Costing Systems & Variance Analyses at the Carpenter & Millbridge Ltd. Welding Alloys Business Unit - a case study -

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Abstract

This case study illustrates how standard or traditional costing systems can reveal information that e.g. ABC methods would reveal, if appropriate variances are calculated. Variance analysis on disaggregated and timely information not only allows for timely corrective action, but it can also determine how e.g. set-up time related to smaller batches should be absorbed. Variance analysis could also indicate whether an alternative raw material is economically feasible or how a product's cost might reflect the use of alternate production facilities. Whereas much of such information would be translated into cost drivers when applying ABC, extended variance analysis could also bring this information to the surface in a "traditional" costing system.

Content

Introduction

Carpenter & Millbridge is a manufacturer of industrial welding alloys. The company uses its costing system and variance analyses as important business tools to target problem areas so it can develop solutions for continuous improvement. The company's costing-related tools include:

1. Disaggregated product line information

Carpenter & Millbridge has been divided into Business Units (BU's) along product lines. The welding alloys business unit is one of these BU's. Earnings statements are developed for each BU and variances are shown as a percentage of production. If production variances exceed 5%, the BU managers are required to provide an explanation and to put together a plan of action to correct the detected problems. To help the process, a plant accountant has been assigned to each BU. As a result of these steps, each unit is able to take a much more pro-active approach to variance analysis.

2. Timely product cost information

In the past, variances were reported only at month-end, but often a particular job already would have been off the shop floor for three or more weeks. Hence, when management questioned the variances, it was too late to review the job. Now, exception reports are generated the day after the last part has been manufactured. Any jobs with variances greater than ε1.000 are displayed on this report. These reports are distributed to the managers, planners or schedulers and plant accountants, which permits people to ask questions while the job is still fresh in everyone's mind.
This leads to:

3. Timely corrective action

Because each job is "costed" (transferred out of work-in-progress and into finished-goods) 10 days after the job has closed, there is adequate time for necessary corrective action. For example, investigating a large material quantity variance might reveal that certain defective finished parts were not included in the final tally of finished goods. Such timely information would allow management to decide whether to rework these parts or to increase the size of the next job. This kind of corrective action was not possible when variances were provided at the end of each month.

4. Effective control system

Summary reports are run weekly, beginning the second week of each month, to show each variance in total euro's as well as each variance by product line and each batch within the product line. In addition, at month-end, the database is up-dated with all variance-related information. As a result, business unit managers can review variances by part number, by job, or by high euro volume.

5. Employee training and empowerment.

Meetings are held regularly with the employees to explain variances and earnings statements for their BU, thereby creating a more positive atmosphere in which the business unit team can work. These meetings help employees understand that management decisions are based on the numbers discussed and that if erroneous data are put into the system, then erroneous decisions may be made. For example, a machine may not be running efficiently. An operator may clock off the job so that his or her efficiency does not look bad. Because the machine's efficiency is not adversely impacted, no maintenance is done to that machine and the inefficiency continues. In addition, because the operator is not charging his or her cost to a job, the cost is being included in indirect labour and manufacturing costs increase. If the operator had reported the hours correctly, management would have questioned the problem and the machine would have been fixed or replaced based on how severe the problems were.

In addition to the aforementioned innovations that Carpenter & Millbridge has made to adapt its costing system to its particular business environment, the company has created the following new variances:

1. the standard run quantity variance (SRQV) to explain situations where the size of a lot is less than the optimal batch quantity.
2. the method variance (MV) to assess situations where different machines can be used for the same job.

3. the material substitution variance (MSV) to evaluate the feasibility of alternative raw materials.

Exhibits 1 and 2 (in appendix[1]) provide the production and cost data for the year ended. Per set-up and per machine the welding alloys business unit can produce up to 2.000 units. The business unit uses two machines. The older machine is of the SD70-X type. It has the same capacity as the new machine (SD95-XL) but requires more direct labour per machine hour than the newer machine and it can produce fewer units per machine hour. Both machines have been in operation during the past year, but the older machine (SD70-X) was switched on only when the SD95-XL could not cope with the planned production (see exhibit 2), i.e. whenever the weekly production exceeded 10.000 units.
Weekly machine maintenance costs amounted to a fixed ε 300,00 (in total for the two machines) and the wage rate was ε 10,00 per labour hour throughout the whole year ended. During the past year 6 full-time equivalents of production labour were hired. Based on a 40-hour work-week, this amounts to a production labour capacity of 11.520 labour hours. Each the SD-95-XL and the older SD70-X have a normal yearly capacity of 9.600 machine hours in total .

1. The Standard Run Quantity Variance (SRQV)

The SRQV represents the amount of set-up cost that was not recovered because the batch size was smaller than the earlier determined optimal batch size. This optimal capacity equals the daily machine capacity of 2.000 units of production on both machines (SD70-X and SD95-XL), whence one set-up per day per machine would be optimal. Because set-up costs are included in the (indirect) labour hours, producing a smaller quantity than the standard batch quantity is likely to create an unfavourable labour efficiency variance (LEV). Unless, however, the impact of actual production inefficiencies is separated from setup-related inefficiencies, the LEV reflects the combined impact of these two causes of inefficiencies and is not really useful for taking the necessary corrective action.
Consider the following example:

Carpenter & Millbridge Ltd. – Welding Alloys BU
Example 1
SRQV: Facts and Workings

	Set-up	Production	Total
- Standard labour time per unit (hours)	4[2]		
- Standard production time[3] (MH/unit)		0,02[4]	

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[1] Data also available on diskette: C&M WA BU.xls
[2] Company's estimate.
[3] Company's estimate for machine hours per unit of production based on the new machine (SD95-XL).
[4] Company's estimate for direct labour hours per unit of production and given the optimal batch size (2.000 units).

- Standard DLH per unit[5] (DLH/unit) $\quad$ 0,02[6]
- Standard (optimal) batch size[7] (units) $\quad$ 2.000
- Standard time per unit (hours/unit) $\quad$ 0,002[8] $\quad$ 0,04[9] $\quad$ 0,042[10]
- Standard labour rate (ε/hour) $\quad$ 10
- Actual production (units) $\quad$ 1.200
- Actual set-up labour time (hours) $\quad$ 4
- Actual total direct labour time (hours) $\quad$ 24
- Actual machine time on SD95-XL $\quad$ 24

Calculations:

<u>If SRQV is determined:</u>
- budgeted labour costs: $\quad$ (24+0,002*1.200)*10 $\quad$ 264
- **SRQV:** $\quad$ **(4–2,40)*10** $\quad$ **16 (U)**
- **LEV:** $\quad$ **(28-28)*10** $\quad$ **<u>0</u>**
- Accrued payroll (actual labour cost): (24+4)*10 $\quad$ 280

<u>If SRQV is **NOT** determined:</u>
- budgeted labour costs: $\quad$ (26.4)*10 $\quad$ 264
- **LEV:** $\quad$ **28-(1.200*0,022)*10** $\quad$ **<u>16 (U)</u>**
- Accrued payroll (actual labour cost): (24+4)*10 $\quad$ 280

2. The Method Variance (MV)

A method variance occurs when more than one machine can be used to manufacture a product. For example, the welding alloys BU of Carpenter & Millbridge has a newer machine (SD95-XL) that it normally would expect to use to manufacture a product, so its standards would be based on such new machines. Yet, the BU also keeps, as a back-up, an older and less efficient machine (SD70-X) that can also manufacture the same product but would require more inputs in the form of machine and labour hours. In order to illustrate this example, consider the company's estimate for the amount of direct labour per unit of production 1/30. As a result, the method variance becomes pertinent because the LEV (labour efficiency variance) from operating the older machines could potentially include the following two impacts. First an older machine may need additional labour hours to perform the same task, and the additional hours would be reflected in the LEV. Second, the LEV would include the workers' efficiency or the lack thereof on the older machine. The usefulness of calculating or extracting the Method Variance (MV), can be illustrated by analysing example 2, where the analysis shows that labour efficiency exceeded standards, although total direct labour costs exceeded the standard amount as calculated on the basis of using the new machine SD95-XL.

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[5] Direct labour per unit of production based on the new machine (SD95-XL).
[6] Company's estimate based on using the SD95-XL machine.
[7] This holds for both the SD70-X and the SD95-XL machines.
[8] Standard set-up time (4 hours) devided by the standard production per batch (2.000 units).
[9] Sum of the standard direct labour and the machine production time.
[10] Sum of the standard set-up time and the standard production time per unit.

Carpenter & Millbridge Ltd. – Welding Alloys BU
Example 2
Method Variance (MV): Facts & Workings

- SD95-XL: standard DLH needed for one unit (minutes)   1,20
- Labour wage rate per hour: 10
- Actual quantity produced on SD70-X (units):   1.200
- Actual direct labour hours used to make 1.200 units: 38
- Actual direct labour costs (ε):   380

Calculations:

    <u>If the MV is calculated:</u>
    - Standard DL cost for 1.200 units: (1,20/60)*1.200*10   240
    - MV: **(1/30 – 0.02)*1.200*10**   **160 (U)**
    - LEV: **(38/1.200-1/30)*1.200*10**   <u>**-20 (F)**</u>
- Actual direct labour costs: 380

    <u>If the MV is NOT calculated:</u>
    - Standard DL cost for 1.200 units: (1,20/60)*1.200*10   240
    - LEV: **(38/1.200 – 1,20/60)*1.200*10**   <u>**140 (U)**</u>
    - Actual direct labour costs: 380

3. The Material Substitution Variance (MSV)

The MSV assumes perfect or near substitutability of raw materials and measures the loss or gain in material costs when a different raw material is used as a substitute for the material designated in the job sheet. Substitutions may be made for many reasons. For example, the designated material may not be available or may not be available in small-enough quantities, or the company may want to use up material it purchased for a product that is discontinued.

In the case of the welding alloys business unit, raw material R comes cheaper than raw material S. The price of material R (per kilogram) is ε0,95, whereas material S comes at ε1,075 per kilogram. The problem now is that the supplier of both raw materials can supply a maximum of 1.850 kilograms of material R per set of 4 weeks (month), allowing a maximum production of 37.000 units. Carpenter& Millbridge, therefore always order this amount, and whenever in a particular month the whole supply of material R is not used, it is kept for production in the following month[11]. Sometimes, however, as exhibit 3 (in appendix[12]) shows, an extra amount of material S is to be ordered such that monthly planned production can go ahead. Both materials R and S are used at a standard (budgeted) rate of 0,05 kilograms per unit of production. Material usage variances are believed to be minimal and are, therefore, neglected.

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[11] There were no raw material inventories at the beginning of the year.

[12] See also diskette C&M WA BU.xls

The usefulness of MSV can be illustrated by analysing the data in example 3. Both materials R and S can be used to manufacture the product. Material R is the material designated but materials S and R are substitutes. Suppose material S is used because R is not available and a valued costumer needs a rush job.

Carpenter & Millbridge Ltd. – Welding Alloys BU
Example 3
MSV: Facts and Workings

- Price per kilogram of material R			ε0,95
- Price per kilogram of material S			ε1,075
- Standard material quantity to make 100 units (kilograms)			5
- Actual quantity produced (units)			2.000
- Actual kilograms used	R	80	
	S	19	

Calculations:

If MSV is determined:
- standard cost raw material (R) used:	100*0,95	95,00
- MEV:	(80*0,95+20*1,075)-95	**2,50(U)**
- MSV-price:		0,00
- MSV-efficiency:	(19-20)*1,075	-1,075
- MSV-total:		**-1,075(F)**
- Actual costs materials used:	(80*0,95 + 19*1,075)	96,425

If MSV is NOT determined:
- standard cost raw material (R) used:	(100*0,95)	95,00
- MEV:		**1,425(U)**
- Actual costs materials used:	(80*0,95 + 19*1,075)	96,425

4. Sales & General Administration

Exhibit 4 (in appendix[13]) provides monthly data on sales & general administration (S&GA) costs. These overhead costs are not – or only indirectly -related to production volume but relate to the administration and invoicing of sales orders. These costs not only include the wage of the person responsible for the administration but also all other (variable) costs that are driven by the number of sales orders[14]. Normally, the administration immediately proceeds sales orders to production and a set-up and production run follows. S&GA labour capacity for the year ended was 960 hours, based on the 0,5 fte used throughout the year.

5. Sales and Revenues

Carpenter & Millbridge operates in what it always took to be a "buyer-market". By this is meant that the company always produced exactly the amount its industrial clients wanted, given the company's

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[13] See also diskette C&M WA BU.xls

[14] The welding alloys business unit hired one person (0,5 fte, i.e. full-time equivalent) at a wage rate of ε10/hour.

listed sales price. An overview of the prices set by the company during the past year is given in Exhibit 5 (in appendix[15]).

The company has never really tried to use its geographical market power by, for example, playing with the demand function it faces.

Assignments

Consider the following data on a job order of 1.600 units.

1.400 Units were processed on the SD95-XL machine, 200 units on the SD70-X machine. Actual machine hours used on this job were 27,3 SD95-XL machine hours and 5,4 SD70-X machine hours. Total direct labour hours (for the 1.600 units) amounted to 34,6 hours, not including set-up labour hours of 3,9 hours. For the job both raw materials R and S were used: 62,5 kilograms of R (at a raw material purchase price of ε 0,95) and 28,5 kilograms of S (at a raw material price of ε 1,05) were consumed.
The goods were sold at a price of ε-cent 38,9.

1. Calculate the SRQV, MV and MSV. Check whether the standard rates mentioned in the main text examples still apply. If they do not, use the ones you think are more appropriate. Explain what you are doing (and why!) and discuss your findings.
2. Calculate estimate profits this job would bring in using (i) "traditional" full cost allocation (volume driven) and (ii) on the basis of an ABC-method. Explain what you are doing and discuss the difference(s) you find.
3. Do you think the sales price of ε-cent 38,9 maximises profits? Estimate demand and caculate maximum expected profits under (i) full-costing and (ii) ABC. Discuss the role of demand elasticity!
4. Discuss the advantages of calculating the SRQV, MV and MSV and the links with activity-based costing (ABC) and Just-in-time management (JIT).

Related literature

Cheatham, C. & L.R. Cheatham, 1996, Redesigning Cost systems: Is Standard Costing Obsolete?, Accounting Horizons, December 1996, pp. 23-31

Harrell, H., 1992, Materials Variance Analysis and JIT: A New Approach, Management Accounting, May 1992, pp. 33-38

Johnsen, D. & P. Sopariwalla, 2000, Standard Costing Is Alive and Well at Parker Brass, Management Accounting Quarterly, Winter 2000, pp. 12-20

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[15] See diskette C&M WA BU.xls

Appendix

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Carpenter & Millbridge Ltd. – Welding Alloys BU
Exhibit 1
Weekly production data (exclusive raw material costs)

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Week	SU[16]	PROD[17]	DLH[18] (hours)	TPC[19]
1	7	14	327,25	ε 3.842,50
2	5	11	225	ε 2.742,50
3	3	6	125,5	ε 1.675,00
4	4	10	194,25	ε 2.397,50
5	6	12,5	285,25	ε 3.395,00
6	5	9	180,75	ε 2.305,00
7	5	9,5	184,5	ε 2.355,00
8	3	6,5	129,25	ε 1.717,50
9	5	10	208,5	ε 2.590,00
10	7	14,5	337,75	ε 3.970,00
11	5	10,75	235,25	ε2.862,50
12	5	10	202,75	ε 2.522,50
13	4	8	167,5	ε 2.132,50
14	4	7,9	154	ε 2.005,00
15	5	10,5	207	ε 2.565,00
16	5	10	208	ε 2.575,00
17	5	10,5	215,75	ε2.655,00
18	6	12	272,75	ε 3.262,50
19	3	5,5	112,5	ε 1.542,50
20	5	10	194,75	ε 2.452,50
21	7	13,5	320,25	ε 3.795,00
22	5	10	191,5	ε2.415,00
23	5	10	208,25	ε2.590,00
24	5	9,75	195,5	ε 2.455,00
25	6	12	273	ε3.267,50
26	3	6,2	123,75	ε 1.657,50
27	3	5,75	120,25	ε 1.627,50
28	5	10	198,25	ε 2.480,00
29	5	10	196,75	ε 2.470,00
30	5	8	155	ε 2.045,00
31	5	10	191	ε 2.412,50
32	5	8,75	170,25	ε 2.200,00
33	3	5,9	120,25	ε 1.617,50
34	5	10	193,75	ε 2.435,00
35	4	8,25	173	ε 2.195,00
36	6	9	183,25	ε 2.372,50
37	5	10,45	216	ε 2.665,00
38	5	10	208,25	ε 2.575,00
39	5	10	208,25	ε 2.590,00
40	4	7,8	163,25	ε 2.100,00
41	4	8	163,75	ε 2.095,00
42	6	12	255,5	ε 3.102,50
43	5	10,1	198	ε 2.472,50
44	7	14	335,5	ε 3.927,50
45	5	10	203,25	ε 2.540,00
46	5	9,9	195,75	ε 2.455,00
47	5	10,55	215	ε 2.657,50
48	7	14	338,25	ε 3.950,00

[16] SU = number of set-ups that week.
[17] PROD = units of production (in thousands)
[18] DLH: Total Labour Hours, excluding set-up & maintenance labour hours.
[19] TPC = Total Production Cost in ε, including weekly (fixed) machine maintenance costs and including direct and indirect (set-up) labour, calculated at constant wage rate of ε 10 per labour hour throughout the whole year. TPC does not include material costs, nor does it include Sales & General Administration (SGA).

Carpenter & Millbridge Ltd. – Welding Alloys BU
Exhibit 2
Actual Machine Hours (monthly data)

Week	machine hours (SD95-XL)	machine hours (SD70-X)
1-4	703,50	140,00
5-8	698,75	67,50
9-12	812,25	143,50
13-16	720,25	13,50
17-20	715,00	67,25
21-24	798,50	97,50
25-28	646,75	57,00
29-32	713,00	0,00
33-36	670,25	0,00
37-40	781,25	12,00
41-44	748,00	170,50
45-48	796,25	130,00

Carpenter & Millbridge Ltd. – Welding Alloys BU
Exhibit 3
Actual Material Usage & Costs (monthly data)

Week	Production[20]	Raw material R[21]	Raw material S[22]	TMC[23]
1-4	41.000	1850,00	198,50	ε1.971
5-8	37.500	1.850,00	25,40	ε1.785
9-12	45.250	1.850,00	417,50	ε2.207
13-16	36.400	1.805,00	0,00	ε1.715
17-20	38.000	1.895,00	4,90	ε1.806
21-24	43.250	1.850,00	308,00	ε2.089
25-28	33.950	1.700,00	0,00	ε1.615
29-32	36.750	1.840,00	0,00	ε1.748
33-36	33.150	1.655,00	0,00	ε1.572
37-40	38.250	1.912,50	0,00	ε1.817
41-44	44.100	2.142,50	63,00	ε2.103
45-48	44.450	1.850,00	390,00	ε2.177

Carpenter & Millbridge Ltd. – Welding Alloys BU
Exhibit 4
Actual SG&A costs (monthly data)

Week	S&GA
1-4	ε1.206
5-8	ε1.201
9-12	ε1.255
13-16	ε1.136
17-20	ε1.164
21-24	ε1.216
25-28	ε1.140
29-32	ε1.189
33-36	ε1.127
37-40	ε1.186
41-44	ε1.204
45-48	ε1.272

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[20] Units produced in the 4-week time-span (see exhibit 1).
[21] Actual usage in kilograms.
[22] Actual usage in kilograms
[23] TMC = Total Material Cost at prices for R and S per kilogram being the same throughout the whole year: ε0,95 resp. ε1,075.

Carpenter & Millbridge Ltd. – Welding Alloys BU
Exhibit 5
Actual Sale Prices and Revenues (monthly data)

Week	Sales price[24]	Revenues
1-4	39,47	ε16.183
5-8	39,94	ε14.978
9-12	38,89	ε17.598
13-16	40,09	ε14.593
17-20	39,87	ε15.151
21-24	39,16	ε16.937
25-28	40,42	ε13.723
29-32	40,04	ε14.715
33-36	40,52	ε13.432
37-40	39,84	ε15.239
41-44	39,05	ε17.221
45-48	39,00	ε17.336
Total		ε187.106

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[24] Prices in eurocents per unit.