Blue Light Robotics and the NPV

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Blue Light Robotics (BLR) is an established business. Its best seller is the M line of general purpose robots. Blue Light knows that for every $1 in resources it spends on producing, researching and marketing the M line, it will receive $1.10, one year later.

This year, BLR has $1,000,000 to spend on projects. If it does what it usually does, and puts all the money toward the M line, it will spend $1,000,000 this year, and get $1,100,000 next year.

BLR's lead researcher, Dr. Weil, proposes an alternative. Dr. Weil has two new projects ready to go. Project X will cost $100,000 this year, and yield income of $200,000 one year later. Project Z will cost $500,000 this year, and yield income of $750,000 one year later. Dr. Weil's participation is crucial for both projects, so the projects are *mutually exclusive*. If BLR chooses to approve one project, Dr. Weil won't have enough time to work on the other.

There are therefore (at least) three options available to BLR this year, when it comes to using its $1,000,000.

- **Option 1**: BLR can spend all $1,000,000 on its M line, as it usually does. This will yield $1,100,000 next year.

- **Option 2**: BLR can approve **Project X**, spending $100,000 on it this year. The remaining $900,000 will be spent on the M line. Next year, this will yield $200,000 from Project X, plus $990,000 from the M line, for a total income of $1,190,000.

- **Option 3**: BLR can approve **Project Z**, spending $500,000 on it this year. The remaining $500,000 will be spent on the M line. Next year, this will yield $750,000 from Project Z, plus $550,000 from the M line, for a total income of $1,300,000.

Comparing the three projects, it's clear that while both Options 2 and 3 are better than Option 1 (business as usual), Option 3 is preferred. All three projects have the same expenditure this year, but Option 3 has the highest income next year. Specifically, compared to Option 1, next year Option 2 provides an extra $190,000, and Option 3 provides an extra $300,000.

There's another, equivalent way of looking at this. Suppose that BLR wanted to obtain the incomes from Options 2 and 3, investing *only* in their usual M line business. How much money would they have to put into the M line this year, to have $1,190,000 next year, as in Option 2, or $1,300,000 next year, as in Option 3?

Since the M line turns $1 invested today into $1.10 in income next year, they would need $1,190,000/1.1 = $1,081,818.18 to replicate the income from Option 2, or $1,300,000/1.1 = $1,181,818.18 to replicate the income from Option 3.

In other words, going for Option 2 provides the same benefits *as if* BLR had invested all of its $1,000,000, *plus* an addition $81,818 in the M line. In that sense, approving Project X is just as good as not approving it, and getting an extra $81,818 to spend on the M line this year.

Similarly, going for Option 3 provides the same benefits *as if* BLR had invested all of its $1,000,000, *plus* an addition $181,818 in the M line. In that sense, approving Project Z is just as good as not approving it, and getting an extra $181,818 to spend on the M line this year.

These amounts are the *net present values* (NPVs) of projects X and Z, evaluated at BLR's minimum acceptable rate of return (MARR), which in this case is the return it can obtain from investing money in its usual business, the M line of robots. Since investing $1 in the M line this year gives BLR $1.1 next year, by inspection BLR's MARR is 10% per year.

- Project X costs $100,000 this year and returns $200,000 next year.
- NPVX = -$100,000 + $200,000 x (P/F,10%,1) = -$100,000 + $200,000/1.1 = $81,818.18.

- Project Z costs $500,000 this year and returns $750,000 next year.
- NPVZ = -$500,000 + $750,000 x (P/F,10%,1) = -$500,000 + $750,000/1.1 = $181,818.18

Projects X and Z are mutually exclusive projects with the same lifetime, and so it is legitimate to compare their NPVs. Project Z's NPV is higher than that of Project X, so Project Z is preferred to Project X.

This is despite the fact that the internal rate of return on Project X (100% per year, by inspection) is greater than the return on Project Y (50% per year, by inspection). By choosing Project X over Project Z, BLR would be missing out on $1,300,000 - $1,190,000 = $110,000 next year.

An incremental rate of return analysis shows that 'upgrading' from Project X, with a lower initial cost, to Project Z, with a high initial cost, is worthwhile given BLR's MARR of 10% per year.

Incremental cash flows (Z-B): (-$500,000 – (-$100,000)) this year, plus ($750,000 - $200,000) next year = -$400,000 this year and $500,000 next year.

The NPV of these incremental flows is -$400,000 + $500,000 x (P/F,i,1) = -$400,000 + $500,000/(1+i). The NPV is zero at the IRR, so the IRR of the incremental cash flow (the incremental IRR, or IIRR) is 500,000/400,000 – 1 = 1.25 – 1 = .25 = 25%. Since this is greater than BLR's MARR of 10% per year, the 'project' of upgrading from choosing Project X, to choosing the more expensive Project Z, is worthwhile.