

Depreciation, Projection, Simulation and Optimization

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0. Executive Summary

The *Assets* module of *Oracle Applications* release 11.0.3 supports *Depreciation Projection* and *What-If Depreciation Analysis*, both of which will be reviewed from a practical point of view. *What-If Depreciation Analysis* does not account for the time-value of money and is not able to simulate the after-tax effects of different depreciation methods. Ranking depreciation methods with respect to potential tax-savings requires the development of a computer program that calculates the present value of different depreciation schedules. The essential details of such a program are described in this article. Output from a sample run is provided.

1. Projecting Depreciation Expense

A *Depreciation Projection* is an estimate of *actual* depreciation expense incurred for assets belonging to a given depreciation book and calendar. A depreciation book is used to store financial information for a group of assets. Figure 1 shows an example of required parameters for a *Depreciation Projection*. For example, the *Report Detail* can be requested at the Cost Center and/or Asset level for up to four Books.

The screenshot shows a window titled "Depreciation Projections" with a menu bar containing "Action", "Edit", "Query", "Go", "Folder", "Special", and "Help". The main area contains several input fields and sections. On the left, there are three rows of input fields: "Projection Calendar" with the value "AFA-KALENDER", "Number of Periods" with the value "7", and "Starting Period" with the value "JUN-00". On the right, there are two more input fields: "Periods Per Year" with the value "12" and "Starting Year" with the value "2000". Below these are two sections: "Books" and "Report Detail". The "Books" section has a list box containing "01B_BASIS" and three empty rows. The "Report Detail" section has two checkboxes: "Cost Center" (unchecked) and "Asset" (checked). At the bottom right, there is a "Run" button.

Figure 1: Form for Depreciation Projections

Note that *Depreciation Projection* can't be run for just a single asset number. If the program *Depreciation Projection* completes normally, it automatically prints the *Depreciation Projection Report*. This is a rather simple report with the choice of up to four possible control breaks (balancing segment, cost center, depreciation expense account, and asset number) producing the corresponding totals.

Running *Depreciation Projection* with the parameters shown in figure 1 will produce a report as in Table 1 below:

- *Detail printing* is composed of 3 columns showing asset number, period name and corresponding depreciation expense for each asset belonging to a given expense account within an entity (usually company).
- *Group printing* is composed of the accumulated depreciation expense for the appropriate control break levels, that is, expense account totals, entity totals, and finally report total.

Table 1 exhibits a section of the report.

Asset Number	Period Name	Book 01B BASIS
24335	JUN-00	302.17
	JUL-00	302.17
	AUG-00	302.17
	SEP-00	302.17
	OKT-00	302.17
	NOV-00	302.17
	DEZ-00	302.17

Table 1: Detail printing of the Depreciation Projection Report

Note that totals are not printed for each asset in the projection.

Depreciation Projection includes additions, transfers, and reclassification transactions performed in the current period. It ignores other asset transactions made in the current period, such as depreciation adjustment for retroactive additions and retroactive transfers entered in the current period. The program ignores fully reserved and fully retired assets as well as prorate conventions for additions. For example, in March an asset is added with a halfyear prorate convention. The report would only show one month's depreciation expense.

Depreciation Projection can only be run for the depreciation rules in the current book and category in the *Assets Categories* form. If *Depreciation Projections* are needed for scenarios other than that specified in the current setup, then *What-If Depreciation Analysis* can be run for a *hypothetical* set of parameters.

2. What-If Depreciation Analysis

What-If Depreciation Analysis is a new feature in Release 11. The term "what-if" is just another word for simulation of future events.

What-if depreciation analysis enhances *Depreciation projection* in that *What-if depreciation analysis* allows you to forecast depreciation for many different scenarios without changing your Oracle Assets data, whereas *Depreciation projection* allows projection only for the parameters set up in Fixed Assets, see [2], p. 5-36.

To perform *What-If Depreciation Analysis*, different combinations of parameters for a set of assets are entered in the *What-If Depreciation Analysis* window, or alternatively you can run the program directly in Report eXchange (or Application Desktop Integrator with Fixed Assets responsibility), using the appropriate window, see [2], p. 5-36.

After running *What-If Depreciation Analysis* based on the parameters you entered, you can run a report in Report eXchange from which you can review the results of the analysis. You can run what-if depreciation analysis for as many scenarios as you like. The results of each analysis will be available for you to download on Report eXchange, and will remain on Report eXchange until you purge them, see [2], p. 5-36.

If you are satisfied with the results of your analysis, you can enter the new parameters in the Mass Changes window to update your assets according to the parameters you specified in the *What-If Depreciation Analysis*, see [2], p. 5-36.

You may want to run *What-If Depreciation Analysis* for several different scenarios for comparison purposes. You can run *What-If Depreciation Analysis* for any number of scenarios. The results of an analysis will not overwrite the results of previous analyses. You

can download the results of any of the analyses in Report eXchange at any time, see [2], p. 5-36.

For all *numerical examples* quoted below the financial information from *Asset Number 24335* will be utilized as input data. Figure 2 illustrates how to find the asset information in the system.

Find Assets

Action Edit Query Go Folder Special Help

Find by Asset Detail

Asset Number 24335

Tag Number

Serial Number

Warranty Number

Description

Category []

Asset Key

Clear Find

Figure 2: Find Assets form (Asset Number = 24335)

Pressing the *Find* button will produce the Assets form (see figure 3), provided Asset Number 24335 is a valid.

Assets

Action Edit Query Go Folder Special Help

Asset Number Description Tag Number Category []

Asset Number	Description	Tag Number	Category
24335	LAN-ANALYSATOR	2038278	30 MASCHINEN

Assignments Source Lines Books

Figure 3: Assets form (Asset Number = 24335)

Pressing the *Books* button in the Assets form will activate the View Financials Information window (see figure 4)

View Financial Information - 24335

Action Edit Query Go Folder Special Help

Book	Cost	Recoverable Cost	Net Book Value
01B_BASIS	36,260.00	36,260.00	8,460.63

Original Cost: 36,260.00
 Salvage Value: 0.00
 Investment Tax Credit
 Date in Service: 02-SEP-1992
 Prorate Convention: FOLGEMONAT
 Method: STL
 Life Years: 10 Months: 0
 Remaining Life Years: 2 Months: 4
 Basic Rate: %
 Bonus Rule:
 YTD Depreciation: 1,510.85
 Accumulated Depr: 27,799.37

Depr Ceiling:
 Revaluation Ceiling:
 Revaluation Reserve: 0.00
 Depreciate
 Prorate Date: 01-OCT-1992

Adjusted Rate: %
 Capacity:
 YTD Production:
 LTD Production:

Transactions Depreciation Cost History

Figure 4: View Financial Information Form (Asset Number = 24335)

In Figure 4 we see that the first depreciation period was OCT-92. Prorate Convention is FOLLOWING MONTH. Depreciation method is straight-line (STL). Useful Life is set to 10 years or 120 months. Remaining Life is equal to 28 months. Pressing the *Depreciation* button in the *View Financial Information Form* will activate the *View Depreciation History Form* (see figure 5).

View Depreciation History - 24335, 01B_BASIS: DEM

Action Edit Query Go Folder Special Help

Period	Expense Account	Depreciation Amount	Revaluation Amortization
MAI-00	CD10B-810000-B411-N230B-E1112-0000-B-0000	302.17	0.00
APR-00	CD10B-810000-B411-N230B-E1112-0000-B-0000	302.17	0.00
MRZ-00	CD10B-810000-B411-N230B-E1112-0000-B-0000	302.17	0.00
FEB-00	CD10B-810000-B411-N230B-E1112-0000-B-0000	302.17	0.00
JAN-00	CD10B-810000-B411-N230B-E1112-0000-B-0000	302.17	0.00
DEZ-99	CD10B-810000-B411-N230B-E1112-0000-B-0000	302.13	0.00
NOV-99	CD10B-810000-B411-N230B-E1112-0000-B-0000	302.17	0.00
OKT-99	CD10B-810000-B411-N230B-E1112-0000-B-0000	302.17	0.00
SEP-99	CD10B-810000-B411-N230B-E1112-0000-B-0000	302.17	0.00
AUG-99	CD10B-810000-B411-N230B-E1112-0000-B-0000	302.17	0.00
JUL-99	CD10B-810000-B411-N230B-E1112-0000-B-0000	302.17	0.00
JUN-99	CD10B-810000-B411-N230B-E1112-0000-B-0000	302.17	0.00

Figure 5: View Depreciation Form (Asset Number = 24335)

In figure 5 the column *Depreciation Amount* illustrates past actual figures up until the most recent in MAI-00. The Depreciation projection report already shown in table 1 (see above)

continues from JUN-00 with projected depreciation amounts for the same asset. Thus future and past depreciation amounts can be inspected at item level.

Entering Asset Number 24335 in the What-If Analysis form (see figure 6) will produce rather similar results as exhibited in table 1. Thus Depreciation Projection partially overlaps with What-If Analysis functionality.

Figure 6: What-If Analysis form with default option "Assets to Analyze"

The drop-down list in the form allows the user to choose either "Assets to Analyze" or "Hypothetical Assets".

In the case of "Assets to Analyze" it would be interesting to find out the effects of changing the depreciation method (if allowed at all) or the effects of an extraordinary depreciation, which may be either optional or mandatory depending on country-specific tax regulations.

- Usually tax regulations put restrictions on the succession of depreciation methods. Typically a switch from tax favored (accelerated) methods to straight-line (STL) depreciation is allowed but not the reverse order. For example, a switch from declining-balance (DBL) depreciation to STL is optional in many countries, but not the other way round.
- Possible methods for extraordinary depreciation on an already existing asset are shown in table 2.

Method	Net book value	Remaining life (years)	Effect on acceleration of depreciation expense
1	Decrease	constant	strong effect
2	Constant	decrease	weak effect
3	Decrease	decrease	medium effect

Table 2: Input parameters for extraordinary depreciation methods

Since there are no fields in the What-If Analysis form for the input of parameters for an extraordinary depreciation method, the corresponding effects on acceleration of depreciation expense can't be simulated.

Figure 7: What-If Analysis Form with option "Hypothetical Assets"

In the case of "Hypothetical Assets" it would be interesting to assess the effect on tax savings if a choice of a tax favored (accelerated) depreciation method exists, but *What-If Analysis* is not able to simulate the after-tax effects of different depreciation methods because the relevant input parameters such as tax rate and interest rate can't be captured in the form.

In the following sections all the essential ingredients for a "tax shield" approach are presented. The goal is to develop a Present Value Program for measuring the relative tax advantage of different depreciation methods.

3. Present value of an entire depreciation schedule

Present value (and its reverse called *future value*) is based on the time value concept of money. The value of 1 Euro received a year from now is not 1 Euro, but something less. How much less is determined by the anticipated interest rate. If the annual interest rate is 10 percent the *present value* necessary to produce 1 Euro in 1 year is 0,909091 Euro.

A depreciation method determines how the cost of an asset is spread over the time it is in use. Since depreciation expense is deducted from revenue, it "shields" a known amount of profit from taxation over the useful life of the asset being depreciated. Thus, the present value of the income that is shielded can be computed. The present value will vary under different depreciation methods.

Calculation of the present value of a depreciation schedule can be easily accomplished with an appropriate computer program. Such a program will compute the depreciation of an asset by using several widespread depreciation methods. It also assesses the differences in the effect on taxes and profit figures. In the following the elements of such an approach will be described in detail.

The approach will calculate the present value of a depreciation schedule under four methods commonly used in today:

- straight-line (STL) depreciation
- sum-of-the-years'-digits (SYD) depreciation
- declining-balance (DBL) depreciation (with or without switch to STL depreciation)
- stepped (STP) depreciation (which is a combination of STL and accelerated depreciation)

One justification for an accelerated method is that many assets become less efficient and require more maintenance as they get older. Thus total costs of using the asset tend to even out per year over the asset's life. But accelerated methods allow for some of the tax to be paid later instead of sooner. Depending on a company's financial objectives and certain operating policies, an accelerated depreciation method can be much preferred to the straight-line method.

Since depreciation is an operating cost that is deductible for income tax purposes, a higher depreciation expense means there will be lower taxable income, lower taxes, and also lower net income. But this is not entirely a tax saving, since later in the life of the asset the accelerated depreciation is no longer available. Depreciation declines, taxable income increases, taxes increase, and net income increases. The direct impact of this situation may not be felt, however, as most companies are continually buying new assets.

4. Calculation of present value discount factors and annuity factors

In this section the basic formulae for calculation of present values will be explained.

The discount factor for a given year is calculated as follows:

$$(1) \text{discount_factor}_{\text{year}} = 1 / (\text{interest_factor})^{\text{year}} \quad \text{for year} = 1, 2, 3, \dots$$

where

$$(2) \text{interest_factor} = (1 + \text{interest_rate in percent} / 100)$$

The present value (PV) of the depreciation expense in a given year is determined by multiplying it with the appropriate discount factor, that is,

$$(3) \text{PV}_{\text{year}} = \text{depr_expense}_{\text{year}} * \text{discount_factor}_{\text{year}} \quad \text{for year} = 1, 2, \dots, \text{number of years}$$

The total present value of a depreciation schedule is equal to the total of all present values PV_{year} of depreciation expense per year until corresponding asset is fully reserved, that is,

$$(4) \text{total_present_value} = \sum \text{PV}_{\text{year}}$$

The annuity factor is given by:

$$(5) \text{annuity factor} = \sum \text{discount_factor}_{\text{year}} \quad \text{for year} = 1, 2, \dots, \text{number of years of useful life}$$

Table 3 exhibits present value discount factors and corresponding annuity factors for an annual interest rate of 5, 10, and 15 percent.

Annual interest rate (%)						
Year	5		10		15	
	Discount factor	Annuity factor	Discount factor	Annuity factor	Discount factor	Annuity factor
(a)	(b)	(c)=cum(b)	(d)	(e)=cum(d)	(f)	(g)=cum(f)
1	0,952381	0,952381	0,909091	0,909091	0,869565	0,869565
2	0,907030	1,859411	0,826446	1,735537	0,756144	1,625709
3	0,863838	2,723248	0,751315	2,486852	0,657516	2,283225
4	0,822703	3,545951	0,683014	3,169866	0,571753	2,854978
5	0,783526	4,329477	0,620921	3,790787	0,497177	3,352155
6	0,746215	5,075692	0,564474	4,355261	0,432328	3,784483
7	0,710681	5,786374	0,513158	4,868419	0,375937	4,160420
8	0,676839	6,463213	0,466507	5,334926	0,326902	4,487321
9	0,644609	7,107822	0,424098	5,759024	0,284262	4,771584
10	0,613913	7,721735	0,385543	6,144567	0,247185	5,018769
...

Table 3: Present value discount factors and annuity factors

The relationship between the columns in table 3 is easy to understand. Each value in the (c), (e), and (g) columns is equal to the accumulated discount factors in the preceding columns up to a given year. For example, the annuity factor for a 10 % ten-year ordinary annuity is equal to 6,144567, see last cell in column (e) of table 3.

Instead of accumulating discount factors formula (6) can be used for calculation of annuity factors.

$$(6) \text{ annuity_factor} = (1 / \text{interest_factor}^{\text{years}}) * (\text{interest_factor}^{\text{years}} - 1) / (\text{interest_factor} - 1)$$

If interest_factor is equal to 1,1 and the number of years is set to 10, then the annuity_factor is given by (7):

$$(7) \quad (1 / 1,1^{10}) * (1,1^{10} - 1) / (1,1 - 1) = 6,144567 \text{ (see table 3, column (e), last cell)}$$

5. Given Parameters for assessing the after-tax effects of depreciation methods

After-tax effects of STL, SYD, DBL, and stepped depreciation schedules will be shown by numerical examples using the parameters listed in table 4.

Given Parameter	Value	Dimension
Original cost	36.260,00	Euro
Useful life	10	Years
Salvage value	0	Euro
Tax rate	0,52	Percent/100
Imputed annual interest rate	0,1	Percent/100
Ceiling for DBL depreciation rate	0,3	Percent/100
Multiplier for STL depreciation rate	3	None
Stepped depreciation rates	13 yrs*5 pct; 4 yrs*10 pct; 3 yrs*5 pct	

Table 4: Given parameters for calculation of after-tax effects of depreciation methods

Most of the given parameters in table 4 are equal to the content of the fields in the *View Financial Information* form shown in figure 4. Some of them are self-explanatory. The rest will be briefly described now.

- Salvage value (also called residual value) is the remaining value of the asset at the end of the entire depreciation period. This value is normally deducted from the original cost of the asset (at the beginning of the period, before computing the depreciation schedule) in STL, SYD, and stepped depreciation, but not in DBL depreciation. Hereafter a salvage value of zero is assumed for all depreciation methods. This assumption is not at all necessary and can be removed without causing any difficulties. It is made only for the purpose of simpler explanations.
- Income tax rate is an essential input parameter. Of course, corresponding tax regulations vary from country to country. Regarding this parameter the German case will be explained. In Germany the tax rate on undistributed profits can be approximated from the given parameters shown in table 5. Corresponding formulae are exhibited in table 6. A constant tax rate is assumed over the entire useful life of an asset. Again this assumption can be released easily, if future tax parameters are exactly known or can be predicted with high reliability. Allowing for varying tax rates over the depreciation period means in technical terms to set up an array into which expected tax rates can be entered for each year of the total useful life.

Tax type	Symbol	Percent
Municipal trade tax levy rate *)	L	400
Trade tax on profit	T	5
Surtax	S	5,5
Corporation tax **)	C	40
*) May be lower or higher in a specified municipal district.		
**) With effect from 2001: 25 percent.		

Table 5: Given parameters for taxes on undistributed profits in year 2000

	Formula	Symbol	Percent	Tax Type
(8)	$(T/100 * L)/(1 + L/100 * T/100)$	TT	16,7	Trade tax
(9)	$(100 - TT) * (C/100)$	CT	33,3	Corporation tax
(10)	$CT * S/100$	ST	1,8	Surtax
(11)	$TT + CT + ST$	TB	51,8	Total tax burden

Table 6: Formulae for approximation of the total tax burden on undistributed profits

Note that trade tax (identified by symbol TT in table 6) is *deductible* from corporate tax, see formula (9).

- Imputed annual interest rate is equivalent to what is frequently called "expected rate of return on investment".
- The declining-balance depreciation method is frequently based on the straight-line depreciation rate. It is calculated by multiplying the appropriate STL depreciation rate by a given factor, usually 1.5, 2.0, 2.5, 3.0, or 3.5. If 2.0 is the multiplier applied to the STL rate, the corresponding method is usually called double-declining balance depreciation. At present German tax regulations require, that the fixed rate used for declining-balance depreciation is 3 times higher than corresponding STL depreciation rate, but not higher than 30 percent. In addition the STL depreciation rate must be less than or equal to the DBL depreciations rate. The following procedure (see figure 8) can be utilized for calculation of a tax-compliant DBL depreciation rate:

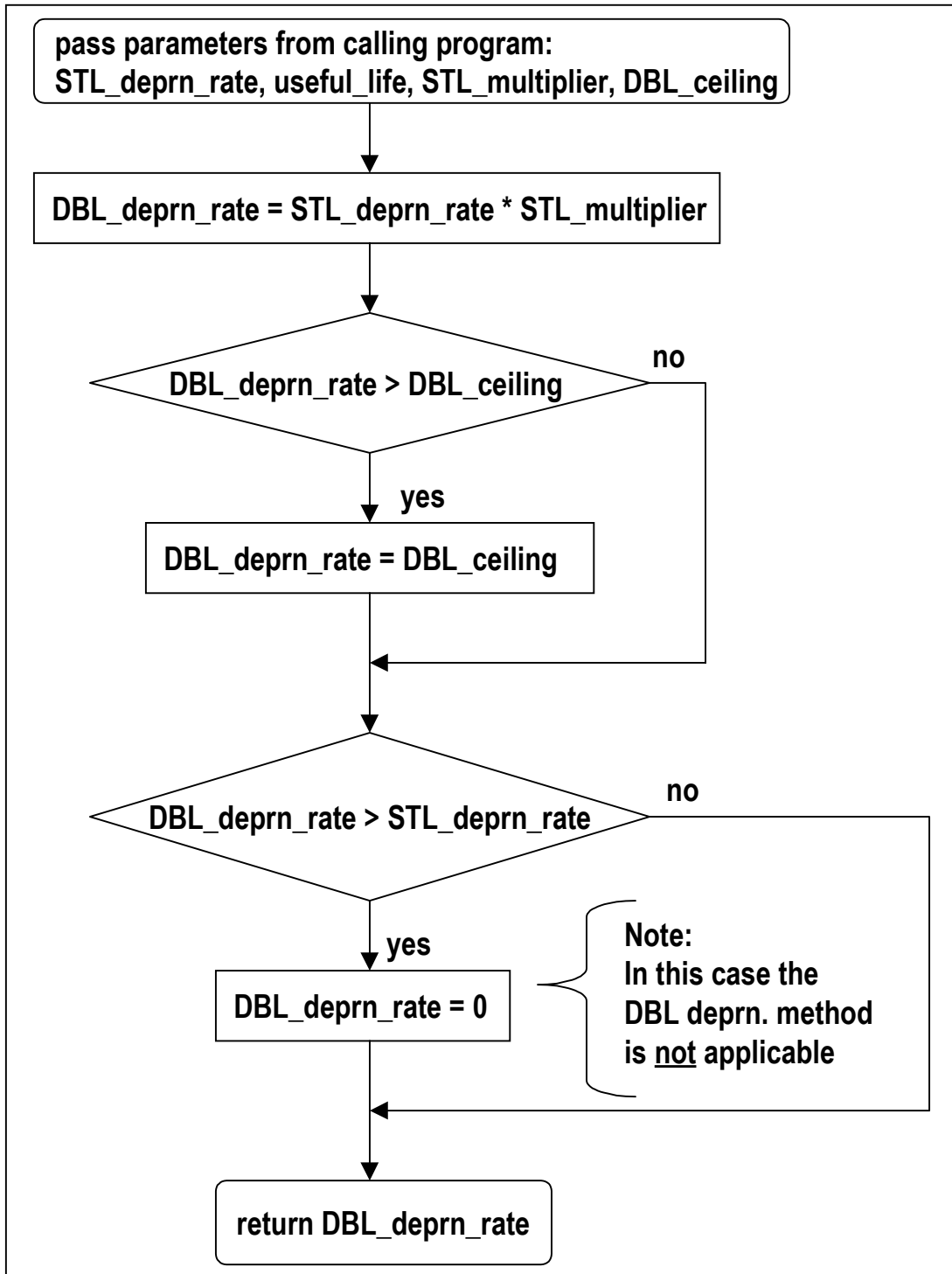


Figure 8: Algorithm for consideration of tax restrictions on the DBL depreciation rate

Table 7 contains DBL depreciation rates calculated in consideration of presently existing tax restrictions in Germany. Columns (c), (e), and (f) illustrate the tax restrictions on the DBL depreciation rates.

Life (years)	STL_deprn_rate, (%)	STL_multiplier	DBL_deprn_rate, (%)	DBL_ceiling (%)	DBL_deprn_rate (%)
(a)	(b)=1/(a)	(c)	(d)=(b)*(c)	(e)	(f)= min((d),(e))
1	100,00	3	300,00	30,00	Not applicable
2	50,00	3	150,00	30,00	Not applicable
3	33,33	3	99,99	30,00	Not applicable
4	25,00	3	75,00	30,00	30,00
5	20,00	3	60,00	30,00	30,00
6	16,67	3	50,01	30,00	30,00
7	14,29	3	42,87	30,00	30,00
8	12,50	3	37,50	30,00	30,00
9	11,11	3	33,33	30,00	30,00
10	10,00	3	30,00	30,00	30,00
11	9,09	3	27,27	30,00	27,27
12	8,33	3	24,99	30,00	24,99
13	7,69	3	23,07	30,00	23,07
14	7,14	3	21,42	30,00	21,42
15	6,67	3	20,01	30,00	20,01
20	5,00	3	15,00	30,00	15,00
30	3,33	3	9,99	30,00	9,99
40	2,50	3	7,50	30,00	7,50
50	2,00	3	6,00	30,00	6,00

Table 7: Present tax restrictions on the declining-balance depreciation rate in Germany

Note that the ceiling on the DBL depreciation rate is effective until useful life = 10 years.

- Stepped depreciation rates are specified using a single character string. A semi-colon is used to delimit the consecutive steps of corresponding depreciation schedule. A procedure for expanding the stepped depreciation rates into a one-dimensional array will be described later.

6. After-tax effects of straight-line (STL) depreciation

STL depreciation can be considered an ordinary annuity because an equal amount is depreciated each year of the useful life of the asset. For example, a piece of equipment at cost of 36.260,00 Euro and with a useful life of ten years will be depreciated at 3626,00 Euro per year under the straight-line method. If the tax rate is approximately 52 percent, then the early tax savings is 1.885,52 Euro, which can be thought of as a ten-year 1.885,52 ordinary annuity. Therefore the present value of the tax savings is equal to 11.585,70. Table 8 summarizes these figures. The present value annuity factor shown in column (e) was already calculated earlier using formula (7).

Life (yrs)	Annual deprn. exp.	Annual tax savings	Total tax savings	Present value annuity factor	Present value
(a)	(b)	(c)=(b)*tax rate	(d)=(c)*(a)	(e)	(f)=(c)*(e)
10	3.626,00	1.885,52	18.855,20	6,144567	11.585,70

Table 8: After-tax effects of straight-line (STL) depreciation

The present value shown in column (f) of table 8 will be used to calculate the relative tax advantage of accelerated depreciation method, that is, SYD, DBL, and stepped depreciation.

An accelerated depreciation method provides for greatest depreciation in the earlier years. At some point in time, switching to a straight-line depreciation will allow a larger amount to be

depreciated in later years than could be done by continuing the use of the accelerated method.

The SYD, DBL, and stepped depreciation methods are accelerated depreciation methods, which allow larger amounts to be depreciated during the early years of the useful life of the asset than in the later years. As will be shown shortly, the present value of the depreciation (that is, the present value of the projected tax savings) is greater under accelerated methods than under the STL method.

7. After-tax effects of sum-of-the-years'-digits (SYD) depreciation

The numerical example is now continued for the SYD depreciation method. Again the relevant parameters listed in table 4 are used.

The algorithm for the sum-of-the-years'-digits depreciation method can be expressed as:

$$(12) \text{ deprn_expense}_{\text{Year}} = \text{recoverable_cost} * (\text{remaining_useful_life}_{\text{Year}} / \text{SYD})$$

where

$$(13) \text{ SYD} = 1 + 2 + \dots + \text{useful_life} = \text{useful_life} * (\text{useful_life} + 1) / 2$$

$$(14) \text{ recoverable_cost} = \text{original_cost} - \text{salvage_value}$$

$$(15) \text{ remaining_life}_{\text{Year}} = \text{useful_life} - \text{years_in_service}_{\text{Year}} + 1$$

In formula (13) the denominator SYD, the sum-of-the-years'-digits, can be simply found by summing the digits from 1 up to the useful_life of the item to be depreciated. According to formula (13) $\text{SYD} = 1 + 2 + 3 + \dots + 10 = 10 * (10 + 1) / 2 = 55$

In formula (15) $\text{remaining_life}_{\text{Year}}$ represents the asset's remaining number of useful years at the beginning of each year. For example, consider a piece of equipment, given the following data: $\text{original_cost} = 36.260,00$ Euro, $\text{salvage_value} = 0$, and $\text{useful_life} = 10$ years. Corresponding SYD depreciation schedule would be as follows:

Years_in_service	Remaining_life	SYD	Deprn_rate	Original_cost	Deprn_expense
(a)	(b)	(c)	(d)=(b)/(c)	(e)	(f)=(d)*(e)
1	10	55	0,181818	36.260,00	6.592,73
2	9	55	0,163636	36.260,00	5.933,45
3	8	55	0,145455	36.260,00	5.274,18
...
9	2	55	0,036364	36.260,00	1.318,55
10	1	55	0,018182	36.260,00	659,27

Table 9: Calculations for a SYD depreciation schedule

To clarify the figures in table 9, in the sum-of-the-years'-digits method, it is necessary to determine a fraction that will be multiplied times the depreciable amount, see column(e). The denominator of that fraction is calculated by adding the whole numbers from one through the number of years useful life, see column (c). The denominator remains the same for all of the annual calculations for that asset. The numerator of the fraction in the first year is the number that represents the useful life, see column (b). The numerator declines by one for each subsequent year until it is just one in the last year. Note that the fraction (= deprn_rate) changes from year to year, see column (d).

The deprn_expense amounts in column (f) of table 9 are equal to the ones shown in column (b) of table 10. Since $\text{tax_rate} = 0.52$ (see table 6) and present value discount factors can be looked-up in table 3, column (d), the present value of the SYD depreciation schedule can be derived.

Year	Deprn. expense	Deprn. reserve	Tax savings	Present value discount factor	Present value
(a)	(b)	(c)=cum.(b)	(d)=(b)*tax rate	(e)	(f)=(d)*(e)
1	6.592,73	6.592,73	3.428,22	0,909091	3.116,56
2	5.933,45	12.526,18	3.085,39	0,826446	2.549,91
3	5.274,18	17.800,36	2.742,57	0,751315	2.060,53
4	4.614,91	22.415,27	2.399,75	0,683013	1.639,06
5	3.955,64	26.370,91	2.056,93	0,620921	1.277,19
6	3.296,36	29.667,27	1.714,11	0,564474	967,57
7	2.637,09	32.304,36	1.371,29	0,513158	703,69
8	1.977,82	34.282,18	1.028,47	0,466507	479,79
9	1.318,55	35.600,73	685,65	0,424098	290,78
10	659,27	36.260,00	342,82	0,385543	132,17
Total present value					13.217,25

Table 10: After-tax effects of sum-of-the-years'-digits (SYD) depreciation

In all cases depreciation expense for sum-of-the-years'-digits method starts out higher, but ends up lower, than that for straight-line. Thus the net book value for the former is always lower than that of the latter, except at the expiration of the life of the asset.

Comparing total present value (13.217,25 Euro) of the SYD depreciation schedule with the present value (11.585,70 Euro) of the STL depreciation schedule reveals a tax advantage of 1.631,55 Euro in favor of the SYD method.

Note that SYD depreciation is a special case of a more general method usually called arithmetically declining depreciation. Using this method will result in a higher total present value. This is proved in appendix 2 (see table 18).

8. After-tax effects of declining-balance (DBL) depreciation

The numerical example is now continued for the DBL depreciation method. Again the relevant parameters listed in table 4 are used.

The formula for the declining-balance algorithm is simply as shown below:

$$(16) \text{ deprn_expense} = \begin{cases} (\text{STL_multiplier} * \text{original_cost}) / \text{useful_life} & \text{for year} = 1 \\ (\text{STL_multiplier} * \text{net_book_value}_{\text{year}}) / \text{useful_life} & \text{for year} = 2, 3, \dots, \text{useful_life} - 1 \\ \text{original_cost} - \text{deprn_reserve} & \text{for year} = \text{useful_life} \end{cases}$$

where net_book_value is the remaining undepreciated cost of the asset at the beginning of period year, and useful_life is the total useful life of the asset. Thus, for the asset with useful_life = 10, STL_multiplier = 3, original_cost = 36.260,00, and salvage_value = 0, the declining-balance depreciation schedule would be as follows:

year	STL_multiplier	depreciable_basis	useful_life	deprn_expense
(a)	(b)	(c)	(d)	(e) = (b)*(c)/(d)
1	3	36.260,00	10	10.878,00
2	3	25.382,00	10	7.614,60
3	3	17.767,40	10	5.330,22
...
9	3	2.090,32	10	627,00
10		1.463,32		1.463,32
depr_reserve				36.260,00

Table 11: Calculations for a DBL depreciation schedule

Notice that the last year's depreciation is simply the remaining undepreciated cost. The last year's depreciation often ends up being more than the next-to-last year's depreciation under DBL. For this reason, some companies will switch to STL during the final years of the depreciation period.

Applying formula (16) to the input parameters is giving the complete DBL depreciation schedule as shown on table 12:

Year	Deprn. expense	Deprn. reserve	Tax savings	Present value discount factor	Present value
(a)	(b)	(c)=cum.(b)	(d)=(b)*tax rate	(e)	(f)=(d)*(e)
1	10.878,00	10.878,00	5.656,56	0,909091	5.142,33
2	7.614,60	18.492,60	3.959,59	0,826446	3.272,39
3	5.330,22	23.822,82	2.771,71	0,751315	2.082,43
4	3.731,15	27.553,97	1.940,20	0,683013	1.325,18
5	2.611,81	30.165,78	1.358,14	0,620921	843,30
6	1.828,27	31.994,05	950,70	0,564474	536,65
7	1.279,79	33.273,84	665,49	0,513158	341,50
8	895,85	34.169,69	465,84	0,466507	217,32
9	627,09	34.796,78	326,09	0,424098	138,29
10	1.463,22	36.260,00	760,87	0,385543	293,35
Total present value					14.192,74

Table 12: After-tax effects of declining-balance (DBL) depreciation

The tax advantage of the DBL method compared to the STL method amounts to 2.607,04 Euro.

9. After-tax effects of declining-balance (DBL) depreciation with STL-switch

The DBL depreciation method explained in the previous section can be revised to change to the STL method at a certain point in the total depreciation time span. Using the same input parameters as before, the consequences of a switch to the STL depreciation method will be demonstrated hereafter.

A switch to STL is favorable, if the following condition becomes true:

$$(17) \text{ deprn_expense}_{\text{year,DBL}} < \text{net_book_value}_{\text{year,DBL}} / \text{remaining_life}_{\text{year}}$$

Notice how similar the content of table 12 and table 13 is. The switch to straight-line depreciation occurs in year = 8, see table 13.

Year	Deprn. expense	Deprn. reserve	Tax savings	Present value discount factor	Present value
(a)	(b)	(c)=cum.(b)	(d)=(b)*tax rate	(e)	(f)=(d)*(e)
1	10.878,00	10.878,00	5.656,56	0,909091	5.142,33
2	7.614,60	18.492,60	3.959,59	0,826446	3.272,39
3	5.330,22	23.822,82	2.771,71	0,751315	2.082,43
4	3.731,15	27.553,97	1.940,20	0,683013	1.325,18
5	2.611,81	30.165,78	1.358,14	0,620921	843,30
6	1.828,27	31.994,05	950,70	0,564474	536,65
7	1.279,79	33.273,84	665,49	0,513158	341,50
8	995,39	34.269,23	517,60	0,466507	241,46
9	995,39	35.264,61	517,60	0,424098	219,51
10	995,39	36.260,00	517,60	0,385543	199,56
Total present value					14.204,31

Table 13: After-tax effects of declining-balance (DBL) depreciation with STL-switch

Without a switch to STL the depreciation expense in year = 8 would amount to 895,85 Euro (see table 12, column (b)). After the switch the depreciation expense for the same year comes to 995,39 Euro. Net book value at the beginning of year = 8 is given by:

$$(18) \text{net_book_value}_{\text{year}} = \text{original_cost}_{\text{year}} - \text{deprn_reserve}_{\text{year}-1} \text{ for year} = 8$$

According to formula (18) net book value is (36.260,00 - 33.273,84 =) 2.986,16 Euro. Dividing this depreciable_basis by the remaining life (= 3 years) comes to 995,39 Euro. The later is the STL depreciation for the 3 remaining years, that is, period 8, 9, and 10.

The tax advantage of the DBL method with STL switch compared to the STL method amounts to 2.618,61 Euro. As expected, this result is somewhat better than the previous one.

10. After-tax effects of stepped depreciation

Stepped depreciation is a mixture of STL and accelerated depreciation methods. This means, that the STL depreciation rates are declining from step to step but are constant within a given step. Assume the stepped depreciation rates are specified in the following manner of writing (compare the given parameters shown in table 4):

3 yrs*5 pct; 4 yrs*10 pct; 3 yrs*5 pct.

Another way to present above depreciation rates is shown in table 14.

step	years	deprn_rate (%) per year	depr_rate (%) per step
(a)	(b)	(c)	(d)=(b) * (c)
1	3	15	45
2	4	10	40
3	3	5	15
	10	total	100

Table 14: Schedule for stepped depreciation

The depreciation schedule exhibited in table 14 may not be a generally accepted depreciation method in some countries. It is included here to prove, that calculation of present values can be performed for any depreciation method, no matter whether it is based on mathematical formulae or based on table entries.

A generic algorithm for expanding the schedule into a one-dimensional table can be designed rather quickly. Column (b) of table 15 exhibits the desired output of the algorithm. The sum of the depreciation rates must be equal to 1, otherwise the input parameters are somehow wrong.

By the way, it is a great pity, that Oracle Assets does not comprise a feature to expand depreciation rates defined by the user as a simple character string with just 2 defined delimiters, (* and ;). Such a feature would be extremely labor-saving and error-preventing regarding the definition of those table-based and life-based depreciation methods which are not a part of the standard delivery. On request the author of this article will disclose the algorithm for expansion of a character string containing the shorthand description of stepped depreciation rates into a one-dimensional array.

Table 15 shows how the calculation of present values is performed by using stepped depreciation rates.

Year	Deprn. rate	Deprn. expense	Deprn. reserve	Tax savings	Present value discount factor	Present value
(a)	(b)	(c)	(d)=cum.(c)	(e)=(c)*tax rate	(f)	(g)=(e)*(f)
1	0,15	5.439,00	5.439,00	2.828,28	0,909091	2.571,16
2	0,15	5.439,00	10.878,00	2.828,28	0,826446	2.337,42
3	0,15	5.439,00	16.317,00	2.828,28	0,751315	2.124,93
4	0,10	3.626,00	19.943,00	1.885,52	0,683013	1.287,83
5	0,10	3.626,00	23.569,00	1.885,52	0,620921	1.170,76
6	0,10	3.626,00	27.195,00	1.885,52	0,564474	1.064,33
7	0,10	3.626,00	30.821,00	1.885,52	0,513158	967,57
8	0,05	1.813,00	32.634,00	942,76	0,466507	439,80
9	0,05	1.813,00	34.447,00	942,76	0,424098	399,82
10	0,05	1.813,00	36.260,00	942,76	0,385543	363,47
	1,00	Total present value				12.727,09

Table 15: After-tax effects of stepped depreciation (3 steps)

The calculations of present values performed for stepped depreciation can be likewise applied to any other tax favored (accelerated) depreciation method where its rates can't be derived by mathematical formulae.

Note that stepped depreciation may possibly require a sub-optimization procedure for finding depreciation rates that are tax-compliant. A set of formulae for sub-optimization of stepped depreciation can be found in [1], p. 628 - 629. As a rule of thumb a schedule with fewer steps performs better with respect to present value maximization. For example, a stepped depreciation schedule derived from 5 yrs*18 pct; 5 yrs*2 pct yields a higher total present value (see appendix 1, table 17) as shown in table 15.

11. Summary of after-tax effects

Table 16 shows the effect of straight-line versus accelerated depreciation methods. Column (b) contains the total present values carried over from the preceding tables. The tax advantage of the non-linear depreciation methods is shown in column (c).

Depreciation method	Present value	Tax advantage compared to STL
(a)	(b)	(c)
Straight-line (STL) deprn. method	11.585,70	0,00
Sum-of-the-years'-digits (SYD) deprn. method	13.217,25	1.631,55
Declining-balance (DBL) without switch to STL	14.192,74	2.607,04
Declining-balance (DBL) with switch to STL	14.204,31	2.618,61
Stepped depreciation	12.727,09	1.141,39

Table 16: Summary - After-tax effects of five depreciation methods

Considering the given input parameters DBL depreciation method with switch to STL is the best choice. Compared to STL its tax advantage amounts to 2.618,61 Euro.

Note that tax rate and interest rate do not affect the ranking of the methods. They serve merely as a scaling factor for obtaining present values at a realistic order of magnitude. Therefore, it is not necessary to be precise about these two input parameters.

The next section contains an explanation as to how all the calculation processes described so far can be subdivided into rather small subroutines. Each subroutine performs a special task.

12. Structure of the Present Value Program

The purpose of the Present Value Program is automation of the calculations for total present value of the depreciation methods considered in this article. Figure 9 displays the program structure chart. The structure chart displays the hierarchy of the entire program based on the notion of "structured programming". Note that each depreciation method uses a set of subroutines. Obviously some of the subroutines are commonly used for all methods in order to avoid redundancy.

At top level the main program can be subdivided into seven parts. The last part prints a comparison summary as shown in table 16. Most of the subroutines at lower level are devoted to printing headings, detail lines, and total lines.

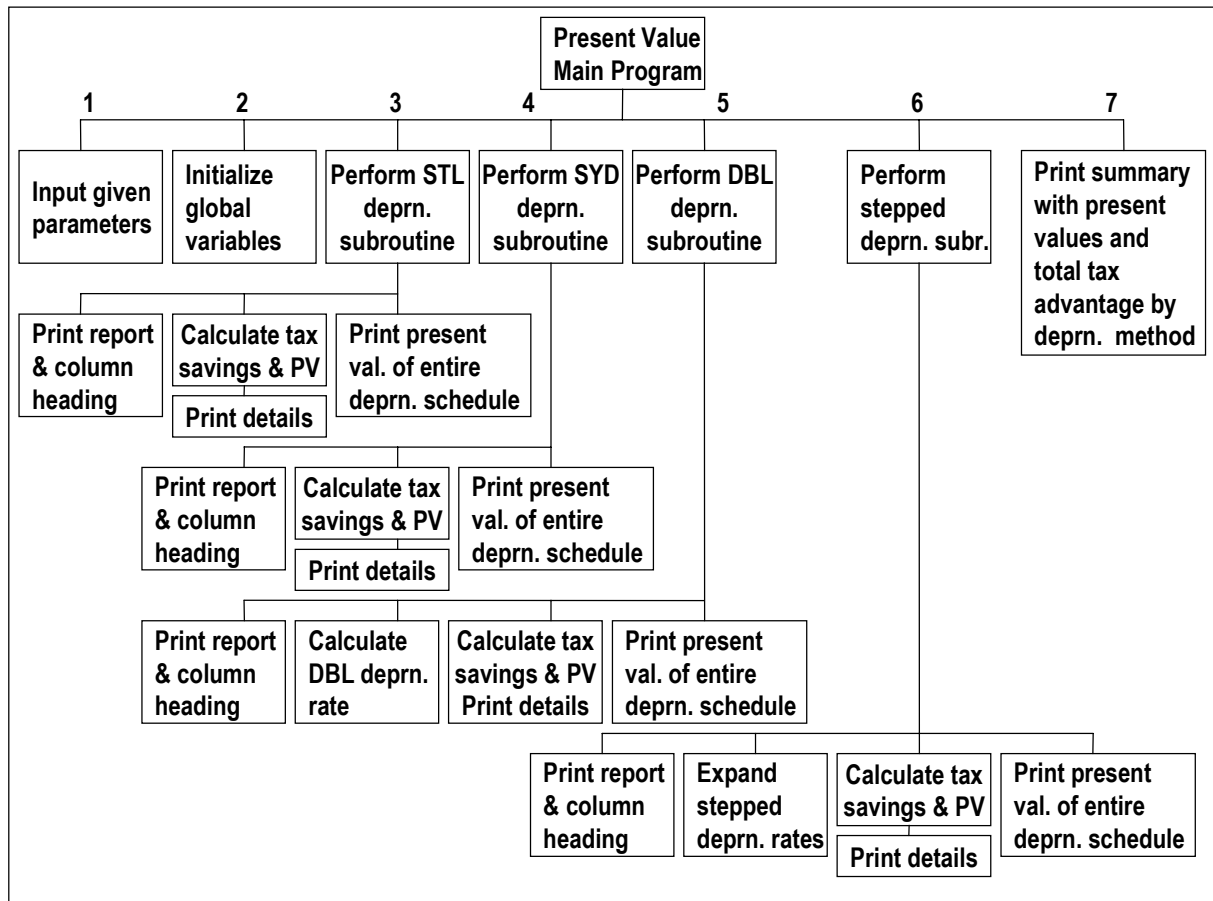


Figure 9: Structure chart of the Present Value Program

After studying and understanding the top-down structure of the Present Value Program it makes sense to review the design of the depreciation subroutines.

13. Design of the depreciation subroutines

The subroutines required to calculate the present value of a depreciation method are very similar. For illustration, the entire subroutine for the SYD method appears in figure 10. This subroutine merits careful study. It comprises 7 logical entities of programming statements. In figure 10 appropriate reference numbers indicate the logical entities.

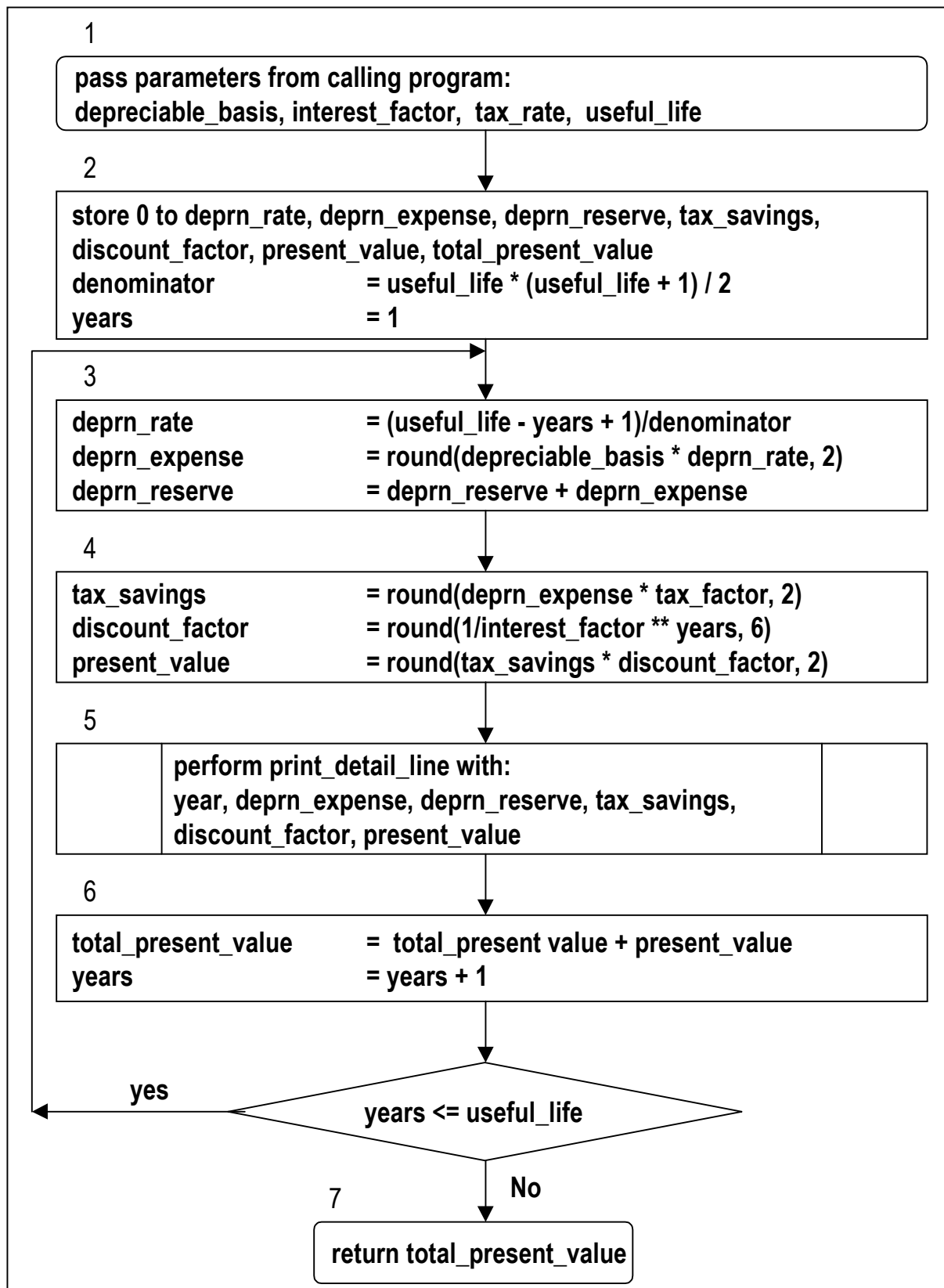


Figure 10: Flow chart of the sum-of-the-years'-digits (SYD) depreciation method

The coding in figure 10 deserves a comment. In box 2 the denominator of the fraction needed for the SYD method is determined. The corresponding statement will calculate the sum of all integers consecutively from 1 through useful_life (in years).

Each subroutine for a given depreciation method follows the same general procedure, refer to figure 10.

1. Pass input parameters from the calling (main) program
2. Initialize local variables
3. Calculate the yearly depreciation expense
4. Calculate yearly tax savings due to this depreciation expense and calculate corresponding present value.
5. Print a detail line, that is, one print-line per depreciation year, as shown in preceding tables
6. Accumulate the total present value of the tax savings for the entire schedule
7. Return the total present value to the calling program

Using an efficient programming language described Present Value Program requires roughly 500 lines of code (including all subroutines).

14. Remark

No claim concerning the completeness and correctness of the statements in this article can be made. They represent purely the author's own understanding of Oracle Assets release 11.0.3

Several people contributed to this article in various ways. These include Mr. Harald Buwing, Mr. Stephen Finch, and Mr. Glyn Frampton. To them all go my heartfelt thanks.

15. Appendix 1

Table 17 exhibits a stepped depreciation schedule having 2 steps.

Year	Deprn. rate	Deprn. expense	Deprn. reserve	Tax savings	Present value discount factor	Present value
(a)	(b)	(c)	(d)=cum.(c)	(e)=(c)*tax rate	(f)	(g)=(e)*(f)
1	0,18	6.526,80	6.526,80	3.393,94	0,909091	3.085,40
2	0,18	6.526,80	13.053,60	3.393,94	0,826446	2.804,90
3	0,18	6.526,80	19.580,40	3.393,94	0,751315	2.549,92
4	0,18	6.526,80	26.107,20	3.393,94	0,683013	2.318,10
5	0,18	6.526,80	32.634,00	3.393,94	0,620921	2.107,37
6	0,02	725,20	33.359,20	377,10	0,564474	212,87
7	0,02	725,20	34.084,40	377,10	0,513158	193,51
8	0,02	725,20	34.809,60	377,10	0,466507	175,92
9	0,02	725,20	35.534,80	377,10	0,424098	159,93
10	0,02	725,20	36.260,00	377,10	0,385543	145,39
	1,00	Total present value				13.753,31

Table 17: After-tax effects of stepped depreciation (2 steps)

Note that the first depreciation rate (= 6.526,80) and the sum of the first 4 depreciation rates (= 26.107,20) are both smaller than corresponding rates calculated for DBL depreciation (see table 12). Therefore the schedule is tax-compliant, if the two restrictions just mentioned are real ones.

16. Appendix 2

Table 18 exhibits an arithmetically declining depreciation schedule. Note that the difference between two consecutive depreciation expense amounts is always 805,00 Euro. Here this constant difference is called D. Assume D has been sub-optimized with the help of mathematical formulae taking into account appropriate tax restrictions. If the value of D has been determined, then depreciation expense (see column (b)) can be calculated as follows:

$$(19) \text{ deprn_expense}_{\text{year}} = \text{depreciable_basis} / \text{useful_life} + D / 2 * (\text{useful_life} - 2 * \text{year} + 1)$$

for year = 1, ..., useful_life

Year	Deprn. expense	Deprn. reserve	Tax savings	Present value discount factor	Present value
(a)	(b)	(c)=cum.(b)	(d)=(b)*tax rate	(e)	(f)=(d)*(e)
1	7.248,50	7.248,50	3.769,22	0,909091	3.426,56
2	6.443,50	13.692,00	3.350,62	0,826446	2.769,11
3	5.638,50	19.330,50	2.932,02	0,751315	2.202,87
4	4.833,50	24.164,00	2.513,42	0,683013	1.716,70
5	4.028,50	28.192,50	2.094,82	0,620921	1.300,72
6	3.223,50	31.416,00	1.676,22	0,564474	946,18
7	2.418,50	33.834,50	1.257,62	0,513158	645,36
8	1.613,50	35.448,00	839,02	0,466507	391,41
9	808,50	36.256,50	420,42	0,424098	178,30
10	3,50	36.260,00	1,82	0,385543	0,70
Total present value					13.577,91

Table 18: After-tax effects of arithmetically declining depreciation

As expected, the total present value shown in table 18 is actually higher than the one shown in table 10.

17. Bibliography

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