P. Sandborn, *Cost Analysis of Electronic Systems*, 1st Edition, World Scientific, Singapore, 2013.

Errata (1st Edition)

Page 28 Equation (2.7) should be, $N_u = \left\lfloor \frac{\pi(0.5D_W - E)^2}{(S+K)^2} e^{-\left[\frac{S+K}{0.5D_W - E}\right]} \right\rfloor$

The "L" appearing in the equation in the book does in fact appear in the original reference [2.2], however, in the original reference it is meant to indicate a "floor" function, not the variable L.

Page 51, The line after Equation (3.37), $(C_{in} + C_1 + C_2)/Y_{in}Y_1Y_2$ should be $(C_{in} + C_1 + C_2)/(Y_{in}Y_1Y_2)$

Page 55 Problem 3.6 should refer to Equation (3.30).

Page 175 In item 3) in Section 9.2.4 $\lceil (N+1)U \rceil$ should be $\lceil NU \rceil$.

Page 178 The second line from the bottom of the page, "95%" should be removed.

Page 187 In Problem 9.3 $\lceil (N+1)U \rceil$ should be $\lceil NU \rceil$.

Page 187, Problem 9.8 in the figure, "19 = x = 50" should be "$19 \leq x \leq 50$"

Page 212 Problem 10.3, the difference in cost between units 51 and 52 should be $0.53.

Page 226, Table 11.1, the last column title should include "per 100 hours". The correct numerical values for the last column should be: 0.010, 0.030, 0.104, 0.244, 0.477, 0.559, 0.800, 0.667, 1.000

Page 227, Figure 11.4, the numerical values on the vertical axis in the right plot should be removed, they do not correspond to a continuous PDF, $f(t)$ that represents the data.

Page 248 Problem 12.10, the problem is missing a repair operation set-up cost (assume $500 for each case).

Page 253 "Games pot" should be "GameStop"

Page 262 The second and third sentences in the paragraph before Equation (13.25) should read: "The expected number of first-time warranty claims in the interval $(0,t]$ is $\alpha F(t)$; if we assume a constant failure rate then this becomes $\alpha(1-e^{-\lambda t})$. Therefore, the expected number of warranty claims in an incremental time, dt, is $\alpha\lambda e^{-\lambda t}dt$ (if the failure rate is small, this can be approximated using $\alpha\lambda dt$."

Page 281 In item (1) in Section 14.4, "1-F( )" should be "F( )".

Page 291 In the sentence before Equation (15.13), "T" and "t" should be switched.

Page 292 Footnote 4, "μ is the ln(t)." should be "μ is the mean of ln(t)."

Page 320 The definition of i after Equation (16.13) should be just "the year", not "the years until refresh"

Page 320 After Equation (16.15), in the data for the example case shown in Fig. 16.6 $Y_R = 20$ should be omitted. The solution is a function of Y_R.

Page 321 The line after Equation (16.17) should read: "Solving Equation (16.17) for Y_R we get[9]"

Page 321 The second Equation (16.17) should be (16.18).

Page 324 Equation (16.18) should be (16.19).

Pages 327-328 In Problems 16.11 and 16.12, C_{DRI_0} should be C_{DR_0}.

Page 376 In Problem 19.2b, the burden rate should be 0.6 to be consistent with the definition of burden rate in Equation (1.3).

Page 393 $V_n =$ "future" value, not "present" value

Pages 406-407 $f^*(s)$, $m^*(s)$, $g^*(s)$ should be $\hat{f}(s)$, $\hat{m}(s)$ and $\hat{g}(s)$ respectively

Errata (online Kindle Edition only) (1st Edition)

Section 8.3.1 "$N_{out} = M_{01} + N_{02} = 87.5 + 7.88 = 95.38$" should be "$N_{out} = N_{01} + N_{02} = 87.5 + 7.88 = 95.38$"

Section 13.3.1 In Equation (13.22), "TW" should be "T_W"

Clarifications and Comments (1st Edition)

Section 3.3 Often each process step will have its own yield model. Therefore, the most general way to accumulate yield is to calculate the individual step yields and take the product, as opposed to summing the defect densities through the process steps and calculating the yield from the total defect density (this assumes that all the steps are governed by the same yield model).

Section 4.4 In the final paragraph a calculation is performed to determine the value of C_C of Machine B from the COO analysis. This calculation results in a value of \$3.09/wafer, which is incorrect. The problem with this calculation is that the production penalty is not part of the cost of Machine B and should be removed. The production penalty is included for comparison purposes only. With the production penalty removed, the effective cost per wafer is \$3729/5498 = \$0.68. There is still nearly an order of magnitude difference between the estimated equipment cost from Section 2.3.2 and this estimate (0.68 >> 0.0872). Equation (2.4) does not account for the following: salvage value, consumable costs, labor costs associated with maintenance, product investment lost (scrappage) due to errors caused by this machine, product repair costs due to errors caused by this machine (this is a large contribution), and lost product cost (this is also a large contribution). Equation (2.4) attempts to account for all the sustainment and the performance cost associated with the machine, with a single factor of 0.6 utilization.

Page 79 Note that the ABC total for Product B in Table 5.4 is actually \$119.474 (all the Table 5.4 numbers are rounded to the nearest dollar). Therefore (in the second line from the bottom of the page) the total ABC expenditure for both products is: (100)(\$265)+(950)(\$119.474) = \$140,000, which is exactly the same as the total expenditure using the TCA approach.

Page 111 Equations (7.14) and (7.15) were previously derived in Section 3.2.1.

Section 7.6.2 It is unclear from the text what “parallel test steps” means. If the parallel test in Figure 7.11 effectively represents a single test that has a different fault coverage with respect to two different defect types (1 and 2), what are Y_{out}, C_{out} and S? Assuming that the total test cost is just C_{test} and that defects 1 and 2 are independent, i.e., no parts have both defects 1 and 2. In this case, $Y_{in} = Y_{in1}Y_{in2}$ and Y_{out} is correctly given by Equation (7.54). If we let $C_{test1} = C_{test}$ and $C_{test2} = 0$ (of vice versa) then C_{out} becomes,

$$C_{out} = \frac{C_{in} + C_{test}}{Y_{in1}^{f_{c1}} Y_{in2}^{f_{c2}}} \tag{7.55}$$

and the total scrap is P,

$$S = 1 - Y_{in1}^{f_{c1}} Y_{in2}^{f_{c2}} \tag{7.56}$$

Note, there are other possible interpretations of a parallel test step and Figure 7.11. One alternative is that if Figure 7.10 represents a logical “AND”, then Figure 7.11 could represent a logical “OR”. In this case, the parallel test step requires a “gatekeeper” that sorts parts into either Test 1 or Test 2 (but not both). If this is the case then an additional parameter is needed that defines the fraction of the parts sorted into one or the other test.

Page 163 Problem 8.2 Assume that the process remains a single-pass process, i.e., the modules scrapped by the test step after rework are scrapped (not diagnosed and reworked again).

Page 179 The confidence levels in Table 9.1 are “two-sided confidence intervals”.

Page 180 Last line, “\$44 (717)” means that there are 717 values that are below \$44.

Page 187 The "confidence" stated in Problem 9.6 is a "two-sided confidence interval".

Page 205 Figure 10.11 and the paragraph that surrounds it incorrectly implies that the learning index from the cumulative average learning curve can be used to find the midpoint in the unit learning curve. This is not correct. The learning index for the cumulative average learning curve and the unit learning curve are in general not the same. In order to use the midpoint formula in Equation (10.20), the learning index for the unit learning curve must be found.

Section 11.2.1, Technically you can't convert a histogram to a PDF because you don't have enough information to do it. However, you can try to find a distribution that "looks like" the histogram. If your histogram looks like a normal distribution, you could assume the distribution is normal and do a fit to find the parameters, then claim that is the PDF. For example, you can calculate the mean and standard deviation of a histogram that can be used to determine a normal distribution. In Figure 11.4, the numerical values on the vertical axis in the right plot should be removed, they do not correspond to a continuous PDF, $f(t)$ that represents the data. If you have the data used to create the histogram there are numerical approaches, e.g., kernel density estimation, which can numerically produce a distribution.

Page 242 The z that appears in Equation (12.14) is a single-sided z-score (the z that appears in Equation (9.12) is two-sided).

Page 248 Problem 12.10 is an Economic Production Quantity (EPQ) problem. EPQ is a simple extension of EOQ, but is not covered in Chapter 12.

Page 262 The exact form of Equations (13.25)-(13.27) are (the present version of these equations are valid only for small failure rate):

$$d(C_{rw} - C_{fw}) = Rb(t)\alpha\lambda e^{-\lambda t}dt = \theta\left(1 - \frac{t}{T_W}\right)\alpha\lambda e^{-\lambda t}dt \tag{13.25}$$

$$C_{rw} = C_{fw} + \int_0^{T_w} \theta\left(1 - \frac{t}{T_W}\right)\alpha\lambda e^{-\lambda t}dt = C_{fw} + \theta\alpha\left[1 - \frac{1 - e^{-\lambda T_w}}{\lambda T_w}\right] \tag{13.26}$$

$$C_{pw} = \frac{C_{rw}}{\alpha} = \frac{C_{fw}}{\alpha} + \theta\left[1 - \frac{1 - e^{-\lambda T_w}}{\lambda T_w}\right] \tag{13.27}$$

Page 262-263 Using the exact for of Equations (13.25)-(13.27), the example at the bottom of page 262 and the top of the page has a final value of $204.86 (and corresponding corrections to the last paragraph in Section 13.3.2).

Page 264 The exact form of Equation (13.34) is (the present version of this equation is only valid for small failure rate):

$$\mathrm{E}\left[X(t)\right] = \int_0^{T_w} \alpha\theta\left(1 - \frac{t}{T_W}\right)e^{-rt}\lambda e^{-\lambda t}dt = \frac{\alpha\theta\lambda}{\lambda + r}\left[1 - \frac{\left(1 - e^{-(\lambda + r)T_w}\right)}{(\lambda + r)T_w}\right] \tag{13.34}$$

Page 294 m is used in Equation (15.21) and associated discussion to represent the number of backorders. This usage of m does not appear in the Notation Appendix for Chapter 15. m is also used in this Chapter to represent the renewal density function.

Pages 312-315 The use of a normal distribution for representing demand is in general inappropriate since the normal distribution includes values of demand that are less than 0. The analysis can be done with any distribution and a distribution which cannot have values below 0 would be more appropriate for the example chosen.

Page 321 A distinction should be made between Y_R and the Y_R that minimizes life-cycle cost. The horizontal axis in Fig. 16.6 is Y_R; the Y_R appearing in Equation (16.17) and the text after Equation (16.17) is the Y_R that minimizes life-cycle cost.

Page 321 Equation (16.17) is only applicable when $r > 0$ (non-zero discount rate) and $rC_{CRo} \geq P_0Q$. For cases where $r = 0$ or $rC_{CRo} < P_0Q$ the optimum refresh date is at $Y_R = 0$.

Pages 319-322 The Porter model only treats the cost of supporting the system up to the refresh, i.e., there is no accommodation for costs incurred after the refresh. In the Porter model, the analysis terminates at Y_R. This means that the time span between the refresh (Y_R) and the end of support of the system is not modeled, i.e., the costs associated with buying parts after the refresh to support the system to some future end-of-support date are not included and are not relevant for determining the optimum refresh date.

Page 335 In Table 17.2, $130,000 is per person.

Page 337, In Equation (17.4), r should be a fraction and D_S and M_S must be percentages.

Page 375, Problem 19.1, the table describing the two groups appears at the top of page 431. Both groups use the Technical Complexity Factors given.

Page 376, Problem 19.1b, the information to solve this part is not contained in the chapter. You must consult [Ref. 19.8] to obtain the appropriate conversion factors.