Disassembling the Replacement Analysis in Capital Budgeting

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When teaching capital budgeting replacement projects, instructors often struggle to explain why the market value of the old machine is recognized in addition to its continued depreciation. Typical explanations about capturing the effect of replacing the old machine and its true impact on the project fall short of illuminating the rationale behind this traditional approach. We disassemble the analysis into two parts: keeping the old machine and purchasing the new machine. This separation shows students that the old machine's sale is a benefit of purchasing the new machine and depreciating the old machine is associated with keeping the old machine.

Keywords: capital budgeting, replacement projects

INTRODUCTION

Capital replacement analysis is one of the key analyses in capital budgeting. The replacement of capital assets affords economic opportunity to the organization where the value of the old asset vs. the replaced asset must be analyzed. The need for replacing the current physical asset often is necessitated due to its decrease in value. One confusing aspect of capital replacement analysis is that the incremental impact of depreciation on the old machine is included as a negative cash flow even though the old machine is presumed to have been sold. When teaching capital budgeting, eventually the course material focuses on replacing an existing project. While the old project has a market value along with its existing depreciation, the next step is to show the incremental effects of adding a new project to an existing set of cash-flows. Textbooks (e.g., Brigham, 2022, Chapter 13) tend to recognize the impact of selling the old machine and yet still show the subtraction of the old depreciation as an incremental impact on a yearly basis.

Frequently, students will ask how both can exist—doesn't the sale of the old asset preclude the existence of its depreciation? One way to explain this conundrum is to argue, unsatisfactorily at times, that you are capturing the "true impact" of the replacement cost and that both can exist. Once pressed on this issue, the instructor often lacks a satisfactory explanation.

This article presents a different approach to the traditional incremental analysis by analyzing the old machine and the new machine separately, similar to the net advantage of leasing (NAL). The NAL calculates the NPV of leasing and of purchasing an asset separately and then nets the two. Not surprisingly, the net of the two individual analyses will equal the result of the combined analysis. This is akin to Shiller's (2012, p. 132) comments on conservation laws in finance that value cannot be created or destroyed via transactions or financing—meaning that value lies with underlying cash-flows and not the financing surrounding the assets. In terms of a balance sheet, it is the assets that create value, not the liabilities. Chen, S. J. & Mayes, T. R. (2012) look at a replacement problem but with the old and new assets having the same existing life. At the end of their article, projects with different lives are discussed but with the focus of using an equivalent annual annuity method to make the decision. Unlike Chen and Mayes, this article takes into account working capital and different useful lives, with the emphasis on using the NPV method to illustrate the conservation of value by demonstrating that the replacement NPV is equal to the difference between the new NPV and the old NPV.

This analysis can help reinforce the idea that a replacement decision is nothing more than two separate NPV's combined. From a pedagogical standpoint, students get a better understanding that recognizing the sale of the old machine and the recognition of its depreciation is consistent with an incremental after-tax cash-flow analysis. Several excel worksheets are included to help explain the process and make it clear to students that when taken separately, the analysis is correct to recognize the fair market value (FMV) of the old machine as well as the old machine's depreciation. The two are not interrelated. FMV of the old machine is a separate opportunity benefit from the old depreciation.

THE PROBLEM

Assume that an existing widget machine and its replacement have the following properties as shown in Table 1:

TABLE 1
INPUTS

	Old Machine	***New Machine***
Purchase Price	$400,000 (**5 years ago**)	$600,000
Market Value	$80,000	$600,000
Book Value	$200,000	$600,000
Salvage Value	$0 (**5 years from now**)	$70,000 (**10 years from now**)
Age	5	0
Original Life	10	10
Yearly capacity	45,000 units	55,000 units
Sales Price	$8/unit	$8/units
Yearly expenses	$55,000	$75,000
Training expenses	not applicable	$30,000
Inventory	$40,000	$50,000
Tax rate	40%	40%
Discount rate	10%	10%

A traditional replacement analysis would be as follows:

Initial (Year 0)

(\$600,000)	Purchase price
\$80,000	Market value
\$48,000	Tax benefit produced for selling at a loss (200,000 -80,000) *.4 = \$48,000
(\$18,000)	After-tax training
(\$10,000)	ΔWorking capital
(\$500,000)	Initial outlay (1)

Intermediate Years 1 - 10

Intermediate (Years 1 – 5)

Old Depr = \$400,000/10 = \$40,000
New Depr = \$600,000/10 = \$60,000

Note: Straight line depreciation is used throughout for simplicity, with an assumed salvage value of zero when calculating the annual depreciation. This will create a taxable event when the actual salvage value is received at the end.

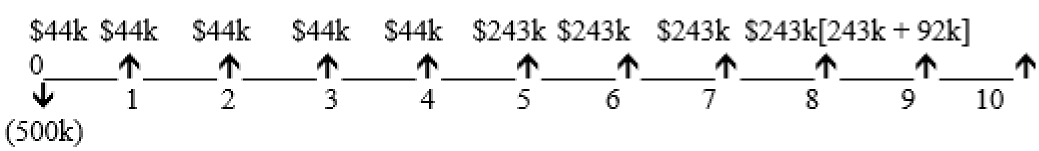
Δ $\text{Depr}_{1\text{-}5}$ = \$20,000
Δ $\text{Rev}_{1\text{-}5}$ = 10,000 units × \$8 = \$80,000
Δ $\text{Costs}_{1\text{-}5}$ = \$75,000- \$55,000 = \$20,000
$\Delta\text{CFAT}_{1\text{-}5}$ = (\$80,000 - \$20,000 -\$20,000) x (1-.40) + \$20,000
= \$44,000 (2a)

Intermediate (Years 6 – 10)

$\Delta\text{Rev}_{6\text{-}10}$ = \$440,000 - \$0 = \$440,000
$\Delta\text{Costs}_{6\text{-}10}$ = \$75,000 - \$0 = \$75,000
Δ $\text{Depr}_{6\text{-}10}$ = \$60,000 - \$0 = \$60,000
$\Delta\text{CFAT}_{6\text{-}10}$ = (\$440,000 - \$75,000 - \$60,000) x (1-.40) + \$60,000
= \$243,000 (2b)

Terminal (Year 10)

SV_{10} = \$70,000 x (1-.4) = \$42,000
ΔWC_{10} = \$50,000
ΔCFAT_{10} = \$42,000 + \$50,000 = \$92,000 (3)



Results

$\text{NPV}_{\text{Original @10\%}}$ = \$274,233
IRR = 17.52%

Table 2 illustrates the above traditional incremental analysis of netting the cashflows for the overlapping years.

TABLE 2
TRADITIONAL ANALYSIS OF OLD AND NEW MACHINES

Depreciable Basis = (Initial Cost - Salvage Value) * assume that the SV is zero.					$ 600,000						
Depreciable Life					10						
Annual Depreciation = Depreciable Basis/Number of years					$ 60,000						
Tax Rate	40%		Cost of Capital		10%						
Year	0	1	2	3	4	5	6	7	8	9	10
I. Initial Outlay											
Cost of new	($600,000)										
Training (1-t)	($18,000)										
Change in NWC	($10,000)										
Market Value of Old Mach	$80,000										
Tax Consequences	$48,000										
Total Initial Outlay	($500,000)										
II. Incremental Operation CFs											
Revenues		$80,000	$80,000	$80,000	$80,000	$80,000	$440,000	$440,000	$440,000	$440,000	$440,000
Less:											
Expenses		($20,000)	($20,000)	($20,000)	($20,000)	($20,000)	($75,000)	($75,000)	($75,000)	($75,000)	($75,000)
Depreciation		($20,000)	($20,000)	($20,000)	($20,000)	($20,000)	($60,000)	($60,000)	($60,000)	($60,000)	($60,000)
Equals:											
EBIT		$40,000	$40,000	$40,000	$40,000	$40,000	$305,000	$305,000	$305,000	$305,000	$305,000
Less:											
Taxes		($16,000)	($16,000)	($16,000)	($16,000)	($16,000)	($122,000)	($122,000)	($122,000)	($122,000)	($122,000)
EAT		$24,000	$24,000	$24,000	$24,000	$24,000	$183,000	$183,000	$183,000	$183,000	$183,000
+ Depreciation		$20,000	$20,000	$20,000	$20,000	$20,000	$60,000	$60,000	$60,000	$60,000	$60,000
Total Incremental Oper. CFs		$44,000	$44,000	$44,000	$44,000	$44,000	$243,000	$243,000	$243,000	$243,000	$243,000
Terminal CFs											
Salvage Value											$70,000
Tax Effect											($28,000)
Recovery of NWC											$50,000
Total Terminal CFs											$92,000
Cash Flows	($500,000)	$44,000	$44,000	$44,000	$44,000	$44,000	$243,000	$243,000	$243,000	$243,000	$335,000
PV of CFs	($500,000)	$40,000	$36,364	$33,058	$30,053	$27,321	$137,167	$124,697	$113,361	$103,056	$129,157
NPV	$274,233										
IRR	17.52%										

TRADITIONAL INCREMENTAL NETTING VS DISSASSEMBLING METHODS

How can you recognize a change in depreciation between the old and the new machines if you sell the old machine initially? In other words, are you double counting the benefit of the old depreciation?

Disassembling the Cashflows

The Old Machine

If we keep the old machine, we expect the following cash-flows:

Initial (Year 0)

$0 There are no initial costs associated with maintaining the old machine.

Intermediate (Years 1 – 5)

$Rev_{1\text{-}5}$ = 45,000 units × \$8 = \$360,000

$Costs_{1\text{-}5}$ = \$55,000

$Depr_{1\text{-}5}$ = \$400,000/10 = \$40,000

$$\Delta CFAT_{1\text{-}5} = (\$360{,}000 - 55{,}000 - 40{,}000)(1-.40) + 40{,}000 = \$199{,}000 \tag{4}$$

Terminal (Year 5)

ΔWC_5 \$40,000 (*Recovery of working capital*)

\$199k \$199k \$199k \$199k [\$199k+\$40k]
0 ↑ ↑ ↑ ↑ ↑
↓ 1 2 3 4 5

$NPV_{Old\ @10\%}$ = \$779,203

IRR_{Old} = N/A IRR_{Old} cannot be computed because there is no cash outflow.

Notice that the terminal cash flow in Year 5 for the old machine is the recovery of $40,000 of working capital, which was used to finance the initial inventory when the old machine was purchased five years ago. This cashflow is missing from the combined analysis in Table 2 because the working capital is not recovered until the end of the new machine's useful life. The above cashflow analysis for the old machine is illustrated in Table 3.

TABLE 3
ANALYSIS OF THE OLD MACHINE – INCLUDING WORKING CAPITAL

Depreciable Basis = (Initial Cost - Salvage Value) * assume that the SV is zero.					$ 400,000						
Depreciable Life					10						
Annual Depreciation = Depreciable Basis/Number of years					$ 40,000						
Tax Rate	40%		Cost of Capital		10%						
Year	0	1	2	3	4	5	6	7	8	9	10
I. Initial Outlay											
Market Value											
Book											
(Book - Mkt) tax rate											
Total Initial Outlay											
II. Incremental Operation CFs											
Revenues		$360,000.00	$360,000.00	$360,000.00	$360,000.00	$360,000.00					
Less:											
Expenses		($55,000.00)	($55,000.00)	($55,000.00)	($55,000.00)	($55,000.00)					
Depreciation		($40,000.00)	($40,000.00)	($40,000.00)	($40,000.00)	($40,000.00)					
Equals:											
EBIT		$265,000.00	$265,000.00	$265,000.00	$265,000.00	$265,000.00	$0.00	$0.00	$0.00	$0.00	$0.00
Less:											
Taxes		($106,000.00)	($106,000.00)	($106,000.00)	($106,000.00)	($106,000.00)	$0.00	$0.00	$0.00	$0.00	$0.00
EAT		$159,000.00	$159,000.00	$159,000.00	$159,000.00	$159,000.00	$0.00	$0.00	$0.00	$0.00	$0.00
+ Depreciation		$40,000.00	$40,000.00	$40,000.00	$40,000.00	$40,000.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total Incremental Oper. CFs		$199,000.00	$199,000.00	$199,000.00	$199,000.00	$199,000.00	$0.00	$0.00	$0.00	$0.00	$0.00
Terminal CFs											
Salvage Value						$0.00					
Tax Effect						$0.00					
Recovery of NWC						$40,000.00					
Total Terminal CFs						$40,000.00					
Cash Flows	$0.00	$199,000.00	$199,000.00	$199,000.00	$199,000.00	$239,000.00	$0.00	$0.00	$0.00	$0.00	$0.00
PV of CFs	$0.00	$180,909.09	$164,462.81	$149,511.65	$135,919.68	$148,400.20	$0.00	$0.00	$0.00	$0.00	$0.00
NPV	$779,203										
IRR	N/A										

The New Machine

If we consider purchasing the new machine and disposing the old machine at the present time, we expect the following cashflows:

Initial (Year 0)

($600,000)	Purchase price	
($18,000)	After-tax training	
$80,000	Sale of the old machine	
$48,000	Tax benefit on the loss of selling the old machine	
$24,827	PV of working capital opportunity benefit	
($10,000)	ΔWorking capital	
($475,163)	Initial outlay	(5)

Intermediate (Years 1 - 10)

Rev_{1-10} = 55,000 units × \$8 = \$440,000
$Costs_{1-10}$ = \$75,000
$Depr_{1-10}$ = \$600,000/10 = \$60,000

$$\Delta CFAT_{1-10} = (\$440,000 - 75,000 - 60,000)(1-.40) + \$60,000 = \$243,000 \quad (6)$$

Terminal (Year 10)

SV_{10} = \$70,000 x (1-.4) = \$42,000
ΔWC_{10} = \$50,000
$$\Delta CFAT_{10} = \$42,000 + \$50,000 = \$92,000 \quad (7)$$

0	1	2	3	4	5	6	7	8	9	10
↓ (\$475k)	↑ \$243k	↑ \$243k	↑ \$243k	↑ \$243k	↑ \$243k	↑ \$243k	↑ \$243k	↑ \$243k	↑ \$243k	↑ [\$243k + \$92k]

$NPV_{New\ @10\%}$ = \$1,053,437
IRR_{New} = 39.01%

Notice that the initial cashflows include the present value of working capital opportunity benefit. This item relates to the working capital needed to finance the initial inventory five years prior to the purchase of the new machine. This will be explained in more detail below. Table 4 illustrates the above cashflow analysis for the new machine.

TABLE 4
ANALYSIS OF THE NEW MACHINE – INCLUDING WORKING CAPITAL

Depreciable Basis = (Initial Cost - Salvage Value) * assume that the SV is zero.					\$ 600,000						
Depreciable Life					10						
Annual Depreciation = Depreciable Basis/Number of years					\$ 60,000						
Tax Rate	40%		Cost of Capital		10%						
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
I. Initial Outlay											
Cost of new	(\$600,000)										
Training (1-t)	(\$18,000)										
Sale of old Machine	\$80,000										
Tax credit on loss	\$48,000										
PV of WC opportunity	\$24,837										
Change in WC	(\$10,000)										
Total Initial Outlay	(\$475,163)										
II. Incremental Operation CFs											
Revenues		\$440,000	\$440,000	\$440,000	\$440,000	\$440,000	\$440,000	\$440,000	\$440,000	\$440,000	\$440,000
Less:											
Expenses		(\$75,000)	(\$75,000)	(\$75,000)	(\$75,000)	(\$75,000)	(\$75,000)	(\$75,000)	(\$75,000)	(\$75,000)	(\$75,000)
Depreciation		(\$60,000)	(\$60,000)	(\$60,000)	(\$60,000)	(\$60,000)	(\$60,000)	(\$60,000)	(\$60,000)	(\$60,000)	(\$60,000)
Equals:											
EBIT		\$305,000	\$305,000	\$305,000	\$305,000	\$305,000	\$305,000	\$305,000	\$305,000	\$305,000	\$305,000
Less:											
Taxes		(\$122,000)	(\$122,000)	(\$122,000)	(\$122,000)	(\$122,000)	(\$122,000)	(\$122,000)	(\$122,000)	(\$122,000)	(\$122,000)
EAT		\$183,000	\$183,000	\$183,000	\$183,000	\$183,000	\$183,000	\$183,000	\$183,000	\$183,000	\$183,000
+ Depreciation		\$60,000	\$60,000	\$60,000	\$60,000	\$60,000	\$60,000	\$60,000	\$60,000	\$60,000	\$60,000
Total Incremental Oper. CFs		\$243,000	\$243,000	\$243,000	\$243,000	\$243,000	\$243,000	\$243,000	\$243,000	\$243,000	\$243,000
Terminal CFs											
Salvage Value											\$70,000
Tax Effect											(\$28,000)
Recovery of NWC											\$50,000
Total Terminal CFs											\$92,000
Cash Flows	(\$475,163)	\$243,000	\$243,000	\$243,000	\$243,000	\$243,000	\$243,000	\$243,000	\$243,000	\$243,000	\$335,000
PV of CFs	(\$475,163)	\$220,909	\$200,826	\$182,569	\$165,972	\$150,884	\$137,167	\$124,697	\$113,361	\$103,056	\$129,157
NPV New	\$1,053,437										
IRR	50.44%										
NPV Old (Table 4)	\$ 779,203										
New - Old	\$ 274,234										

Discussion of the Disassembled Cashflows

The analysis shows that the old machine provides most of the total benefits as students will see at the bottom of Table 4, where NPV_{New}, the NPV of selling the old machine and purchasing the new machine, is compared to NPV_{Old}, keeping the old machine. Furthermore, students can see that depreciation of the old machine is relevant in the analysis shown in Table 3. Students will also see in Table 4 that the cash inflow from selling the old machine is a benefit that accrues to the purchase of the new machine. Separating the depreciation on the old machine (Table 3) from selling the old machine (Table 4) facilitates students' understanding of why the combined analysis includes depreciation of the old machine even though it would be sold to acquire the new machine. Thus, the depreciation that is recognized in this and in the original analysis is correct.

Comparison of the Results Under the Traditional and Disassembling Methods

Subtracting NPV_{Old} from NPV_{New} results in the same net NPV of $274,234 as in the traditional combined analysis, $NPV_{Original}$ in Table 2. Note that the benefit from selling the old machine could alternately be shown in the analysis of the old machine as the foregone opportunity costs of <u>not</u> selling the old machine.

The initial change in working capital for the new machine is the combination of the additional $10,000 (negative outflow) needed to run the new machine and the benefit having spent the $40,000 five-years ago rather than at the present time. The $40,000 spent five years ago is the discounted value in reverse and only has a current benefit of $24,836. The change in net working capital is equal to the $14,836, [$40,000 $\times PVIF_{n=5,\ i=10\%}$] - $10,000 =$14,836. This is the most difficult concept to explain to students because it requires them to place themselves at time zero and realize that the $40,000 did not have to be expended at that time. The $40,000 already exists currently in the form of the old inventory associated with the old machine. In the traditional analysis where the cashflows are netted, this benefit is hidden because the existing inventory is rolled over each year. The net contains a hidden opportunity benefit of not having to purchase existing inventory.

By subtracting the NPV_{Old} of $779,203 from the $1,053,437 NPV_{New}, we end up with the same net NPV of $274,234 as in the initial analysis (Table 2). Therefore, netting the depreciation is indeed an accurate inclusion in the traditional NPV approach. What the disassembling method also highlights is that the majority of the NPV is derived from the old machine. Of the $1,053k that is produced by the new machine, $779k would have been produced by the old machine.

Recognizing Working Capital in a Different Manner

It is important to note that if working capital is completely ignored from the computation of the old machine's NPV by having all working capital affect only the new machine, the net result would be the same $274k. This occurs because the inflow of old working capital returned in year 5 is not counted (see Table 5). However, recognizing the inflow of the return of all of the working capital at the end of the new machine's useful life simplifies the calculation and makes it easier to explain. This avoids having to explain the new machine's working capital as a combination of the new marginal outflow need of $10,000 that is added to the present value of an opportunity benefit of $24,837 (see Table 6).

TABLE 5
ANALYSIS OF THE OLD MACHINE – WITHOUT WORKING CAPITAL

Depreciable Basis = (Initial Cost - Salvage Value) * assume that the SV is zero.					$ 400,000						
Depreciable Life					10						
Annual Depreciation = Depreciable Basis/Number of years					$ 40,000						
Tax Rate	40%		Cost of Capital		10%						
Year	0	1	2	3	4	5	6	7	8	9	10
I. Initial Outlay											
Market Value											
Book											
(Book - Mkt) tax rate											
Total Initial Outlay											
II. Incremental Operation CFs											
Revenues		$360,000	$360,000	$360,000	$360,000	$360,000					
Less:											
Expenses		($55,000)	($55,000)	($55,000)	($55,000)	($55,000)					
Depreciation		($40,000)	($40,000)	($40,000)	($40,000)	($40,000)					
Equals:											
EBIT		$265,000	$265,000	$265,000	$265,000	$265,000	$0	$0	$0	$0	$0
Less:											
Taxes		($106,000)	($106,000)	($106,000)	($106,000)	($106,000)	$0	$0	$0	$0	$0
EAT		$159,000	$159,000	$159,000	$159,000	$159,000	$0	$0	$0	$0	$0
+ Depreciation		$40,000	$40,000	$40,000	$40,000	$40,000	$0	$0	$0	$0	$0
Total Incremental Oper. CFs		$199,000	$199,000	$199,000	$199,000	$199,000	$0	$0	$0	$0	$0
Terminal CFs											
Salvage Value						$0					
Tax Effect						$0					
Recovery of NWC						$0					
Total Terminal CFs						$0					
Cash Flows	$0	$199,000	$199,000	$199,000	$199,000	$199,000	$0	$0	$0	$0	$0
PV of CFs	$0	$180,909	$164,463	$149,512	$135,920	$123,563	$0	$0	$0	$0	$0
NPV	$754,367										
IRR	N/A										

TABLE 6
ANALYSIS OF THE NEW MACHINE – WITH ONLY NEW WORKING CAPITAL

Depreciable Basis = (Initial Cost - Salvage Value) * assume that the SV is zero				$ 600,000							
Depreciable Life				10							
Annual Depreciation = Depreciable Basis/Number of years				$ 60,000							
Tax Rate	40%		Cost of Capital	10%							
Year	0	1	2	3	4	5	6	7	8	9	10
I. Initial Outlay											
Cost of new	($600,000)										
Training (1-t)	($18,000)										
Sale of old Machine	$80,000										
Tax credit on loss	$48,000										
Change in WC	($10,000)										
Total Initial Outlay	($500,000)										
Revenues		$440,000	$440,000	$440,000	$440,000	$440,000	$440,000	$440,000	$440,000	$440,000	$440,000
Less:											
Expenses		($75,000)	($75,000)	($75,000)	($75,000)	($75,000)	($75,000)	($75,000)	($75,000)	($75,000)	($75,000)
Depreciation		($60,000)	($60,000)	($60,000)	($60,000)	($60,000)	($60,000)	($60,000)	($60,000)	($60,000)	($60,000)
Equals:											
EBIT		$305,000	$305,000	$305,000	$305,000	$305,000	$305,000	$305,000	$305,000	$305,000	$305,000
Less:											
Taxes		($122,000)	($122,000)	($122,000)	($122,000)	($122,000)	($122,000)	($122,000)	($122,000)	($122,000)	($122,000)
EAT		$183,000	$183,000	$183,000	$183,000	$183,000	$183,000	$183,000	$183,000	$183,000	$183,000
+ Depreciation		$60,000	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000
Total Incremental Oper. CFs		$243,000	$243,000	$243,000	$243,000	$243,000	$243,000	$243,000	$243,000	$243,000	$243,000
Terminal CFs											
Salvage Value											$70,000
Tax Effect											($28,000)
Recovery of NWC											$50,000
Total Terminal CFs											$92,000
Cash Flows	($500,000)	$243,000	$243,000	$243,000	$243,000	$243,000	$243,000	$243,000	$243,000	$243,000	$335,000
PV of CFs	($500,000)	$220,909	$200,826	$182,569	$165,972	$150,884	$137,167	$124,697	$113,361	$103,056	$129,157
NPV	$1,028,600										
IRR	48%										
Old (Table 6)	$754,367										
New - Old	$274,233										

Regardless of how working capital is treated, Table 7 depicts that while the net NPV will remain the same (Column c), it does affect the NPV attributed to the new and the old machines because of the opportunity benefit associated with not recognizing the working capital, specifically the opportunity benefit of not having to spend an additional $40,000. Again, the reverse present value of the net working capital is equal to $24,837.

An alternative way to show the opportunity cost of foregoing the return of the $40,000 of working capital that would have been returned at the end of Year 5 if the company kept the old machine is to report it as a cash outflow at the end of Year 5. Table 2 would show an outflow of $40,000 on the Recovery of NWC row for Year 5. This would reduce the NPV by $24,837 to $249,396 and reduce the IRR by 0.66% to 16.86%. In Table 4, the Initial change in NWC would be reduced by $24,837 to an outflow of $10,000, which represents the increase in working capital needs for additional inventory. Table 4 would also show an outflow of $40,000 on the Recovery of NWC row for Year 5.

These changes would reduce the NPV of the new machine by $24,837 to $1,028,600 and the IRR of the new machine by 2.64% to 47.80%. The net change in NPV, $NPV_{New} – NPV_{Old}$, would also be reduced by $24,837 to a NPV of $249,396. Is one more correct than the other? This depends on how closely one wants to mirror the traditional method of replacement analysis. Row 1 of Table 7 treats the numbers that are most likely to be computed in the traditional computation. Row 2 demonstrates the calculation that allows for a simpler explanation for the working capital. Although both approaches result in the same NPV, Row 2 makes it easier for students to understand why the market value of the old machine is recognized, as is the continued depreciation on the old machine. Lastly, because working capital is a minor consideration for most projects, the method of choice used will likely not affect the overall decision. For example, in calculating the net advantage of leasing (NAL), the recognition of revenue does not impact the overall NAL.

However, the revenue will determine if the individual NPV of leasing is positive or not and likewise the NPV of purchasing is positive or negative. The revenue is neutral for the NAL, but not for the component NPVs. Similarly, the working capital does not impact the overall NPV, but the component NPVs of the existing and new projects.

TABLE 7
COMPARISON OF VALUE WITH AND WITHOUT INCLUDING WORKING CAPITAL

	NPV of old Machine (a) (Table 3)	*NPV of New Machine (b) (Table 4)*	*Net NPV (c) (b) – (a)*
Using ΔWC (1)	$779,203	$1,053,437	$274,234
	NPV of old Machine (a) (Table 5)	*NPV of New Machine (b) (Table 6)*	*Net NPV (c) (b) – (a)*
Not Using ΔWC (2)	$754,367	$1,028,600	$274,234

CONCLUSIONS

Too often, analyzing replacement projects in capital budgeting leads to confusion when it comes to recognizing the sale of the old machine while also using its depreciation at the same time. This paper disassembled the analysis into the continuation of the old machine and the adoption of the new machine. Disassembling the analysis allows students to appreciate how the individual components correctly capture the true value of the decision. While Chen & Mayes (2012) address the replacement analysis in a similar fashion, this article focuses on a more general pedagogy, on the taking apart of cashflows associated with the new and old machines to illustrate to students that the methods contained in modern textbooks are correct. The numerical examples help illustrate the additive nature of the NPV analysis. Here are a few of the major takeaways to help the students.

- Recognizing the sale of the old machine is a separate opportunity benefit that is not related to the depreciation. Both exist and should be part of the analysis.
- Likewise, the after-tax salvage value is separate from the recognition of depreciation.
- Selling the old machine reduces the cost of the new machine. This treatment is more understandable than imputing an opportunity cost of not selling the old machine in the old machine analysis. Note that eliminating the sale of the old machine as an outflow in the analysis of the old machine also prevents calculating an IRR due to having no cash outflow.
- Accounting for working capital or not, will not change the net NPV. However, it does affect the new and old NPVs without affecting the overall decision. It merely affects the percentage of NPV the old and new projects contribute to the net NPV.

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