

NSRP SP-4 Panel Project on Process Based Cost Estimating Revisited

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OVERVIEW



- Information Source
- The Quantative Approach Revisited
- Data Tables
- Work Stage Table Additions
- Work Process Table & Welding Table Additions
- Work Processes Additions
- Example Application
- Conclusions

Information Source



- SP-4 Panel Project Report – March 1991 - September 1992
 - “Evaluating the Producibility of Ship Design Alternatives”, Dr. James R Wilkins, Jr., Wilkins Enterprise Inc.; Captain Gilbert L. Krane (USCG), Enterprise Assistance, Inc.; and Daniel H. Thompson, Coastal Group Technology
 - Two producibility evaluations presented
 - Quantitative results in man-hours or dollars
 - Relative results based on weighting factors

The Quantitative Approach



- Cost Estimating EXCEL™ spreadsheets were Developed Based on **Discrete Work Processes**
 - Structure
 - Mild Steel
 - Aluminum
 - HY80
 - HTS
 - Piping
 - Electrical
 - HVAC

Data Tables For Each Material Type



- 8 Work Stage Factors
- 6 Process Factors based on thickness
- Welding Factors based on thickness
 - 2 Machine Welding Factors
 - 9 Manual Welding Factors

WORK STAGE FACTORS		
STAGE DESCRIPTION	STAGE NO.	STAGE FACTOR
FABRICATION	1	1.0
PREOUTFITTING HOT	2	1.5
PAINT	3	2.0
PREOUTFITTING COLD	4	3.0
ERECTION	5	4.5
OUTFITTING	6	7.0
WATERBORNE	7	10.0
TEST AND TRIALS	8	15.0

THICKNESS (INCHES)	FLAME CUTTING AUTO	FLAME CUTTING MANUAL	EDGE PREP GRINDING FLAT	EDGE PREP GRINDING VERTICAL	EDGE PREP GRINDING OVERHEAD	ASSEMBLY
0.250	0.05	0.09	0.02	0.04	0.06	0.56
0.375	0.05	0.09	0.03	0.05	0.07	0.56
0.500	0.05	0.09	0.04	0.06	0.08	0.56
0.750	0.07	0.12	0.06	0.12	0.17	0.56
1.00	0.07	0.16	0.08	0.17	0.26	0.56
1.25	0.08	0.17	0.12	0.21	0.30	0.56
1.5	0.10	0.18	0.17	0.26	0.34	0.56
2	0.12	0.23	0.17	0.26	0.34	0.56
3	0.15	0.26	0.26	0.34	0.43	0.56
4	0.16	0.28	0.31	0.41	0.52	0.56
5	0.17	0.32	0.37	0.49	0.62	0.56

WELDING-MACHINE	
FILLET	BUTT
0.04	na
0.05	na
0.07	0.48
0.08	0.58
0.09	0.70
0.11	0.85
0.13	1.02
0.16	1.22
0.19	1.47
0.23	1.76
0.28	2.12

THICKNESS (INCHES)	WELDING-MANUAL			WELDING-MANUAL			THICKNESS FACTOR	POSITION VERT	FACTORS OVHD
	DOWN	FILLET VERT	OVHD	DOWN	BUTT VERT	OVHD			
0.250	0.12	0.24	0.36	0.62	1.24	1.86	1.00	2.00	3.00
0.375	0.23	0.38	0.54	1.00	1.67	2.33	1.20	1.67	2.33
0.500	0.34	0.51	0.68	1.30	1.95	2.60	1.20	1.50	2.00
0.750	0.60	1.20	1.70	1.80	3.60	5.10	1.20	2.00	2.83
1.00	1.00	2.13	3.25	2.40	5.10	7.80	1.20	2.13	3.25
1.25	1.20	2.10	3.00	3.20	5.60	8.00	1.20	1.75	2.50
1.5	1.44	2.20	2.88	3.80	5.81	7.60	1.20	1.53	2.00
2	1.73	2.64	3.46	5.10	7.80	10.20	1.20	1.53	2.00
3	2.07	2.71	3.43	6.12	8.00	10.12	1.20	1.31	1.65
4	2.49	3.25	4.12	7.34	9.60	12.15	1.20	1.31	1.65
5	2.99	3.90	4.94	8.81	11.52	14.58	1.20	1.31	1.65

Work Stage Table Additions



- Work Stage Additions

STAGE DESCRIPTION	STAGE NO.	STAGE FACTOR	STAGE SUPPORT FACTOR		STAGE NO.	STAGE FACTOR
S1 CUT MATERIAL - MACHINE	1	1.0	1.01			
S2 CUT MATERIAL - MANUAL	2	1.3	1.02			
S3 FABRICATION - FAB SHOP W/JIG OR FIXTURE	3	1.8	1.03			
S4 FABRICATION - UNIQUE PIECE ASSEMBLY	4	2.1	1.06	FABRICATION	1	1.0
S5 BLOCK ASSEMBLY	5	4.9	1.1			
S6 BLOCK ASSEMBLY - PREOUTFIT INVERTED	6	4.8	1.15	PREOUTFITTING HOT	2	1.5
S7 BLOCK ASSEMBLY - PREOUTFIT UPRIGHT 1 LEVEL HIGH	7	5.7	1.2			
S8 PAINT	8	5.8	1.1	PAINT	3	2.0
S9 PREOUTFITTING COLD 1 LEVEL HIGH	9	6.4	1.25	PREOUTFITTING COLD	4	3.0
S10 PREOUTFITTING COLD 2 OR MORE LEVELS HIGH	10	8.8	1.3			
S11 ERECTION	11	11.7	1.35	ERECTION	5	4.5
S12 OUTFITTING ON WAYS	12	12.2	1.4	OUTFITTING	6	7.0
S13 WATERBORNE OUTFITTING	13	13.5	1.5	WATERBORNE	7	10.0
S14 TEST AND TRIALS DURING WATERBORNE OUTFITTING	14	13.6	1.35			
S15 TEST AND TRIALS POST OUTFITTING	15	11.3	1.1	TEST AND TRIALS	8	15.0

Work Process Table Additions



THICKNESS (INCHES)	FLAME CUTTING AUTO	FLAME CUTTING MANUAL	EDGE PREP GRINDING FLAT	EDGE PREP GRINDING VERTICAL	EDGE PREP GRINDING OVERHEAD	ASSEMBLY	MACHINE CUT	MANUAL CUT	PRESS & MACHINE BEND
0.250	0.05	0.09	0.02	0.04	0.06	0.02	0.02	0.04	0.04
0.375	0.05	0.09	0.03	0.05	0.07	0.03	0.02	0.05	0.05
0.500	0.05	0.09	0.04	0.06	0.08	0.04	0.03	0.05	0.05
0.750	0.07	0.12	0.06	0.12	0.17	0.06	0.03	0.06	0.06
1.00	0.07	0.16	0.08	0.17	0.26	0.08	0.04	0.07	0.07
1.25	0.08	0.17	0.12	0.21	0.30	0.12	0.04	0.08	0.08
1.5	0.10	0.18	0.17	0.26	0.34	0.17	0.05	0.09	0.09
2	0.12	0.23	0.17	0.26	0.34	0.17	0.06	0.12	0.12
3	0.15	0.26	0.26	0.34	0.43	0.26	0.07	0.14	0.14
4	0.16	0.28	0.31	0.41	0.52	0.31	0.09	0.19	0.19
5	0.17	0.32	0.37	0.49	0.62	0.37	0.13	0.26	0.26

STUD WELDING

STUD SIZE (INCHES)	
0.250	0.033
0.375	0.05
0.500	0.067
0.750	0.083
1.00	0.1

Work Process Additions



- 31 Original Work Processes
- 169 Work Processes Added

			MATERIAL: THICKNESS: STUD SIZE		AL 0.25 0.75	INCHES INCHES				
	WORK PROCESS	WORK UNITS	PROCESS FACTOR (MNHRS/ (WORK UNIT)	# OF PIECES	UNIT AMOUNT	STAGE	STAGE FACTOR	SUPPORT	MNHRS REQ'D	
1	ORDER & RECEIVE MATERIAL									
	OBTAIN MATERIAL - PLATE	LINE ITEM	1.000	1	1	1	1.0	1.01	1	
	OBTAIN MATERIAL - OTHER	LINE ITEM	1.000	7	7	1	1.0	1.01	7	
	RECEIPT & PREP	PIECE	0.200	26	26	1	1.0	1.01	5	
2	CUTTING									
	AUTOMATIC - PLATE CUT	LN FT	0.050	211	208.91	1	1.0	1.01	10	
	MANUAL - PLATE CUT	LN FT	0.090		0.00	2	1.3	1.02	0	
	MACHINE - PIECE	CUT	0.020	261	261.00	1	1.0	1.01	5	
	MANUAL SHOP - PIECE	LN FT	0.040	200	110.72	2	1.3	1.02	6	
	MANUAL (Specific Stage)	LN FT	0.040		0.00	3	1.8	1.03	0	
	MANUAL (Specific Stage)	LN FT	0.040		0.00	4	2.1	1.06	0	
	MANUAL (Specific Stage)	LN FT	0.040		0.00	5	4.9	1.10	0	
	MANUAL (Specific Stage)	LN FT	0.040		0.00	6	4.8	1.15	0	
	MANUAL (Specific Stage)	LN FT	0.040		0.00	7	5.7	1.20	0	
	MANUAL (Specific Stage)	LN FT	0.040		0.00	8	5.8	1.10	0	
	MANUAL (Specific Stage)	LN FT	0.040		0.00	9	6.4	1.25	0	
	MANUAL (Specific Stage)	LN FT	0.040		0.00	10	8.8	1.30	0	
	MANUAL (Specific Stage)	LN FT	0.040		0.00	11	11.7	1.35	0	
	MANUAL (Specific Stage)	LN FT	0.040		0.00	12	12.2	1.40	0	

Example Application



- Typical 30'x50' C4I Space (Stick-built vs. RapidTrac™)
 - 36 Consoles and Chairs
 - 8 Stanchions for mounting small items
- Process
 - Determine process steps for each stage and the related cut lengths, cuts, pieces, weld lengths, and special processes for a space or similar space
 - Determine predominate material and thickness
 - Enter details in the EXCEL™ spreadsheet for the appropriate material

WORK PROCESS			WORK UNITS	PROCESS FACTOR (MNHRS/)(WORK UNIT)	# OF PIECES	UNIT AMOUNT	STAGE	STAGE FACTOR	SUPPORT	MNHRS REQ'D
		MATERIAL:				AL				
		THICKNESS:				0.25	INCHES			
		STUD SIZE				0.75	INCHES			
1	OBTAIN MATERIAL - PLATE	LINE ITEM	1.000			1	1	1.0	1.01	1
	OBTAIN MATERIAL	LINE ITEM	1.000			7	1	1.0	1.01	7
	RECEIPT & PREP	PIECE	0.200			26	1	1.0	1.01	5
2	CUTTING									
	AUTOMATIC - PLATE CUT	LN FT	0.050	211		208.91	1	1.0	1.01	10
	MANUAL -PLATE	LN FT	0.090			0.00	2	1.3	1.02	0
	MACHINE	CUT	0.020	261		261.00	1	1.0	1.01	5
	MANUAL SHOP	LN FT	0.040	200		110.72	2	1.3	1.02	6

Example Application (Cont'd)



- Example Results (Manhours)

STAGE	STICK-BUILT		RAPIDTRAC™	
	FALSE DECK	FDNS	FALSE DECK	FDNS
1	207	79	187	79
2	35	14	14	14
3		486	111	486
4	331			
12	3962	1336	3007	367
TOTAL	4535	1915	3319	946

Conclusions



- The original work for the SP-4 Panel provides an effective Process Based estimating tool.
- Using this Process Based estimating tool would provide a more accurate comparison of man-hour cost then weight based estimating in formulating the Business Case Analysis required by DoD 5000.2-R.
- There are nuggets in the NSRP archives that are worth revisiting.