefit to the students. It turned out that my concern was completely unjustified.

Exhibit I - SR 52 CODING INSTRUCTIONS FOR ABSORPTION COSTING SIMULATION

LOC	CODE	KEY	LOC	CODE	KEY	LOC	CODE	KEY	LOC	CODE	KEY
000	46	2ND LBL	053	95	=	106	43	RCL	159	75	-
001	11	A	054	98	2ND PRT	107	00	0	160	53	(
002	42	STO	055	42	STO	108	06	6	161	43	RCL
003	01	1	056	00	0	109	65	x	162	00	0
004	01	1	057	06	6	110	43	RCL	163	07	7
005	81	HLT	058	53	(	111	00	0	164	65	x
006	46	2ND LBL	059	43	RCL	112	01	1	165	43	RCL
007	12	B	060	00	0	113	54	)	166	01	1
008	42	STO	061	03	3	114	54	)	167	00	0
009	00	0	062	85	+	115	95	=	168	54	)
010	01	1	063	53	(	116	98	2ND PRT	169	98	2ND PRT
011	81	HLT	064	43	RCL	117	99	PAP	170	99	PAP
012	46	2ND LBL	065	00	0	118	42	STO	171	54	)
013	13	C	066	01	1	119	00	0	172	98	2ND PRT
014	42	STO	067	75	-	120	08	8	173	99	PAP
015	00	0	068	43	RCL	121	53	(	174	75	-
016	03	3	069	00	0	122	43	RCL	175	43	RCL
017	81	HLT	070	02	2	123	01	1	176	01	1
018	46	2ND LBL	071	54	)	124	01	1	177	02	2
019	14	D	072	54	)	125	65	x	178	98	2ND PRT
020	42	STO	073	95	=	126	53	(	179	75	-
021	00	0	074	98	2ND PRT	127	43	RCL	180	43	RCL
022	04	4	075	42	STO	128	00	0	181	00	0
023	81	HLT	076	00	0	129	02	2	182	08	8
024	46	STO	077	07	2	130	54	(	183	98	2ND PRT
025	16	2ND A'	078	53	(	131	54	(	184	99	PAP
026	53	(	079	43	RCL	132	98	2ND PRT	185	95	=
027	43	RCL	080	01	1	133	99	PAP	186	98	2ND PRT
028	01	1	081	03	3	134	75	-	187	99	PAP
029	06	6	082	85	+	135	53	(	188	99	PAP
030	75	-	083	43	RCL	136	53	(	189	43	RCL
031	43	RCL	084	01	1	137	43	RCL	190	01	1
032	01	1	085	04	4	138	00	0	191	01	1
033	01	1	086	85	+	139	03	3	192	98	2ND PRT
034	54	)	087	43	RCL	140	65	x	193	43	RCL
035	55	÷	088	01	1	141	43	RCL	194	00	0
036	43	RCL	089	05	5	142	00	0	195	01	1
037	01	1	090	85	+	143	04	4	196	98	2ND PRT
038	07	7	091	43	RCL	144	54	)	197	81	HLT
039	95	=	092	00	0	145	98	2ND PRT	198	43	RCL
040	42	STO	093	06	6	146	85	+	199	01	1
041	00	0	094	54	)	147	53	(	200	00	0
042	02	2	095	95	=	148	43	RCL	201	42	STO
043	98	2ND PRT	096	98	2ND PRT	149	00	0	202	00	0
044	53	(	097	42	STO	150	01	1	203	04	4
045	43	RCL	098	01	1	151	65	x	204	43	RCL
046	00	0	099	00	0	152	53	(	205	00	0
047	05	5	100	53	(	153	43	RCL	206	07	7
048	55	÷	101	43	RCL	154	01	1	207	42	STO
049	43	RCL	102	00	0	155	00	0	208	00	0
050	00	0	103	05	5	156	54	)	209	03	3
051	09	9	104	75	-	157	54	)	210	81	HLT
052	54	)	105	53	(	158	98	2ND PRT			

Exhibit II

ABSORPTION COSTING SIMULATION RESULTS

RESULTS OF DECISIONS	Period 1	Period 2	Period 3	Period 4
Quantity sold	20.	30.	40.	50.
Fixed overhead rate	$ 5.	$ 5.	$ 5.	$ 5.
Ending inventory (units)	30.	20.	20.	70.
Mfg. cost per unit	$ 14.	$ 14.	$ 14.	$ 14.
Under-applied overhead	$ 250.	$ 400.	$ 350.	$ 0.
Sales	$ 520.	$ 720.	$ 880.	$ 1000.
Beginning inventory	$ 0.	$ 420.	$ 420.	$ 280.
Cost of goods mfd.	700.	280.	420.	1400.
Ending inventory	420.	280.	280.	980.
Cost of goods sold	$ 280.	$ 420.	$ 560.	$ 700.
Expenses:				
Operating	$ 200.	200.	$ 200.	$ 200.
under-applied overhead	250.	400.	350.	0.
Net income	$ -210.	$ -300.	$ -230.	$ 100.
DECISIONS				
Price	$ 26.	$ 24.	$ 22.	$ 20.
Units manufactured	50.	20.	30.	100.

Participation in the simulation experiment by the students indicated that the students' knowledge of absorption costing was somewhat superficial. This was revealed by the students' failure to immediately develop a game strategy inherently contained in the nature of the absorption costing model. Other things being equal, the best strategy would have been **t** always produce at full capacity regardless of the demand. For the firs: three periods of play all participants attempted to adjust production to demand which was determined by price. In absorption costing, assuming no carrying costs, income can always be increased by producing in excess of demand. It was not until the fourth period of play that several of the teams suddenly realized the significance of the simulation being based on an absorption costing model. Some of the students were embarrassed that they had not thought to apply the theory of absorption costing sooner in the game. The students were unanimous in stating that the significance of absorption costing was not likely to be forgotten.

SUMMARY

The two important findings resulting from the simulation experiment with the programmable calculator were: (1) simulations can be processed in the classroom on programmable calculators, and (2) simulations processed on programmable calculators can result in significant learning experiences.