



TECHNICAL REPORT

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Unit Production Cost Tracking Model UPCT 6

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OCTOBER 1985



ENGINEERING DESIGN INTEGRATION

BULLETIN NO. 1-B

**UNIT PRODUCTION COST TRACKING MODEL
UPCT6**

ELECTRONIC INDUSTRIES ASSOCIATION

ENGINEERING DEPARTMENT

2001 EYE STREET, N.W.

WASHINGTON, D.C. 20006

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UNIT PRODUCTION COST TRACKING MODEL

UPCT6



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FOREWARD

This EIA Engineering Design Integration Bulletin was developed by the EIA G-47 Engineering Design Integration Committee to describe the use of the Unit Production Cost Tracking Model UPCT4 in the analytical and reporting tasks of a Design-to-Cost program.

This revision to Engineering Design Integration Bulletin No. 1 describes the use of the latest version of the Unit Production Cost Tracking Model UPCT6. The description of the computer program differs somewhat from that in the previous revisions of this bulletin, and some differences are required in application. This version of the Tracking Model, UPCT6 offers features not found in previous versions.

Some components purchased in very large quantities do not benefit from further cost reduction for increased quantity. The current version of the Tracking Model, UPCT6 can accommodate this characteristic.

Some components are included in equipment design while they are still in the process of development. Cost estimates for such components vary depending upon their maturity at the expected time of purchase. UPCT6 can consider the expected cost reduction, and incorporate it into a Unit Production Cost estimate for an equipment using the component, for any time of production from the current time to the time of component maturity.

Data entry has been simplified in the Global control file.

The Unit Production Cost Tracking Model UPCT6 was developed by Mr. Harvey Barton of RCA as G-47 Task Leader. We extend our thanks to Mr. Barton and the members of the committee who participated and applied the model to particular programs.

The committee particularly welcomes comments on additional applications of the model to specific programs.

Comments or suggestions may be forwarded to:

The G-47 Staff Engineer
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2001 Eye Street, N.W.
Washington, D.C. 20006

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INTRODUCTION

This userguide contains a description of the Unit Production Cost Tracking Model for use in design tradeoffs and control and reporting tasks of a Design-to-Cost program. This model is designed to compare two Cost Breakdown Structures (CBS) to show elemental and summary cost differences. The two Cost Breakdown Structures may represent design alternatives, or a target allocation and the current design approach for comparison.

Several features of the model make it especially useful for its purposes:

- o It makes a search to assure comparison of identical Cost Breakdown Structure (CBS) element identifiers. This assures comparison of comparable elements, even if elements are added to or deleted from one alternative.
- o Analysis can be restricted to a subset of the CBS for a tradeoff not affecting other parts of the CBS.
- o Reporting level of detail can be limited for summary purposes.
- o Costs are separated by processes, which may be identified as material and labor of various classes, or various accounts. Process sums are developed in addition to and within those of equipment elements.
- o Labor costs may be carried in terms of man-hours or other time elements, and labor rates and burden rates assigned by process. Material costs may be burdened by assigned Material Handling Expense burden rates.
- o Learning factors may be assigned to processes to ease estimation of unit costs for various production quantities, and for various elemental cost basis quantities. These computations are accurate over a broad range of intended production quantities.
- o The use of escalation or inflation factors enables reporting costs on any common time basis, and allows combining elemental cost estimates developed at various points in the development cycle.

Reports have been designed to be effective in the analytical, control and reporting aspects of a DTC program.

- oo A Status Report limits the level of detail as desired, for reporting status to management or the customer. It may be limited to a branch of the CBS for tradeoff

purposes. An accompanying graph shows historical changes in DTC performance.

- oo A Problem Analysis Report is issued for corrective action when a design element or process exceeds its allocated goal.

The Design-to-Cost process requires establishment of Design-to-Cost goals, to which equipments are to be designed and their costs controlled. The designs must be reviewed periodically to evaluate their conformance with the established goals. The design process is controlled by goal allocation to designers and assistance in evaluation of their design alternatives. The mere existence of a cost goal lends incentive to designers to address the goal. When progress against the goal is monitored and reported, this incentive is increased. When the designer is required to explain a variance from the goal and his proposed solution, his attention to cost is encouraged.

Usual requirements on Defense Design-to-Cost contracts include periodic reports of performance against a Unit-Production-Cost goal, to three or more levels of Cost Breakdown Structure (CBS). These are used to satisfy Government directives for monitoring Design-to-Cost contracts.

MODEL APPLICATION

The EIA UPC Tracking Model answers these requirements in two ways:

- o Most important, it serves as a tool to assist management awareness of performance against allocated goals, and of the causes of deviation, and provides rapid feedback of tradeoff results for selection of design alternatives.
- o It produces reports for transmittal of UPC status to the customer.

The model compares cost elements associated with two Cost Breakdown Structure arrays. It can be used to compare elemental costs of a current design against elements of a standard or target design. If the standard design is comprised of UPC goal allocations, the model will evaluate performance against these goal allocations, by showing elemental cost differences from allocated goals. Cost elements are summarized to succeeding levels of the Cost Breakdown Structure and cost differences are determined at each level.

Use of the model for design tradeoff is encouraged by its capability to partition a Cost Breakdown Structure array and analyze only part of a design. This permits any portion of the current cost CBS to be compared with the target to determine the cost impact of design change or later cost estimate. Figure 1 illustrates the flow of the model.

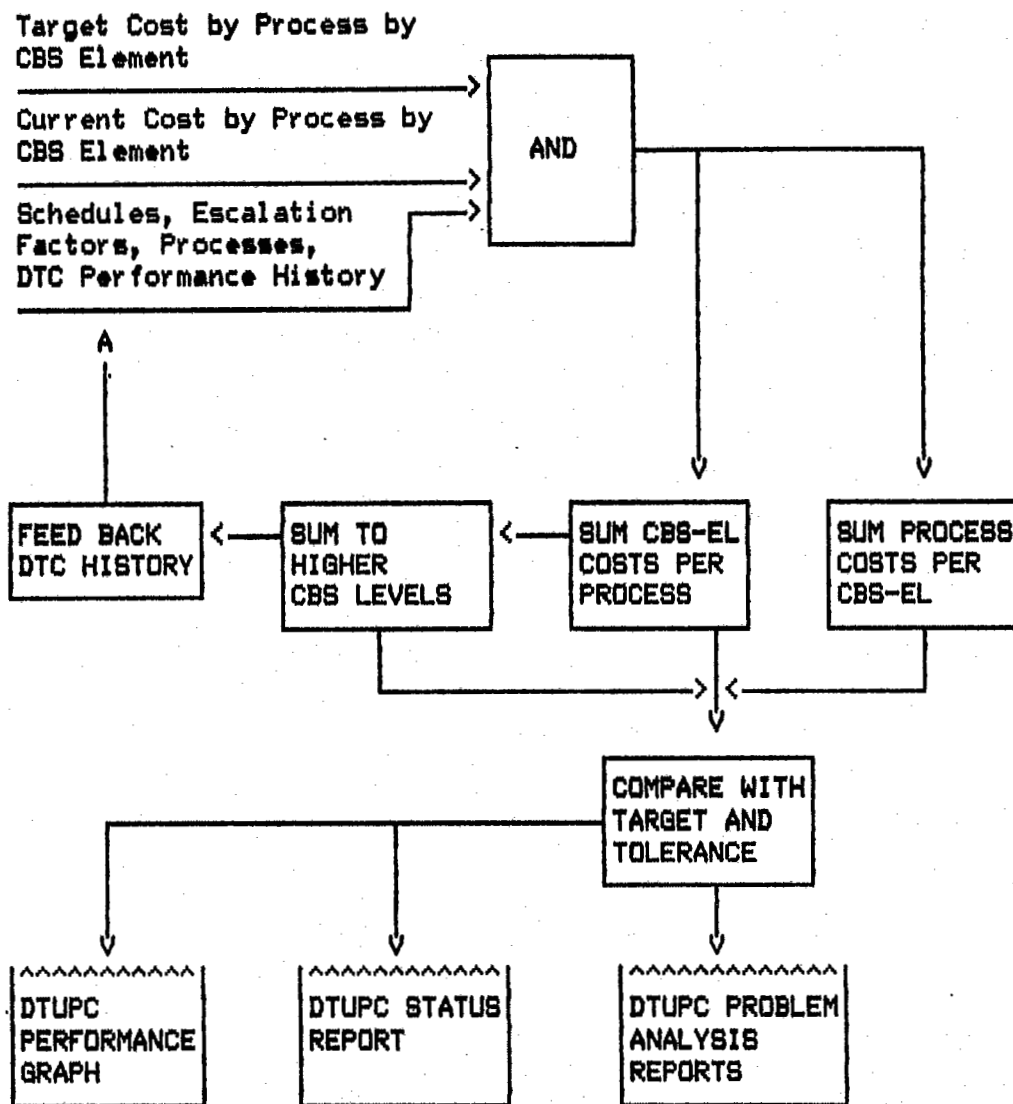


Figure 1. Model Flow

MODEL OPERATION

The model reads two "bottom-up" CBS-ordered files. It matches CBS identifiers to assure comparison of equivalent CBS elements. For each CBS element, it reads nonrecurring and recurring costs and updates them by application of escalation or deflation as directed. Recurring costs are those which represent the materials incorporated into the production units, and the labor required for the tasks related directly to production quantity. The model uses them as to be attributed to a single production unit. If production quantity increases, the unit production cost can be expected to decrease due to increased quantity discounts on purchased material and increased task skill through practice.

Nonrecurring costs represent the investments required for production tooling, developing manufacturing processes and like requirements not directly dependent upon production quantity. Total nonrecurring cost for production may be constant over a range of production quantities. In this case, the nonrecurring unit cost for any quantity within this range is the total divided by the production quantity.

If the quantity basis for any CBS element is different from the desired production quantity, recurring costs are modified by application of learning-curve computations, so that their new quantity basis is the desired production quantity. The model can treat any recurring cost element as having fixed unit cost, a unit cost subject to learning, or a unit fraction of a fixed total cost, depending upon the value of its associated learning factor. The application of learning curve computations is controlled by assignment of learning curve values between 80 and 99 (percent). Assignment of a nonzero value less than 80 indicates a fixed unit cost. A zero value causes cost elements to be treated as unit fractions of a fixed total cost. In this case, a production quantity modification initiates computation of the aggregate nonrecurring cost as the multiple of the unit cost and quantity basis. This amount is divided by the desired production quantity to determine the new nonrecurring cost.

Current nonrecurring and recurring costs are subtracted from target values for the same CBS element. Current costs and differences are reported for each element. Current and Target costs are added to those of previous CBS elements to construct costs of higher level CBS elements and the total system.

In addition to the Cost Breakdown Structure organization, cost elements may be divided further into 98 categories. These categories may be named processes such as purchased material, assembly and test; or shop orders to identify cost centers; or common components used in several assemblies. Costs are accumulated by "process" as well as CBS element.

aid in tracking "cost driving" processes. Each process has an associated learning curve slope, which is used for unit-cost modification for varying production quantities. Each process may have a labor rate as well as a burden rate, so cost elements may be constructed from task-times.

Processes may be subdivided further, into Subprocesses, Processes and Process Groups. Using this feature, labor costs of Assembly, Test and Quality may be combined for Factory Labor cost, and this can be summed with Engineering Labor for total Labor cost. Material costs can be subsumed similarly before accumulating total costs for each Cost Breakdown Structure element.

MODEL OUTPUTS

Three kinds of reports are issued:

1. DTUPC Status Report
2. DTUPC Tracking Chart
3. DTUPC Problem Analysis Report

1. The DTUPC Status Report records the cost performance for the total Cost Breakdown Structure, or a selected branch. It is generated on a periodic basis as a customer report. It may be limited to a desired level of detail.

Variance between Current and Target cost is calculated and reported. If this variance exceeds the acceptable tolerance limit, a DTUPC Problem Analysis Report is generated. The CBS elements and processes are accumulated and summarized to each succeeding CBS level. At the top level of assembly, a loading factor is applied to the Independent Research & Development, and any other desired factors which are computed as a percentage of all preceding costs, and including profit. Overhead costs are to be included in the basic cost elements, or as process burdens, so are not part of the final loading factor. Government-Furnished Equipment (GFE) or Material (GFM) may be excluded from the sum to which the loading factor is applied.

Figure 2 is an example of the DTUPC Status Report, limited to two levels of assembly, and total cost per CBS element.

Figure 3 shows a DTUPC Status Report which includes cost by Process Group.

Figure 4 shows a DTUPC Status Report to the same two levels of assembly, but with all processes shown.

Figure 5 is an example of a DTUPC Status Report with all processes, and to the third level of assembly, but restricted to Branch 2.2.

2. The DTUPC Tracking Chart illustrates overall cost performance toward the Target. The normalized unit cost is plotted against the Target and a time-variant tolerance profile. The tolerance profile is developed by linear interpolation from initial and final program values. This report is shown in Figure 6.
3. The DTUPC Problem Analysis Report is issued automatically for each CBS element or process whose current cost projection exceeds its tolerance limit. It initiates corrective action and provides for approvals by a review committee and the Program Manager. Figure 7 illustrates this report.

DATA TESTER

TABLE 1

DTUPC STATUS REPORT

PAGE 1

REPORT 19 8/85 TARGET TOLERANCE +0.09,-0.09

PRODUCTION QUANTITY 10000.

COST BASIS DATE 1/84

TECHNOLOGY DATE 3/86

ELEMENT/ PROCESS	CURRENT COST		TARGET COST		VARIANCE FROM TGT	
	NONRECUR	RECUR	NONRECUR	RECUR	NONRECUR	RECUR
2. 1. 0. 0. 0. 0 I/O ASSEMBLY	2.38	307.44	2.55	297.13	-0.17	10.31
2. 2. 0. 0. 0. 0 CONVERTER	1.98	200.48	1.75	162.24	0.23	38.24
2. 3. 0. 0. 0. 0 CHASSIS	18.08	173.32	18.87	167.65	-0.78	5.67
2. 0. 0. 0. 0. 0 TESTER	41.02	760.59	42.07	706.84	-1.05	53.76
25.0% LOAD	10.	190.	11.	177.	-0.	13.
DTUPC TOTAL	51.	951.	53.	884.	-1.	67.
TOTAL DTUPC ESTIMATE	1002.		936.		66.	

Figure 2. DTUPC Status Report



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TABLE 1

DTUPC STATUS REPORT

PAGE 1

REPORT 19 8/85 TARGET TOLERANCE +0.09,-0.09

PRODUCTION QUANTITY 10000.

COST BASIS DATE 1/84

TECHNOLOGY DATE 3/86

ELEMENT/ PROCESS	CURRENT COST NONRECUR RECUR	TARGET COST NONRECUR RECUR	VARIANCE FROM TGT NONRECUR RECUR
2. 1. 0. 0. 0. 0 I/O ASSEMBLY	8164310-501		
92 MATERIAL	0.00 264.11	0.00 255.14	0.00 8.97
91 LABOR	2.38 43.33	2.55 41.99	-0.17 1.34
99 MFG. TOTAL	2.38 307.44	2.55 297.13	-0.17 10.31
2. 2. 0. 0. 0. 0 CONVERTER	8164311-503		
92 MATERIAL	0.00 178.84	0.00 139.86	0.00 38.98
91 LABOR	1.98 21.63	1.75 22.37	0.23 -0.74
99 MFG. TOTAL	1.98 200.48	1.75 162.24	0.23 38.24
2. 3. 0. 0. 0. 0 CHASSIS	8164312-502		
92 MATERIAL	3.74 57.92	3.99 52.16	-0.25 5.75
91 LABOR	14.34 115.41	14.87 115.49	-0.53 -0.08
99 MFG. TOTAL	18.08 173.32	18.87 167.65	-0.78 5.67
2. 0. 0. 0. 0. 0 TESTER	8164302-504		
92 MATERIAL	3.74 500.87	3.99 447.16	-0.25 53.70
91 LABOR	37.28 259.73	38.08 259.67	-0.80 0.05
99 MFG. TOTAL	41.02 760.59	42.07 706.84	-1.05 53.76
25.0% LOAD	10. 190.	11. 177.	-0. 13.
DTUPC TOTAL	51. 951.	53. 884.	-1. 67.
TOTAL DTUPC ESTIMATE	1002.	936.	66.

Figure 3. DTUPC Status Report With Process Groups



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TABLE 1

DTUPC STATUS REPORT

PAGE 1

REPORT 19 8/85 TARGET TOLERANCE +0.09,-0.09

PRODUCTION QUANTITY 10000.

COST BASIS DATE 1/84

TECHNOLOGY DATE 3/86

ELEMENT/ PROCESS	CURRENT COST		TARGET COST		VARIANCE FROM TGT	
	NONRECUR	RECUR	NONRECUR	RECUR	NONRECUR	RECUR
2. 1. 0. 0. 0. 0						
I/O ASSEMBLY	8164310-501					
1 ASSEMBLY	0.58	18.48	0.58	17.83	0.00	0.64
2 IE&PROD CTRL	0.00	0.93	0.00	1.10	0.00	-0.17
3 PRODUCIBILITY	1.18	0.00	1.30	0.00	-0.12	0.00
4 QC&FIELD QA	0.00	2.87	0.00	3.06	0.00	-0.18
5 TEST	0.63	11.82	0.68	11.82	-0.05	0.00
7 FACTORYLABOR	2.38	34.10	2.55	33.81	-0.17	0.29
8 ENGINEERING	0.00	9.24	0.00	8.18	0.00	1.05
9 CAPACITORS	0.00	13.40	0.00	13.12	0.00	0.28
10 OTHER MAT'L	0.00	250.70	0.00	242.01	0.00	8.69
92 MATERIAL	0.00	264.11	0.00	255.14	0.00	8.97
91 LABOR	2.38	43.33	2.55	41.99	-0.17	1.34
99 MFG. TOTAL	2.38	307.44	2.55	297.13	-0.17	10.31
2. 2. 0. 0. 0. 0						
CONVERTER	8164311-503					
1 ASSEMBLY	0.46	9.96	0.34	10.43	0.13	-0.47
2 IE&PROD CTRL	0.00	0.56	0.00	0.64	0.00	-0.08
3 PRODUCIBILITY	0.82	0.00	0.75	0.00	0.07	0.00
4 QC&FIELD QA	0.00	1.74	0.00	1.79	0.00	-0.05
5 TEST	0.70	4.52	0.66	4.74	0.04	-0.22
7 FACTORYLABOR	1.98	16.78	1.75	17.60	0.23	-0.82
8 ENGINEERING	0.00	4.85	0.00	4.77	0.00	0.08
9 CAPACITORS	0.00	14.66	0.00	14.88	0.00	-0.22
10 OTHER MAT'L	0.00	164.19	0.00	124.98	0.00	39.20

Figure 4. DTUPC Status Report With All Processes



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TABLE 1

DTUPC STATUS REPORT

PAGE 2

REPORT 19 8/85 TARGET TOLERANCE +0.09,-0.09

PRODUCTION QUANTITY 10000.

COST BASIS DATE 1/84

TECHNOLOGY DATE 3/86

ELEMENT/ PROCESS	CURRENT COST		TARGET COST		VARIANCE FROM TGT	
	NONRECUR	RECUR	NONRECUR	RECUR	NONRECUR	RECUR
92 MATERIAL	0.00	178.84	0.00	139.86	0.00	38.98
91 LABOR	1.98	21.63	1.75	22.37	0.23	-0.74
99 MFG. TOTAL	1.98	200.48	1.75	162.24	0.23	38.24
2. 3. 0. 0. 0. 0						
CHASSIS	8164312-502					
1 ASSEMBLY	10.09	85.96	10.44	85.64	-0.35	0.32
2 IE&PROD CTRL	0.00	3.29	0.00	3.22	0.00	0.07
3 PRODUCIBILITY	4.25	0.00	4.43	0.00	-0.18	0.00
4 QC&FIELD QA	0.00	2.03	0.00	2.09	0.00	-0.05
7 FACTORYLABOR	14.34	91.28	14.87	90.95	-0.53	0.33
8 ENGINEERING	0.00	24.13	0.00	24.54	0.00	-0.42
10 OTHER MAT'L	3.74	57.92	3.99	52.16	-0.25	5.75
92 MATERIAL	3.74	57.92	3.99	52.16	-0.25	5.75
91 LABOR	14.34	115.41	14.87	115.49	-0.53	-0.08
99 MFG. TOTAL	18.08	173.32	18.87	167.65	-0.78	5.67
2. 0. 0. 0. 0. 0						
TESTER	8164302-504					
1 ASSEMBLY	11.13	121.79	11.36	121.34	-0.23	0.45
2 IE&PROD CTRL	0.00	5.33	0.00	5.52	0.00	-0.19
3 PRODUCIBILITY	6.24	0.00	6.48	0.00	-0.23	0.00
4 QC&FIELD QA	0.00	14.83	0.00	15.30	0.00	-0.48
5 TEST	19.90	70.52	20.24	70.85	-0.34	-0.33
6 PACK&PKG	0.00	5.83	0.00	5.76	0.00	0.07
7 FACTORYLABOR	37.28	218.29	38.08	218.77	-0.80	-0.48
8 ENGINEERING	0.00	41.43	0.00	40.91	0.00	0.53

Figure 4. DTUPC Status Report With All Processes
(Continued)

DATA TESTER

TABLE 1

DTUPC STATUS REPORT

PAGE 3

REPORT 19 8/85 TARGET TOLERANCE +0.09,-0.09

PRODUCTION QUANTITY 10000.

COST BASIS DATE 1/84

TECHNOLOGY DATE 3/86

ELEMENT/ PROCESS	CURRENT COST		TARGET COST		VARIANCE FROM TGT	
	NONRECUR	RECUR	NONRECUR	RECUR	NONRECUR	RECUR
9 CAPACITORS	0.00	28.06	0.00	28.00	0.00	0.06
10 OTHER MAT'L	3.74	472.80	3.99	419.16	-0.25	53.65
92 MATERIAL	3.74	500.87	3.99	447.16	-0.25	53.70
91 LABOR	37.28	259.73	38.08	259.67	-0.80	0.05
99 MFG. TOTAL	41.02	760.59	42.07	706.84	-1.05	53.76
25.0% LOAD	10.	190.	11.	177.	-0.	13.
DTUPC TOTAL	51.	951.	53.	884.	-1.	67.
TOTAL DTUPC ESTIMATE	1002.		936.		66.	

**Figure 4. DTUPC Status Report With All Processes
(Concluded)**