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Approach to Automated Construction Cost Estimating

Approche d'une estimation automatique des coûts de construction

Automatisierte Kosten-Kalkulation

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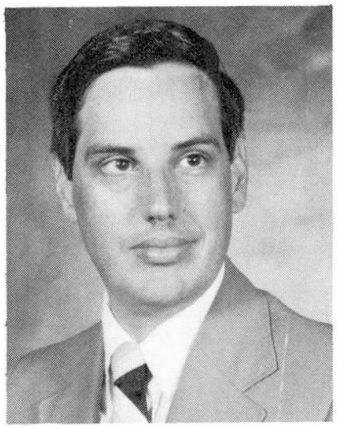


Robert Williamson, born 1946, B.S. degree in aerospace eng. at Park College of St. Louis Univ., M.S. degree in eng. management at Univ. of Missouri – Rolla. For the past 13 years, involved with developing and implementing project management scheduling and cost control systems. Currently responsible for MCAUTO's new construction cost estimating system.

SUMMARY
The article describes a computerized construction cost estimating system. The system uses a comprehensive cost data base composed of more than 37000 detail items, labor wages rates and major material prices which may be supplemented or overridden by the estimator. Work packages calculate quantities and select the proper items from the cost data. The equations and logic of the work packages may be modified without reprogramming. Flexible reporting is achieved by selection criteria which control selecting and sorting of reports.

RESUME
Un système informatisé d'estimation des coûts de construction est présenté. Il met à contribution une base de données des coûts portant sur plus de 37000 articles, ainsi que sur les taux horaires et les prix des matières premières par région. Ces données peuvent être complétées ou modifiées par l'utilisateur. Le système calcule les quantités et extrait les valeurs appropriées de la base de données. La logique et la formulation des fonctions peuvent être modifiées sans reprogrammation. L'édition des rapports est flexible, elle peut être effectuée sur la base de critères de sélections multiples et de tri.

ZUSAMMENFASSUNG
Dieser Bericht beschreibt ein EDV-Kosten-Kalkulationssystem für Bauwerke. Das Programm benützt eine umfassende Kosten-Datenbank, bestehend aus über 37000 Detail-Einheiten, örtlichen Arbeitslöhnen und Materialpreisen, die vom Kalkulator hinzugefügt oder überschrieben werden können. Verschiedene Programmteile beschreiben die Mengen und wählen die richtigen Einheiten aus den Kosten-Daten. Die einzelnen Abhängigkeiten können ohne Neuprogrammierung geändert werden.

INTRODUCTION

In January 1980, a team was formed consisting of the R. S. Means Company, McDonnell Douglas Automation Company (MCAUTO), and Comprehensive Management Services, Inc./Smith, Hinchman, & Grylls (CMSI•SH&G). The objective of the partnership was to develop a powerful, comprehensive automated tool to aid in the preparation of detailed construction estimates. The system was to be flexible and would allow the estimator to use his judgement in easily overriding standard cost information and equations used in the system. Another major design consideration was to make the system flexible and open so that it could be easily adaptable to systems and budget level estimates without reprogramming. ESTEK is the result of the combined efforts of the three organizations.

The R. S. Means Company has been the United State's leading publisher of construction cost books for the past 40 years. They are responsible for the cost data base used by ESTEK.

CMSI • SH&G are members of the Smith Group, an affiliation of ten architectural/ engineering firms. They are responsible for the algorithms and decision logic used in ESTEK's work packages.

MCAUTO, a division of McDonnell Douglas Corp., is one of the leading data processing service bureaus. MCAUTO's responsibilities are for the system analysis, programming, data processing services, and support of ESTEK. Figure 1 shows the basic system outline of ESTEK.

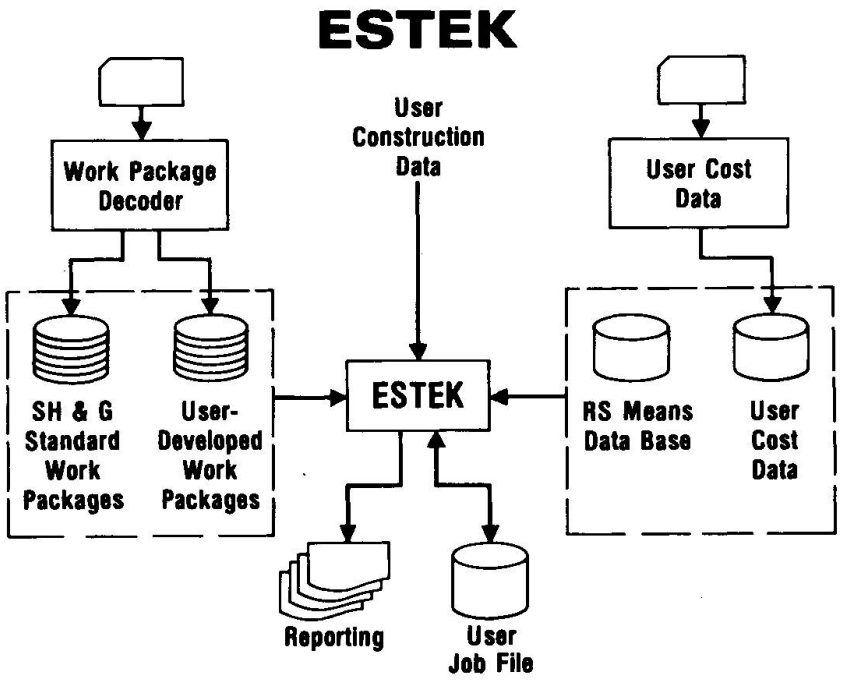


Figure 1

COST DATA BASE

The ESTEK Cost Data Base has more than 37,000 line items developed from the R. S. Means publications, Building Construction Data and Mechanical & Electrical Cost Data (see Figure 2). Labor rates for 46 trades are used to compute the installation costs. Material prices are derived by contacting manufacturers, dealers, and distributors throughout the United States and Canada.

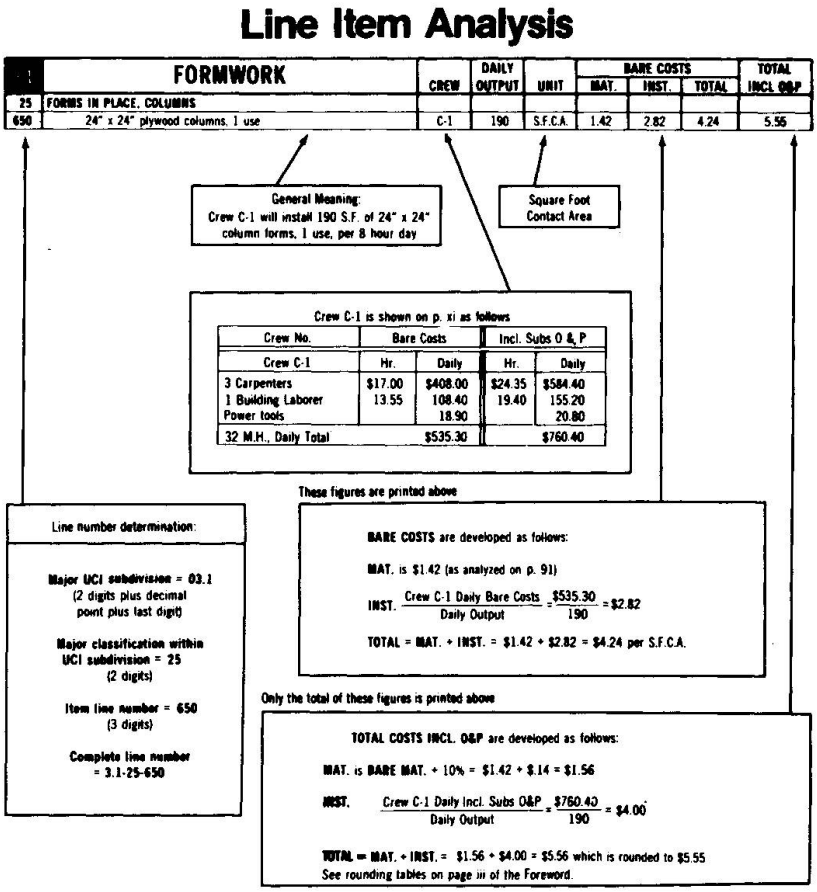


Figure 2

The labor rates for 46 construction trades and material prices for 109 key materials have been used to develop zip code location factors. These factors are used to compute the cost for any specific location defined by the first 3 digits of the Postal Zip Code.

The format of the ESTEK Cost Data Base is illustrated in Figure 3. The definition of the column titles is as follows:

1. UCI Code is patterned after the 16-division Uniform Construction Index, adopted by the American Institute of Architects, Associated General Constructors of America, Inc. and the Construction Specifications Institute, Inc. The system is widely used by most segments of the building industry.

   (Example 03.1-250-6500) = FORMWORK

2. UNIFORMAT Number is a U. S. Government General Services Administration (GSA) logical numbering framework for classification of building systems. It redefines the 16 Trade Systems into 12 Building Systems.

   (Example 0311) = SUPERSTRUCTURE STRUCTURAL FRAME

Building Construction Cost Data

(1) UCI CODE	(2) UNI-FORMAT	(3) DESCRIPTION	(4) MAT CODE	(5) MAT FACTOR	(6) WKMEN COMP	(7) CREW CODE	(8) DAILY OUTPUT	(9) UNIT	(10) BARE COSTS MAT	INST	TOTAL	(11) TOTAL INCL O&P
03.1-250-5000	0311	FRMS IN PLC COL PLY 8" SQ 1 USE	PBB6	.0029	5213	C1	165.00	S.F.C.A.	1.80	3.24	5.04	6.60
03.1-250-5050	0311	FRMS IN PLC COL PLY 8" SQ 2 USE	PBB6	.0015	5213	C1	195.00	S.F.C.A.	1.03	2.75	3.78	5.05
03.1-250-5100	0311	FRMS IN PLC COL PLY 8" SQ 3 USE	PBB6	.0011	5213	C1	210.00	S.F.C.A.	.78	2.55	3.33	4.48
03.1-250-5150	0311	FRMS IN PLC COL PLY 8" x 8" SQ 4 USE	PBB6	.0009	5213	C1	215.00	S.F.C.A.	.65	2.49	3.14	4.25
03.1-250-5500	0311	FRMS IN PLC COL PLY 12" SQ 1 USE	PBB6	.0025	5213	C1	180.00	S.F.C.A.	1.60	2.97	4.57	6.00
03.1-250-5550	0311	FRMS IN PLC COL PLY 12" SQ 2 USE	PBB6	.0014	5213	C1	210.00	S.F.C.A.	.92	2.55	3.47	4.63
03.1-250-5600	0311	FRMS IN PLC COL PLY 12" SQ 3 USE	PBB6	.0010	5213	C1	220.00	S.F.C.A.	.69	2.43	3.12	4.22
03.1-250-5650	0311	FRMS IN PLC COL PLY 12" SQ 4 USE	PBB6	.0008	5213	C1	225.00	S.F.C.A.	.57	2.38	2.95	4.01
03.1-250-6000	0311	FRMS IN PLC COL PLY 16" SQ 1 USE	PBB6	.0024	5213	C1	185.00	S.F.C.A.	1.46	2.89	4.35	5.70
03.1-250-6050	0311	FRMS IN PLC COL PLY 16" SQ 2 USE	PBB6	.0013	5213	C1	215.00	S.F.C.A.	.84	2.49	3.33	4.46
03.1-250-6100	0311	FRMS IN PLC COL PLY 16" SQ 3 USE	PBB6	.0009	5213	C1	230.00	S.F.C.A.	.63	2.33	2.96	4.00
03.1-250-6150	0311	FRMS IN PLC COL PLY 16" SQ 4 USE	PBB6	.0008	5213	C1	235.00	S.F.C.A.	.52	2.28	2.80	3.81
03.1-250-6500	0311	FRMS IN PLC COL PLY 24" SQ 1 USE	PBB6	.0023	5213	C1	190.00	S.F.C.A.	1.42	2.82	4.24	5.55
03.1-250-6550	0311	FRMS IN PLC COL PLY 24" SQ 2 USE	PBB6	.0013	5213	C1	220.00	S.F.C.A.	.81	2.43	3.24	4.35
03.1-250-6600	0311	FRMS IN PLC COL PLY 24" SQ 3 USE	PBB6	.0009	5213	C1	235.00	S.F.C.A.	.60	2.28	2.88	3.90
03.1-250-6650	0311	FRMS IN PLC COL PLY 24" SQ 4 USE	PBB6	.0008	5213	C1	240.00	S.F.C.A.	.50	2.23	2.73	3.72
03.1-250-7000	0311	FRMS IN PLC COL PLY 36" SQ 1 USE	PBB6	.0027	5213	C1	200.00	S.F.C.A.	1.53	2.68	4.21	5.50
03.1-250-7050	0311	FRMS IN PLC COL PLY 36" SQ 2 USE	PBB6	.0015	5213	C1	230.00	S.F.C.A.	.86	2.33	3.19	4.25
03.1-250-7100	0311	FRMS IN PLC COL PLY 36" SQ 3 USE	PBB6	.0011	5213	C1	245.00	S.F.C.A.	.64	2.18	2.82	3.81
03.1-250-7150	0311	FRMS IN PLC COL PLY 36" SQ 4 USE	PBB6	.0009	5213	C1	250.00	S.F.C.A.	.53	2.14	2.67	3.62
03.1-250-7500	0311	FRMS IN PLC COL STL PLY 8" SQ 4 U/M	PBB6	.0006	5213	C1	290.00	S.F.C.A.	.54	1.85	2.39	3.22
03.1-250-7550	0311	FRMS IN PLC COL STL PLY 10" SQ 4U/M	PBB6	.0005	5213	C1	300.00	S.F.C.A.	.43	1.78	2.21	3.01
03.1-250-7600	0311	FRMS IN PLC COL STL PLY 12" SQ 4U/M	PBB6	.0005	5213	C1	310.00	S.F.C.A.	.36	1.73	2.09	2.85
03.1-250-7650	0311	FRMS IN PLC COL STL PLY 16" SQ 4U/M	PBB6	.0004	5213	C1	335.00	S.F.C.A.	.34	1.60	1.94	2.64
03.1-250-7700	0311	FRMS IN PLC COL STL PLY 20" SQ 4U/M	PBB6	.0004	5213	C1	350.00	S.F.C.A.	.30	1.53	1.83	2.50

Figure 3

3. DESCRIPTION is the general description of the item written in a maximum of 35 characters.

   (Example FRMS IN PLC COL PLY 24" SQ 1 USE)

4. MATERIAL CODE is a four-digit alphanumeric code that represents a material similar to the main material in the line item.

   (Example PBB6) is 3/4" PLYFORM, BB CLASS I that has a unit of measure of MSF.

5. MATERIAL FACTOR is generated on January 1 of every year, based on the Means 30-city average rate for the particular material that is being referenced.

   (Example: Material Code PBB6) = $592.30 1/1/82

   $$\frac{\text{Jan 1, 1982 Line Item \$1.42}}{\text{Jan 1, 1982 Material \$592.30}} = .0023 \text{ Factor}$$

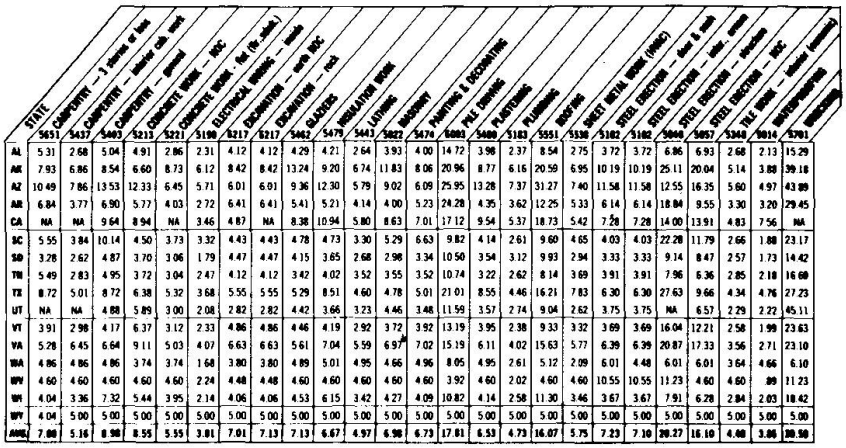
6. WORKER'S COMPENSATION Insurance is a four-digit number assigned to each different work classification. The rates vary by trade, state, and contractor (see Figure 4).

   (Example 5213) = CONCRETE WORK - NOC, TEXAS - 6.38

7. CREW CODE is the trade or trades required to install the described item. The C-1 Crew is shown in Figure 2 with 3 carpenters, 1 building laborer, and some power tools. The crew will always show:

   a) The number and type of tradesmen required
   b) The number, size, and type of equipment required, if any.

Workers' Compensation



STATE	CARPENTRY — 3 Stories or less	CARPENTRY — Interior cab. work	CARPENTRY — general	CONCRETE WORK — misc.	CONCRETE WORK — Ref. (Tk. walls)	ELECTRICAL WIRING — inside	EXCAVATION — earth misc.	EXCAVATION — rock	GLAZIERS	INSULATION WORK	LATHING	MASONRY	PAINTING & DECORATING	PILE DRIVING	PLASTERING	PLUMBING	ROOFING	SHEET METAL WORK (HVAC)	STEEL ERECTION — door & walk	STEEL ERECTION — misc. areas	STEEL ERECTION — structural	TILE WORK — interior (ceramic)	WATERPROOFING	WRECKING
	5651	5437	5403	5213	5221	5190	6217	6217	5462	5479	5443	5022	5474	6803	5480	5183	5551	5538	5182	5182	5040	5057	5348	9014	5701
AL	5.31	2.68	5.04	4.91	2.86	2.31	4.12	4.12	4.29	4.21	2.64	3.93	4.00	14.72	3.98	2.37	8.54	2.75	3.72	3.72	6.86	6.93	2.68	2.13	15.29
AK	7.93	6.86	8.54	6.60	8.73	6.12	8.42	8.42	13.24	9.20	6.74	11.83	8.06	20.96	8.77	6.16	20.59	6.95	10.19	10.19	25.11	20.04	5.14	3.88	39.18
AZ	10.49	7.86	13.53	12.33	6.45	5.71	6.01	6.01	9.36	12.30	5.79	9.02	6.09	25.95	13.28	7.37	31.27	7.40	11.58	11.58	12.55	16.35	5.60	4.97	43.89
AR	6.84	3.77	6.90	5.77	4.03	2.72	6.41	6.41	5.41	5.21	4.14	4.00	5.23	24.28	4.35	3.62	12.25	5.33	6.14	6.14	18.84	9.55	3.30	3.20	29.45
CA	NA	NA	9.64	8.94	NA	3.46	4.87	NA	8.38	10.94	5.80	8.63	7.01	17.12	9.54	5.37	18.73	5.42	7.28	7.28	14.00	13.91	4.83	7.56	NA
SC	5.55	3.84	10.14	4.50	3.73	3.32	4.43	4.43	4.78	4.73	3.30	5.29	6.63	9.82	4.14	2.61	9.60	4.65	4.03	4.03	22.28	11.79	2.66	1.88	23.17
SD	3.28	2.62	4.87	3.70	3.06	1.79	4.47	4.47	4.15	3.65	2.68	2.98	3.34	10.50	3.54	3.12	9.93	2.94	3.33	3.33	9.14	8.47	2.57	1.73	14.42
TN	5.49	2.83	4.95	3.72	3.04	2.47	4.12	4.12	3.42	4.02	3.52	3.55	3.52	10.74	3.22	2.62	8.14	3.69	3.91	3.91	7.96	6.36	2.85	2.18	16.68
TX	8.72	5.01	8.72	6.38	5.32	3.68	5.55	5.55	5.29	8.51	4.60	4.78	5.01	21.01	8.55	4.46	16.21	7.83	6.30	6.30	27.63	9.66	4.34	4.76	27.23
UT	NA	NA	4.88	5.89	3.00	2.08	2.82	2.82	4.42	3.66	3.23	4.46	3.48	11.59	3.57	2.74	9.04	2.62	3.75	3.75	NA	6.57	2.29	2.22	45.11
VT	3.91	2.98	4.17	6.37	3.12	2.33	4.86	4.86	4.46	4.19	2.92	3.72	3.92	13.19	3.95	2.38	9.33	3.32	3.69	3.69	16.04	12.21	2.58	1.99	23.63
VA	5.28	6.45	6.64	9.11	5.03	4.07	6.63	6.63	5.61	7.04	5.59	6.97	7.02	15.19	6.11	4.02	15.63	5.77	6.39	6.39	20.87	17.33	3.56	2.71	23.10
WA	4.86	4.86	4.86	3.74	3.74	1.68	3.80	3.80	4.89	5.01	4.95	4.66	4.96	8.05	4.95	2.61	5.12	2.09	6.01	4.48	6.01	6.01	3.64	4.66	6.10
WV	4.60	4.60	4.60	4.60	4.60	2.24	4.48	4.48	4.60	4.60	4.60	4.60	4.60	3.92	4.60	2.02	4.60	4.60	10.55	10.55	11.23	4.60	4.60	.89	11.23
WI	4.04	3.36	7.32	5.44	3.95	2.14	4.06	4.06	4.53	6.15	3.42	4.27	4.09	10.82	4.14	2.58	11.30	3.46	3.67	3.67	7.91	6.28	2.84	2.03	18.42
WY	4.04	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
AVG.	7.08	5.16	8.98	8.55	5.55	3.81	7.01	7.13	7.13	6.67	4.97	6.98	6.73	17.81	6.53	4.73	16.07	5.75	7.23	7.10	20.27	16.10	4.46	3.86	30.50

Figure4

8. DAILY OUTPUT indicates the number of units the crew will produce in one 8-hour day. This is an average figure, and job conditions will determine the actual field productivity. ESTEK provides ways to override the average productivity with the user's own (see Figure 2).

9. UNIT is the unit of quantity by which the items are measured and priced.

10. BARE COSTS consist of 3 columns that tabulate the unit costs of the items not including the subcontractor's overhead and profit.

    a) MATERIAL is the average contractor purchase price for the items, including delivery to the job within a 10-mile radius.
    b) INSTALLATION is calculated by dividing the daily bare crew cost by the daily output, as shown in the Figure 2.
    c) TOTAL Bare Costs are the arithmetic total of costs from a) and b).

11. TOTAL, INCL O&P represents the total price for the item, including the installing contractor's overhead and profit. It is determined in the following manner (see Figure 2):

    a) Material cost is the bare material cost plus 10%.
    b) Installation cost is calculated by dividing the crew cost, including subcontractors' O & P, by the daily output.
    c) The TOTAL, INCL O & P is the arithmetic sum of a) and b) above.

R. S. Means statisticians maintain the Data Base Material File with quarterly pricing surveys from across the United States and Canada. This file also allows monitoring the state sales tax for fine-tuning the estimate. The quarterly material cost data is keyed to the first three digits of the postal zip code (see Figure 5) for adjusting an estimate to any specific location.

The labor prices used in the ESTEK System are from the Means' Labor Rate File, Figure 6. The rates include the union local number, base wage, plus the fringe benefit package. There are over 360 cities that report on the 46 building trade rates. This amounts to over 16,500 current rates. The file can provide historical as well as future wages under contract with trade unions.

Zip Code to City Cross Reference

ZIP CODE	STATE	CITY	LABOR CITY CODE	MATERIAL CITY CODE
726	ARKANSAS	HARRISON	ARLR	
727	ARKANSAS	FAYETTEVILLE	ARFS	
728	ARKANSAS	RUSSELLVILLE	ARFS	
729	ARKANSAS	FORT SMITH	ARFS	
730	OKLAHOMA	OKLAHOMA CITY	OKOC	
731	OKLAHOMA	OKLAHOMA CITY	OKOC	
734	OKLAHOMA	ARDMORE	OKLW	OKOC
735	OKLAHOMA	LAWTON	OKLW	
736	OKLAHOMA	CLINTON	OKOC	
737	OKLAHOMA	ENID	OKEN	OKOC
738	OKLAHOMA	WOODWARD	OKEN	OKOC
739	OKLAHOMA	GUYMON	OKEN	OKOC
740	OKLAHOMA	TULSA	OKTL	
741	OKLAHOMA	TULSA	OKTL	
743	OKLAHOMA	MIAMI	OKTL	
744	OKLAHOMA	MUSKOGEE	OKTL	
745	OKLAHOMA	MCALESTER	OKOC	
746	OKLAHOMA	PONCA CITY	OKEN	
747	OKLAHOMA	DURANT	OKOC	
748	OKLAHOMA	SHAWNEE		
749	OKLAHOMA	POTEAU	TXBY	TXHS
			TXHS	
750	TEXAS		TXGL	TXHS
751	TEXAS	BEAUMONT	TXBM	
752		BEAUMONT	TXBM	
753	TEXAS	BRYAN	TXBY	TXAS
779	TEXAS	VICTORIA	TXCC	
780	TEXAS	SAN ANTONIO	TXSN	
781	TEXAS	SAN ANTONIO	TXSN	
782	TEXAS	SAN ANTONIO	TXSN	
783	TEXAS	CORPUS CHRISTI	TXCC	

Figure 5

Labor Rates

* HOUSTON, TEXAS 1.232.802

BUILDING CONSTRUCTION TRADES	LOCAL UNION NO	JANUARY 1, 1982 BASE WAGE RATE	FRINGE BENEFIT PACKAGE	TOTAL WAGE RATE	[illegible]
COMMON BUILDING LABORERS	18	10.85	1.66	12.51	92.5
AIR TOOL	18	10.03	1.66	11.69	84.6
ASBESTOS WORKERS	22	15.05	2.36	17.41	92.7
BOILER MAKERS	74	14.80	2.28	17.08	89.3
BRICKLAYERS	7	15.05	2.21	17.26	98.0
HELPERS	18	11.34	1.56	12.90	53.3
CARPENTERS	213	14.90	2.02	16.92	99.5
CARPET & LINOLEUM LAYER	1863			E16.20	98.5
CEMENT FINISHERS	681	14.50	1.88	16.38	98.7
ELECTRICIANS	716			E20.50	104.8
ELEVATOR CONSTRUCTORS	31	13.90	3.16	17.06	51.4
EQUIPMENT OPERATORS-HEAVY	450			E17.55	58.5
EQUIPMENT OPERATORS-MEDIUM	450	15.09	2.09	17.18	59.5
EQUIPMENT OPERATORS-LIGHT	450	13.32	2.09	15.41	94.1
EQUIPMENT OPERATORS-OILERS	450	12.39	2.09	14.48	96.0
EQUIP OPERATOR MASTER MECH	450			E18.40	59.8
GLAZIERS	1778			E16.49	98.3
LATHERS	224	14.90	1.39	16.29	99.0
MARBLE SETTERS	20	13.67	1.50	15.17	90.5
MOSAIC & TERRAZZO WORKERS	20			15.17	92.4
MOSAIC & TERR HELPERS	108	9.45	1.30	10.75	80.0
MILLWRIGHTS	2252	15.29	2.02	17.31	99.0
PAINTERS ORDINARY	130	14.44	2.23	16.67	103.3
PAINTERS SPRAY	130	14.81	2.23	17.04	101.3
PAINTERS STRUCTURAL STEEL	130	14.81	2.23	17.04	101.7
PAPER HANGERS	130	14.44	2.23	16.67	101.6
PILE DRIVERS	2079	14.90	2.02	16.92	98.8
PLASTERERS	79			E16.65	101.0
PLASTERERS HELPERS	18	11.34	1.56	12.90	51.6
PLUMBERS	68	15.12	1.69	16.81	87.1
PLUMBERS HELPERS	68			E11.29	86.9
RODMEN (REINFORCING)	84	14.76	2.60	17.36	94.3
ROOFERS, COMPOSITION	116	11.83	1.48	13.31	82.6
ROOFERS, PRECAST	116	12.71	1.48	14.19	86.8
ROOFERS, TILE & SLATE	116	12.71	1.48	14.19	86.8
ROOFERS HELPERS (COMP)	116			E11.60	55.1
SHEET METAL WORKERS	54	15.26	1.98	17.24	91.3
SPRINKLER INSTALLERS	669			17.11	90.3
STEAMFITTERS/PIPEFITTERS	211	15.20	2.02	17.22	88.4
STONE MASONS	7	15.05	2.21	17.26	98.1
STRUCTURAL STEEL WORKERS	84	14.76	2.60	17.36	93.8
STRUCTURAL STEEL WELDERS	84	14.76	2.60	17.36	93.8
TILE LAYERS (FLOOR)	20			15.17	93.2
TILE LAYERS HELPERS	108	9.45	1.30	10.75	82.2
TRUCK DRIVERS-LIGHT	1111	10.79	1.85	12.64	91.7
TRUCK DRIVERS-HEAVY	1111	11.21	1.85	13.06	92.9
[illegible]				16.66	95.3

Figure 6

USER-SUPPLIED COST DATA BASE

ESTEK is not limited to using only the R. S. Means cost data. The estimator may supply his own information to be used exclusively or in conjunction with the Means data. The types of data that can be supplied include labor rates, crews, major material prices, and the basic line items. ESTEK has multiple options for determining which cost data is used: only user-supplied cost, only R. S. Means cost data, or a combination of both. In this manner, the estimator may supply only a portion of the cost data base and rely on Means for the remaining information.

WORK PACKAGE CONCEPT

ESTEK uses work packages to simplify the preparation of estimates. A work package describes a grouping of related construction tasks that are required to install a particular building system. It computes quantities and logically determines which items are to be selected from the cost data base.

To use a work package, estimators supply dimensions and pick appropriate choices from a matrix describing construction methods and quality of materials. Figure 7 shows the work package (SD03050) used for taking off concrete walls, columns, and piers. This work package routine calculates quantities for concrete walls used in exterior or interior construction, retaining walls, and foundation walls. The package will also calculate quantities for columns and piers (round or square), including capitals. Other capabilities of the work package include descriptions of forms and form liners, reinforcing, moisture protection, curing methods, finishes, accessories, and insulation.

An example of the use of this work package is to describe a wall 10 feet high (3.05m) by 30 feet long (9.14m) by 1 foot thick (.30m) with vertical reinforcing, #6 bars every 12 inches (305mm) and horizontal reinforcing, #4 bars every 18 inches (457mm). Other specifications for the wall are 4000 psi concrete (27575 kPa), 1-inch (25.4mm) urethane sheet insulation, and a 5-foot (1.52m) by 4-foot (1.22m) block out.

The required input to ESTEK would first be the dimensions:

A Wall Length
B Wall Thickness
C Wall Height
E Vertical Reinforcing
F Horizontal Reinforcing
L Block-out Length
M Block-out Height
Q Insulation Thickness

Next the appropriate choices are picked from the decision matrix:

Several choices in the decision matrix, particularly columns 4, 5, 7, and 8 on concrete placing method and forms, are not given in the specifications or dimensions. The estimator has to bring his knowledge of construction to the preparation of the estimate, but the decision matrix also serves as a handy reminder or checklist. Figure 8 is the Quantity Survey Report showing the takeoff produced by this example.

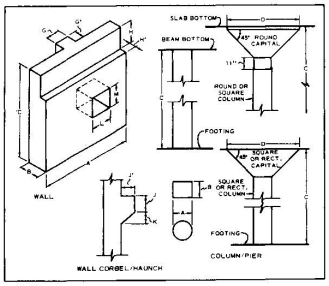
Extensive error checking is also performed by the work package routines. Illogical errors, such as conflicting decision matrix choices or out-of-scope dimensions, produce messages of various error severity (from informational messages to major error conditions).

CONCRETE WALLS, COLUMNS, AND PIERS

SD03050

Calculates quantities and costs for concrete walls used in exterior and interior construction, retaining walls and foundation walls. The package also calculates round and square columns and piers including capitals. Other capabilities include:

forms and form liners
reinforcing
curing and finishes
accessories and insulation



VARIABLE NAME	DEFINITION	UNIT OF MEASURE
A	WALL LENGTH -OR- LONG SIDE OF SQUARE/RECT COLUMN -OR- ROUND COLUMN DIAMETER	FEET FEET FEET
B	WALL THICKNESS -OR- OTHER COLUMN SIDE	FEET
C	WALL OR COLUMN HEIGHT	FEET
D	LONGER SIDE OR DIAMETER OF CAPITAL	FEET
E	VERTICAL BARS:WALL- SPACING (INCHES) (POS 1-4) AND SIZE (#) (POS 5-6) -OR- :COLUMN- NUMBER (EACH) (POS 1-4) AND SIZE (#) (POS 5-6)	
F	HORIZONTAL BARS-WALL SPACING (INCH) (POS 1-4) AND SIZE (#) (POS 5-6) -OR- WALL REINF. ALLOWANCE (POS 1-4) -OR- COLUMN REINFORCING ALLOWANCE (POS 1-4)	
G	PILASTER WIDTH OR DIAMETER (POS 1-4) AND PROJECTION (POS 5-6)	INCHES
H	BEARING LEDGE - HEIGHT (POS 1-4) AND WIDTH (POS 5-6)	INCHES
J	CORBEL/HAUNCH - CAP HEIGHT (POS 1-4) AND WIDTH (POS 5-6)	INCHES
K	CORBEL/HAUNCH HEIGHT	INCHES
L	BLOCK-OUT LENGTH OR DIAMETER	FEET
M	BLOCK-OUT HEIGHT (ZERO IF ROUND)	FEET
N	LENGTH OF ACCESSORIES	FEET
P	WATERSTOP WIDTH (4, 6 OR 9 IN)	IN
Q	INSULATION THICKNESS	IN

DECISION MATRIX

SD03050

Concrete Walls, Columns, and Piers

	WALL TYPE (CHOOSE ONE) 1	COLUMN / PIER TYPE (CHOOSE ONE) 2	CONCRETE REGULAR WEIGHT 3	CONCRETE PLACING METHOD 4	FORMS (WALLS) 5	FORM LINERS WALL - ONE SIDE COLUMNS - ALL 6	FORMS (COLUMNS) 7	FORM USE 8	REINFORCING WALL / COLUMN 9	FINISHES 10	MOISTURE PROTECTION W/ PROJECT. BOARD 11	CONCRETE CURING 12	ACCESSORIES 13	WALL INSULATION (APPLIED-ON) 14	CONCRETE ADDITIVES 15	
0	FOUNDATION WALL	RECTANGULAR OR SQUARE COLUMN	2050 PSI	DIRECT POUR	MODULAR PREFAB PLYWOOD & STEEL FRAMED	AGED WOOD	PREFAB PLYWOOD & STEEL FRAMED	RENTED - 1 USE PER MONTH	WALL - 1 FACE SPACING & SIZE STOP WITHIN WALL	POINT & PATCH	BITUMINOUS DAMPPROOFING 2 - COAT BRUSH	LIQUID MEMBRANE	CHAMFER STRIP	GLASS FIBER SHEET 1/2 TO 1 IN	HIGH EARLY CEMENT	0
1	BASEMENT WALL	CIRCULAR COLUMN	2500 PSI	CRANE & BUCKET	MODULAR PREFAB PLYWOOD	FRACTURED ROPE RIB	JOB BUILT PLYFORM	2 USE PER MONTH	WALL - 2 FACE SPACING & SIZE STOP WITHIN WALL	BURLAP RUB WITH GROUT	SILICONE DAMPPROOFING	WATERPROOF PAPER	FLASHING REGLET	POLYSTYRENE SHEET 1/2 TO 1 IN	SET ACCELERATOR ADMIXTURE	1
2	EXTERIOR WALL (STRUCTURAL)	RECTANGULAR OR SQUARE COLUMN WITH RECT/SQ CAPITAL	3000 PSI	PUMP	JOB BUILT PLYFORM	RIBBED LOOK 1/2,3/4 IN DP	ROUND FIBER TUBE 8 - 48 INCHES	3 USE PER MONTH	WALL - 1 FACE SPACING & SIZE WITH FLOOR LAPP	CARBORUNDUM DRY RUB	CEMENTITIOUS DAMPPROOFING (CEMENT PARGING)	PLSTIC SHEETING	DOVETAIL INSERTS	URETHANE SHEET 1/2 TO 1 IN	WATER REDUCING ADMIXTURE	2
3	EXTERIOR WALL (NON-STRUCTURAL)	RECTANGULAR OR SQUARE COLUMN WITH ROUND CAPITAL 4 - 7 FT DIAM	3500 PSI	CARTS	RADIAL SMOOTH	STRIATED RANDOM 1/8,1/4 IN DP	ROUND FIBER TUBE SEAMLESS 8 - 48 INCHES	4 USE PER MONTH	WALL - 2 FACE SPACING & SIZE WITH FLOOR LAPP	CARBORUNDUM WET RUB	MEMBRANE WATERPROOFING	BURLAP	UNISTRUT INSERTS 1-7/8 IN DEEP	FOAMED GLASS SHEET 1 TO 3 IN	INTEGRAL WATERPROOFING	3
4	INTERIOR WALL (STRUCTURAL)	CIRCULAR COLUMN WITH ROUND CAPITAL 4 - 7 FT DIAM	4000 PSI	CONVEYOR BELT	RADIAL 2 FT CORD	SOLID BOARD FINISH UNIFORM	ROUND FIBERGLASS 12 - 36 INCHES	JOB BUILT 1 USE	WALL - LB/SF ALLOWANCE BY ESTIMATOR	BUSH HAMMER GREEN CONCRETE	METALLIC WATERPROOFING (IRON OXIDE)	CURING BLANKET	UNISTRUT INSERTS 1 3/8 IN DEEP	PERLITE BOARD 1 TO 3 IN	WHITE CEMENT	4
5	INTERIOR WALL (PARTITION)	RECTANGULAR OR SQUARE PIER	4500 PSI		SLIPFORM STRAIGHT	SOLID BOARD FINISH NON-UNIFORM	ROUND STEEL 12 - 60 INCHES	2 USE	COLUMN - NO OF BARS & SIZE STOP WITHIN COLUMN	BUSH HAMMER CURED CONCRETE	BENTONITE CLAY WATERPROOFING (PANELS)	ELECTRICALLY HEATED PAD 18 W PER SF	KEYWAY - VERTICAL WITH BULKHEAD FORMS		MARK-TONE CEMENT	5
6	PITS & TRENCHES	CIRCULAR PIER	5001 PSI		SLIPFORM RADIAL	RUSTIC BRICK PATTERN		3 USE	COLUMN - NO OF BARS & SIZE WITH FLOOR LAP	SANDBLAST LIGHT PENETRATION	BENTONITE CLAY WATERPROOFING - TROWELED ON ADMIXTURE	ELECTRICALLY HEATED PAD 90 W PER SF	KEYWAY HORIZONTAL		INTEGRAL COLORS (REDS)	6
7	TUNNEL WALLS	CONCRETE ENCASING OF STEEL COLUMN RECT/SQUARE	FIELD MIX 2250 PSI					4 USE	COLUMN - LB PER LF ALLOWANCE BY ESTIMATOR	SANDBLAST MEDIUM PENETRATION			VERTICAL KEYWAY & PVC WATERSTOP 4,6,9 IN DEEP		INTEGRAL COLORS (BLACK)	7
8	SITE STRUCTURES WALLS	CONCRETE ENCASING OF STEEL COLUMN ROUND	FIELD MIX 3000 PSI						WALLS/COLUMNS PROGRAMMED - LB PER CY ALLOWANCE	SANDBLAST HEAVY PENETRATION			HORIZONTAL KEYWAY & PVC WATERSTOP 4,6,9 IN DEEP		INTEGRAL COLORS (GREENS)	8
9	RETAINING WALLS								STEEL COLUMN WRAP	ACID ETCH			EXPANSION JOINT PRE-MOLDED FILLER			9

Figure 7

TAKE-OFF ORIGIN	VARIABLE CODE	U.C.I. CODE	TAKE-OFF NUMBER	UNIFORMAT NUMBER	QUANTITY	UNIT OF MEASURE	DESCRIPTION	TOTAL $ (BURDENED)
SD03050		03.1-650-2550		041100	609.00	S.F.C.	FRMS IN PLC JOB BLT PLY TO 16' 4USE	2,051
		03.2-040-0720		041100	0.60	TON	REINFORCING GRADE 60 WALLS	429
		03.3-120-0300		041100	11.04	C.Y.	CONCRETE, READI MIX REG WT 4000 PSI	741
		03.3-160-0250		041100	6.00	S.F.	CONCRETE CURING PLASTIC SHEETHING	1
		03.3-280-0010		041100	600.00	S.F.	FIN WLS BREAK TIES & PATCH	213
		03.3-280-0700		041100	300.00	S.F.	FIN WLS SAND BLST LT PENTN	173
		03.3-380-5200		041100	11.04	C.Y.	PLC CONC&VBRT WALLS 12" THK C&B	229
		07.1-700-0100		041100	300.00	S.F.	SILICONE/STEARATE SPRA ON MASON 2CT	157
		07.2-800-1500		041100	300.00	S.F.	WALL INSUL RIGID URETHANE N BKG 1"T	194
<SUBTOTAL(SD03050)>								

Figure 8

Table 1 lists the 48 work packages that are currently available in ESTEK. These work packages are divided into the major categories of General Conditions, Civil, Architectural, Structural, Mechanical, and Electrical.

WORK PACKAGE DECODER

One of the more important features of ESTEK is that it allows the user to modify the algorithms and logic of the work packages and to add new work packages. This is accomplished through the work package decoder subsystem of ESTEK. The estimator (not a programmer) may modify or create work packages directly without reprogramming the system. The types of functions available with the decoder are:

- Input definitions of variables
- Decision matrix definitions
- Internal or intermediate variables
- Equations with algebraic, trigonometric, and logarithmic functions.
- Logic conditions
- Table lookups
- Error message definitions

The basic function of the work package is to compute quantities from the input dimensions and to determine logically which UCI codes the quantities should be assigned. The work packages also allow the user to create or modify the production rate and the Uniformat code of the takeoff item selected from the cost data base.

Available as part of the user documentation of ESTEK is a set of manuals containing all of the inputs used to define the standard work packages. By modifying the standard work packages or creating new ones, the estimator may develop his own private library of work packages that satisfy his own special requirements.

UPDATING/FINE TUNING AN ESTIMATE

ESTEK is designed so that any processing of the system may include a mix of work package executions, updates to previous takeoffs, updates to control information (i.e., labor rates, major material, and prices) and report requests. The updating process was designed to be flexible and to allow fine tuning of the estimate easily. The types of updates available fall into two categories: control information (global changes) and line item information (detail changes). When a new estimate is started, all the required control information (labor rates, major material prices, equipment rates, and overheads) is initialized from the R. S. Means or the user-supplied cost data bases. The estimator may modify any of this control information and cause all of the appropriate values on the detail takeoff items to be recalculated.

Table 1 Work Packages

General Conditions
- Personnel
- Job Requirements

Civil
- Site Earthwork
- Excavation
- Piles and Caissons
- Sewers
- Site Utilities
- Site Paving

Structural
- Foundations
- Concrete Walls, Columns, and Piers
- Concrete Beams and Slabs
- Slab on Grade
- Masonry, Stone Work, and Accessories
- Structural Steel Framing
- Miscellaneous Metals and Stairs
- Metal Deck and Concrete Fill

Architechtural
- Built-up, Single Ply, and Fluid Applied Roofing
- Shingle, Metal, and Special Roofing
- Roof Accessories
- Interior Finishes (Floors and Ceilings)
- Interior Finishes (Walls)
- Plaster Work (Walls)
- Drywall Work (Walls)
- Washroom Accessories
- Elevators

Mechanical
- Ductwork
- Piping (HVAC)
- Piping (Waste, Vent, and Storm)
- Plumbing Fixtures
- Piping (Water, Fuel, and Lab gases)
- Fire Protection Piping Systems
- Mechanical Controls

Electrical
- Conductor and Conduit
- Busway Systems
- Busway Devices
- Switchboard and Distribution Panels
- Circuit Breaker Panel Boards
- Transformers
- Wiring Devices (Receptacles)
- Wiring Devices (Switches)
- Motor Controllers and Connections
- Cable Trays
- Under Floor Duct
- Under FLoor Duct (Trench)
- Lighting Fixtures
- Emergency Power Sources
- Electric Heating
- Motor Control Centers

On individual takeoff items, the estimator may adjust the production rate, quantity, and the various unit prices (labor, material, equipment, bare total, and burdened total). Whichever values the estimator chooses to update, ESTEK will automatically perform the necessary recalculations. This allows the estimator to exercise his judgement and modify any of the information contained within the estimate.

REPORTING

ESTEK produces a variety of reports that can be segregated into three categories: processing diagnostics, file maintenance, and analysis reports. The processing diagnostics convey information about the status and execution of the system. These are used by the estimator to ensure that the input data and processing of the system is correct. These reports are produced automatically or semiautomatically.

The file maintenance reports are used to verify the results of the system, but they are primarily used for turnaround documents. The Update Report, for example, is in a format that may be marked up and used as a data entry document.

There are a variety of analysis reports produced by ESTEK. In general these reports may display detail or summarized information. In addition to the basic formats of the reports, selection criteria options allow the estimator to tailor the reports to his needs by means of sorting, selecting, and titling features. Figure 9 is an example of the Quality Survey Report. It displays all the takeoff items and quantities produced by the work packages. The major sort order is by work package ID so the estimator may verify the quantities calculated.

Figures 10 and 11 are examples of the Project Cost Report. This report can be used for analysis and as a final reporting document. The information may be displayed in detail or summarized formats by UCI or Uniformat codes. Figure 10 is a UCI detail format, and Figure 11 is a summarized Uniformat report. The Project Cost Report also has various options for displaying subcontractor and general contractor overheads and profits.

Another example of the type of reports available is Figure 12, the Labor Hours Analysis Report. This report can produce detail or summarized information (as shown) for each labor trade. The report displays statistics, such as number of hours, average base rates, fringe, and overhead rates, and the distribution between foremen, journeymen, and apprentices.

The ESTEK reporting features are designed to display information in a variety of formats so the estimator may choose those that satisfy his needs. These standard reports, when used with the selection criteria options, allow flexible reporting.

QUANTITY SURVEY REPORT
FILE NAME = PAPER2
FILE NUMBER = 001

E S T E K
QUANTITY SURVEY REPORT EXAMPLE
HOUSTON TEXAS

PAGE 5
05/26/82

TAKE-OFF ORIGIN	VARIABLE CODE	U.C.I. CODE	TAKE-OFF NUMBER	UNIFORMAT NUMBER	QUANTITY	UNIT OF MEASURE	DESCRIPTION	TOTAL $ (BURDENED)
SUBTOTAL(SD10000)								2,217
SD15150		15.2-320-2960		081400	2.00	EA.	LVTRY/FTG WHT VNTY VTCHN 20"X17"1BL	317
		15.2-560-8200		081400	1.00	EA.	SHOWER ENAM STEEL RECEPTOR 30"SQARE	155
		15.2-680-0050		081400	1.00	EA.	URNL WHNG PECI FLSHPIP&STRAIN4'X18"	535
		15.2-800-1000		081400	2.00	EA.	WC TNKTYP VCHN,SET SUP&STP FLR 1 PC	1,170
SUBTOTAL(SD15150)								2,177
SD15200		15.1-401-1180		081100	90.00	L.F.	PIPE COPR TYPE K 50/50 SOLDR 3/4"	511
		15.1-410-0120		081100	15.00	EA.	PIPE COPPER 90<EL WROUGHT 3/4" SDR	154
		15.1-410-0500		081100	6.00	EA.	PIPE COPPER TEE WROUGHT 3/4" SDR JT	97
		15.1-800-3440		081100	9.00	EA.	VALVE BRNZ GATE 125# THD 3/4"	231
		02.3-030-1310		082100	4.58	C.Y.	TRENCH BACKFILL BY MACHINE W/EXCAV	3
		02.3-180-0400		082100	2.43	C.Y.	EXCAVTG TRCH4'WX8'D3/4CY HYDLC BKHO	5
		15.1-551-0580		082100	30.00	L.F.	PIPE STL BLK SCH 40 THREDED 1"	159
		15.1-560-5100		082100	1.00	EA.	PIPE 90<EL THD BLK MI 150# 1"	16
		02.3-190-2100		081100	30.00	L.F.	CHAIN TRENCH AND B/F 6" WD 18" DEEP	10
		15.1-401-1180		081100	30.00	L.F.	PIPE COPR TYPE K 50/50 SOLDR 3/4"	170
		15.1-410-0120		081100	6.00	EA.	PIPE COPPER 90<EL WROUGHT 3/4" SDR	62
SUBTOTAL(SD15200)								1,419
SD16000		16.0-200-1871		091200	5.00	L.F.	CONDUIT TO 15' HIGH GALV. 2"	38
		16.0-200-2130		091200	2.00	EA.	COND ELBOW GALVANIZED 2" DIA	66
		16.0-200-5021		092100	1,443.82	L.F.	CONDUIT TO 15' HIGH EMT 3/4"	591
		16.0-200-5041		092100	110.66	L.F.	CONDUIT TO 15' HIGH EMT 1"	278
		16.0-200-6220		092100	119.00	EA.	EMT CPLNG SET SCREW STEEL 3/4" DIA	101
		16.0-200-6240		092100	11.00	EA.	EMT CPLNG SET SCREW STEEL 1" DIA	15
		16.0-200-6520		092100	70.00	EA.	EMT BOX CONN SET SCR STL 3/4" DIA	48
		16.0-200-6540		092100	2.00	EA.	EMT BOX CONN SET SCR STL 1" DIA	7
		16.0-550-1000		091200	4.00	EA.	CONDUIT LOCKNUT 2" DIA	3
		16.0-550-1500		091200	2.00	EA.	CONDUIT BUSHING STEEL INSUL 2" D	39
		16.0-550-2960		091200	1.00	EA.	CONDUIT EXPANSION COUPLING 2"D	123
		16.1-100-1500		092100	3.50	C.L.F.	WIRE 600V THHN COPPER STR #2	469
		16.1-100-4110		092100	18.48	C.L.F.	WIRE 600V TW COPPER STRANDED #14	85
		16.1-100-4120		092100	6.68	C.L.F.	WIRE 600V TW COPPER STRANDED #12	190
		16.1-100-4130		092100	26.67	C.L.F.	WIRE 600V TW COPPER STRANDED #10	276

Figure 9

PROJECT COST REPORT
FILE NAME = PAPER2
FILE NUMBER = 002

E S T E K
PROJECT COST SUMMARY EXAMPLE - DETAIL UCI REPORT
HOUSTON TEXAS

PAGE 1
06/16/82

UCI SUBDIVISION	DESCRIPTION	QUANTITY	UNIT OF MEASURE	TOTAL UNIT $	TOTAL MATERIAL $	TOTAL LABOR $	TOTAL EQUIPMENT $	TOTAL $ (BURDENED)
02 - SITE WORK								
02.1 - SITE CLEARING & EXPLORATION								
	CLEAR & GRUB BRUSH	1.03	ACRE	1,437.085	0	613	1,129	1,742
	SUBTOTAL (BURDENED)				0	613	1,129	1,742
02.3 - EARTHWORK								
	BACKFILL BY HAND NO COMP LIGHT SOIL	4.98	C.Y.	10.032	0	59	0	59
	BACKFILL COMPACTION VIB PLATE ADD	4.98	C.Y.	2.404	0	11	3	14
	TRENCH BACKFILL BY MACHINE W/EXCAV	4.58	C.Y.	0.675	0	1	3	4
	BACKFILL DOZER BULK 300' AIR TAMPED	249.98	C.Y.	4.746	0	416	981	1,396
	BORROW BANK RUN GRAVEL SPREAD/ D-7	68.89	C.Y.	7.261	353	75	161	589
	BORROW COMMON BORROW SPREAD/ D-7	833.33	C.Y.	5.304	2,329	919	1,955	5,202
	EXCAVTG TRCH4'WX5'D1/2CY TRCTR BKHO	300.58	C.Y.	0.000	0	0	0	0
	EXCAVTG TRCH4'WX8'D3/4CY HYDLC BKHO	2.43	C.Y.	2.129	0	3	3	6
	EXCAVTG TRCH TRIM SIDES/BTM REGULAR	5.86	C.Y.	0.000	0	0	0	0
	CHAIN TRENCH AND B/F 6" WD 18" DEEP	30.00	L.F.	0.349	0	6	6	12
	GRADING HAND GRADING FINISH	413.78	S.Y.	1.876	0	914	0	914
	HAUL,DISPL,EXV,NAT ON SITE 4LOADS/H	300.58	C.Y.	0.000	0	0	0	0
	HAULING SOIL 16CY DP TR 4M RT1.6L/H	958.33	C.Y.	2.370	0	788	1,885	2,673
	SUBTOTAL (BURDENED)				2,682	3,192	4,997	10,869
	DIVISION TOTAL (BURDENED)	10.56% OF TOTAL PROJECT $3.15 PER SQUARE FOOT			2,682	3,805	6,126	12,611
03 - CONCRETE								
03.1 - FORMWORK & EXPANSION JOINTS								
	FRMS IN PLC COL RD FIBTU 8"D 1 USE	10.00	L.F.	7.326	31	54	2	86
	FRMS IN PLC FTGS CONTIN WALL 4 USE	662.00	S.F.C.	0.320	242	0	0	242
	FRMS IN PLC EDGE FRM TO 12" H 4 USE	32.67	S.F.C.	2.226	21	63	2	86
	FRMS IN PLC JOB BLT PLY TO 16' 4USE	1,219.00	S.F.C.	3.367	709	4,022	100	4,831
	SUBTOTAL (BURDENED)				1,003	4,139	104	5,245
03.2 - REINFORCING STEEL								
	RESTL IN PLC FOOTINGS #4-#7	0.44	TON	887.566	262	198	0	460
	REINFORCING GRADE 60 WALLS	1.20	TON	714.318	685	324	0	1,009
	WELDED WIRE FABR ROLLS 6X6 #8/8	37.24	C.S.F.	23.785	475	567	0	1,043
	SUBTOTAL (BURDENED)				1,422	1,089	0	2,512
03.3 - CAST IN PLACE CONCRETE								

Figure 10

PROJECT COST REPORT — E S T E K — PAGE 2
FILE NAME = PAPER2 — PROJECT COST SUMMARY EXAMPLE - SUMMARY UNIFORMAT REPORT — 05/26/82
FILE NUMBER = 001 — HOUSTON TEXAS

UNIFORMAT LEVEL		TOTAL MATERIAL $	TOTAL LABOR $	TOTAL EQUIPMENT $	TOTAL $ (BURDENED)
063 - SPECIALTIES		799	135	0	936
DIVISION TOTAL (BURDENED)	2.86% OF TOTAL PROJECT $0.83 PER SQUARE FOOT	1,839	1,318	140	3,301
08 - MECHANICAL					
081 - PLUMBING		2,008	1,390	5	3,408
082 - H.V.A.C.		4,620	1,008	4	5,637
DIVISION TOTAL (BURDENED)	7.83% OF TOTAL PROJECT $2.26 PER SQUARE FOOT	6,628	2,398	9	9,045
09 - ELECTRICAL					
091 - SERVICE & DISTRIBUTION		4,703	2,169	0	6,878
092 - LIGHTING & POWER		10,964	3,389	0	14,362
DIVISION TOTAL (BURDENED)	18.40% OF TOTAL PROJECT $5.31 PER SQUARE FOOT	15,667	5,558	0	21,240
12 - SITE WORK					
121 - SITE PREPARATION		1,978	1,970	4,220	8,169
DIVISION TOTAL (BURDENED)	7.08% OF TOTAL PROJECT $2.04 PER SQUARE FOOT	1,978	1,970	4,220	8,169
*** TOTAL (BURDENED)	$28.85 PER SQUARE FOOT	67,835	41,031	6,453	115,380
*** MAIN OFFICE EXPENSE OVERHEAD					8,884
*** GENERAL CONTRACTOR'S PROFIT					11,538
*** PROJECT TOTAL	$33.95 PER SQUARE FOOT				135,802

Figure 11

LABOR HOURS REPORT — E S T E K — PAGE 1
FILE NAME = PAPER2 — LABOR HOURS ANALYSIS EXAMPLE - SUMMARY REPORT — 05/26/82
FILE NUMBER = 001 — HOUSTON TEXAS

LABOR CODE DESCRIPTION				TOTAL HOURS	BASE RATE	FRINGE RATE	FIXED O/H RATE	TOTAL
BRHE - BRICKLAYER HELPERS	0.00% FOREMEN	100.00% JOURNEYMEN	0.00% APPRENTICE	376.0	11.235	1.660	2.014	5,607
BRIC - BRICKLAYERS	0.00% FOREMEN	100.00% JOURNEYMEN	0.00% APPRENTICE	373.6	15.050	2.210	2.698	7,457
CARP - CARPENTERS	10.04% FOREMEN	89.96% JOURNEYMEN	0.00% APPRENTICE	123.0	14.950	2.020	2.952	2,452
CEFI - CEMENT FINISHERS	0.00% FOREMEN	100.00% JOURNEYMEN	0.00% APPRENTICE	54.7	14.500	1.880	2.716	1,044
CLAB - COMMON BUILDING LABORERS	0.00% FOREMEN	100.00% JOURNEYMEN	0.00% APPRENTICE	100.0	10.850	1.660	2.099	1,463
ELEC - ELECTRICIANS	0.00% FOREMEN	100.00% JOURNEYMEN	0.00% APPRENTICE	162.6	18.084	2.416	3.046	3,831
EQHV - EQUIPMENT OPERATORS, CRANE OR SHOVEL	0.00% FOREMEN	100.00% JOURNEYMEN	0.00% APPRENTICE	4.5	15.423	2.127	6.243	108
EQLT - EQUIPMENT OPERATORS, LIGHT EQUIPMENT	0.00% FOREMEN	100.00% JOURNEYMEN	0.00% APPRENTICE	18.1	13.320	2.090	2.420	323
EQMD - EQUIPMENT OPERATORS, MEDIUM EQUIPMENT	0.00% FOREMEN	100.00% JOURNEYMEN	0.00% APPRENTICE	32.6	15.090	2.090	2.822	654
EQOL - EQUIPMENT OPERATORS, OILERS	0.00% FOREMEN	100.00% JOURNEYMEN	0.00% APPRENTICE	4.5	12.390	2.092	5.818	89
PLUM - PLUMBERS	0.00% FOREMEN	83.16% JOURNEYMEN	16.84% APPRENTICE	66.1	14.611	1.685	2.573	1,251

Figure 12

CONCLUSION

A comprehensive cost estimating system is comprised of three important components.

1. A cost data base that is:

   - Comprehensive in scope and able to cover all items of cost
   - Easily adjusted to local unit prices
   - Maintained with up-to-date information by an experienced staff
   - Accurate.

2. Computer software that:

   - Is designed to minimized the takeoff effort
   - Allows for easy adjustments to the estimate
   - Is opened ended by allowing the user to customize the algorithms and logic used in computing quantities
   - Has flexible reporting to meet a variety of needs.

3. Support that is:

   - Continuous, for development of new enhancements and features
   - Available to train and assist users of the system.

ESTEK was designed by R. S. Means Company, CMSI•SH&G, and MCAUTO as a comprehensive construction cost estimating tool.