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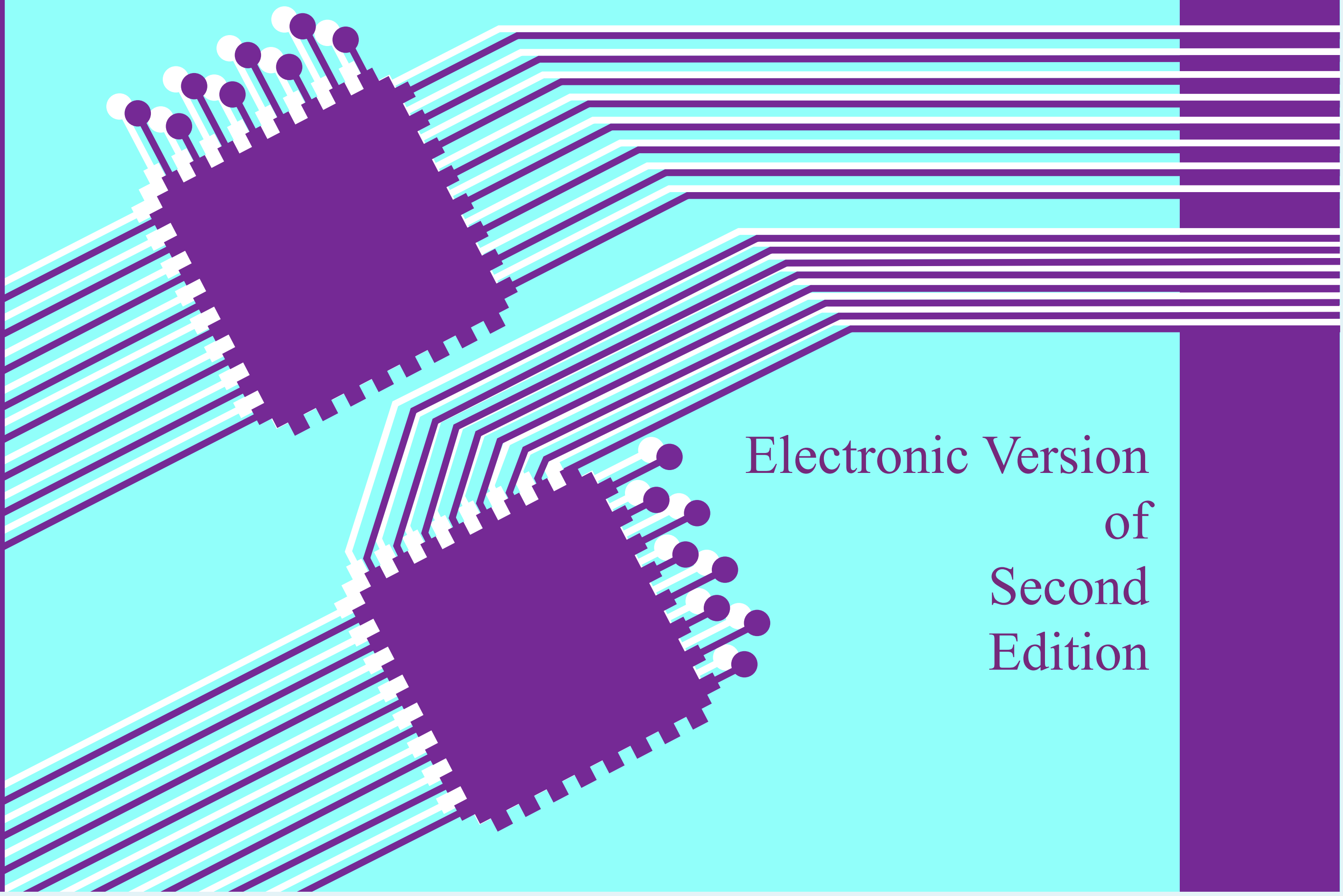
The Economics of Automatic Testing

Chapter 11
Financial appraisal

Brendan Davis



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IRR calculation using UK capital allowances	= 10.63%
NPV with inflation of 5% added to MARR	= –$3,643
NPV with 5% inflation added to MARR and savings	= $3,541
NPV with 5% inflation added to MARR, saving and depreciation	= $7,373

11.18 Example: Comparing three alternative in-circuit board testers

DEF Electronics manufacture professional audio equipment. They have been using a fairly simple tester but as their production volume has grown this is rapidly running out of steam both in terms of capacity and the ability to cope with increased complexity. Having researched the available equipment they narrowed the field down to three testers with varying degrees of price and performance.

After a thorough evaluation of all three products DEF came to some conclusions about programming costs, test and diagnosis times, diagnostic accuracy, fault coverage and other important parameters. Using a commercially available test strategy cost model the DEF engineers performed a comparison of cost and quality considerations for the three short-listed testers. The results of this analysis are summarized in Table 11.17. This data was then used to develop net present values for the three alternatives using an MARR of 15 per cent, a five year straight-line depreciation and a 50 per cent tax rate. Since taxes on incremental profits resulting from the investment would be paid in the following tax year, they shifted the tax on savings by one year and added a sixth year to the calculation to account for the taxes on the year 5 savings. Since this investment will be for additional equipment, relative to continuing with present methods, the whole cost of the testers is used as the incremental investment amount. The results of the NPV calculations are shown in Tables 11.18A, 11.18B & 11.18C.

Obviously system A is the winner with a profitability index of 2.04 relative to the next best alternative, system B, with a PI of 1.61. Incidentally, an IRR calculation based on the net cash flows for system A gives the result of 54.19 per cent. The reinvestment assumption would require that the cash flows generated by this investment would have to be reinvested each year in something that would return 54.19 per cent (after tax) for this IRR to be valid. Clearly the IRR method is not appropriate for high return projects. The IRR calculated for system C is 17.9 per cent. This is quite a good return even though system C is clearly the poorest use of funds of these three alternatives. This highlights a potential problem with ATE or any other investment in automation when the current method is manual or semi-automatic. Even the poorest alternative may give a high ROI when compared to the present method. If DEF Electronics were to arbitrarily set themselves a capital budget limit of $150,000 they might not even perform an ROI analysis on system A.

If we assume that the present method of testing cannot cope with the problem and that one of the commercial testers has to be purchased, then we should look at the incremental situation as well as, or instead of, comparing the three testers with the non-viable current method. If we do this then the system with the highest operating costs effectively becomes the baseline case. This is obviously system C, because this showed the lowest savings relative to the current method. Since we have all of the data, we can simply compare system A to system C (or system B to system C) by using the difference between investments and the differences between the savings. If this is done using the same MARR of 15 per cent you will find that the net present value for investment in system A relative

	A	B	C
Present cost/board	18.22	18.22	18.22
Expected cost/board	9.21	11.51	13.82
Savings/board	9.01	6.71	4.4
Annual volume (1500 x 12)	18,000	18,000	18,000
Total savings	162,180	120,780	79,200
Avge. programming cost/board	3,000	4,000	5,000
Avge. fixture cost/board	5,000	4,000	3,500
First year set-up costs (10 bd types)	80,000	80,000	85,000
First year savings	82,180	40,780	42,500
Set-up costs for subsequent years (5 board types per year)	40,000	40,000	42,500
At the expected growth in board volume of 20% per year			
Year 2 operational savings	194,616	144,936	95,040
Year 2 savings after set-up costs	154,616	104,936	52,540
Year 3 operational savings	233,539	173,923	114,048
Year 3 savings after set-up costs	193,539	133,923	71,548
Year 4 operational savings	280,247	208,708	136,858
Year 4 savings after set-up costs	240,247	168,708	94,358
Year 5 operational savings	336,296	250,449	164,229
Year 5 savings after set-up costs	296,296	210,449	121,729

Table 11.17 Annual savings calculations for three alternatives

to system C is $195,986. This is the same as the difference between the NPVs for system A and system C when the two are compared with the baseline of the current method. This is only what you would logically expect, but clearly shows the concept of incremental investment as outlined in Chapter 4.

This positive cash flow of $195,986 (present value) over the six years we have looked at is the result of the incremental investment of $50,000 for system A relative to system C. The correct interpretation of this takes some thought because we already determined that system C will itself generate a good return relative to continuing with current methods. The return from system A over system C is therefore incremental, or in addition, to the return from system C. This is an important point when performing an incremental analysis. You, and your financial department, must not lose sight of the fact that any return will be on top of what would be a good return even for the poorest alternative. For example, if

System A: $200,000 investment							
Year	Savings	Tax on savings	Depn.	Tax saved (Depn.)	Net cash flows	PV factor 15.5%	DCF
1	82,180	0	40,000	20,000	102,180	0.866	88,897
2	154,616	41,090	40,000	20,000	133,526	0.756	101,480
3	193,539	77,308	40,000	20,000	136,231	0.649	89,912
4	240,247	96,770	40,000	20,000	163,477	0.562	93,182
5	296,296	120,124	40,000	20,000	196,172	0.487	98,086
6	0	148,148	0	0	(148,148)	0.421	(63,704)
						Present value =	407,853
Net present value (NPV) = $207,853							
Profitability Index (PI) = 407,853/200,000 = 2.04							

Figure 11.18A NPV and PI calculations for alternative A

System B: $180,000 investment							
Year	Savings	Tax on savings	Depn.	Tax saved (Depn.)	Net cash flows	PV factor 15.5%	DCF
1	40,780	0	36,000	58,780	102,180	0.866	51,139
2	104,936	20,390	36,000	18,000	102,546	0.756	77,935
3	133,923	55,468	36,000	18,000	99,455	0.649	65,640
4	168,708	66,962	36,000	18,000	119,746	0.562	68,225
5	210,449	84,354	36,000	18,000	144,095	0.487	72,048
6	0	105,225	0	0	(105,225)	0.421	(45,247)
						Present value =	289,770
Net present value (NPV) = $109,770							
Profitability Index (PI) = 289,770/180,000 = 1.61							

Table 11.18B NPV and PI calculations for alternative B

an incremental analysis shows a negative NPV when performed with your agreed upon MARR, the project may be thrown out for not meeting the criterion or hurdle rate. This is one time when performing an IRR calculation might be useful. If the MARR is, say, 15 per cent and the IRR for an incremental analysis is 10 per cent then you have to remember

System C: $150,000 investment							
Year	Savings	Tax on savings	Depn.	Tax saved (Depn.)	Net cash flows	PV factor 15.5%	DCF
1	(5,800)	0	30,000	15,000	9,200	0.866	8,004
2	52,540	(2900)	30,000	15,000	70,440	0.756	53,534
3	71,548	26,270	30,000	15,000	60,278	0.649	39,783
4	94,358	35,774	30,000	15,000	73,584	0.562	41,943
5	121,729	47,179	30,000	15,000	89,550	0.487	44,775
6	0	60,865	0	0	(60,865)	0.421	(26,172)
						Present value =	161,867
Net present value (NPV) = $11,867							
Profitability Index (PI) = 161,867/150,000 = 1.08							

Table 11.18C NPV and PI calculations for alternative C

that this is 10 per cent more than you would get if you chose the alternative used as the baseline. It is not an absolute 10 per cent because it was not an absolute analysis. The assumption here, of course, is that at least one of the alternatives has to be purchased in order to continue with production.

There is, however, a potential problem with using IRR in an incremental analysis. If the incremental investment is small relative to the baseline alternative, but there are large operating cost differences, then the calculated incremental IRR might be enormous and therefore will be totally meaningless. My own preference in cases where the purchase of a system is mandatory, because present methods cannot cope, is to assume that the return for any system will exceed the MARR and to simply compare the sum of the net cash flows (undiscounted) with the incremental investment.

For completeness let us now take a look at the payback times for the three alternative testers.

Payback calculations

The payback period can be determined by cumulating the net (undiscounted) cash flows to determine in which year the payback is reached, and then using interpolation to determine when in that year it is reached. For system A the cumulative cash flows are…