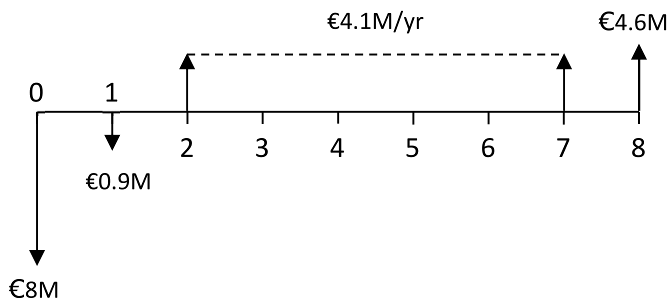
Lockheed Martin has secured a satellite launch contract from a European communications company that will pay them €5M per year for the next 8 years. To land that contract, they will have to invest €13M in a satellite tracking system. Of that amount, €8M will be paid up front and the remaining €5M will be paid during the first year of operation. The annual operating costs for the satellite tracking system are estimated at €0.9M per year. At the end of the contract, it is estimated that the equipment will have a salvage value of €0.5M. How long will it take Lockheed-Martin to break even on their initial investment?

First, let's draw the ***net*** cash flow diagram to make our job easier:



Now we just add up all of the cash flows starting at Time 0. When the sum exceeds zero we've found our payback period:

Year 0: $-$ €8.0^M

Year 1: $-$ €8.0^M $-$ €0.9^M = $-$€8.9^M

Year 2: $-$ €8.9^M + €4.1^M = $-$€4.8^M

Year 3: $-$ €4.8^M + €4.1^M = $-$€0.7^M

Year 4: $-$ €0.7^M + €4.1^M = +€3.4^M

So it takes 4 years (or 3.2 years if you interpolate) for the satellite launch contract to pay back Lockheed-Martin's €13^M investment in the satellite tracking facilities.

If Lockheed-Martin had two projects with similar present worth values and one had a payback period of 4 years and the other had a payback period of 8 years, which one do you think they would choose to pursue?

Ignoring the time value of money makes the calculations quick and simple, but it will always underestimate the time needed to break even because the dollars used to determine future revenues aren't worth as much as the dollars used to determine present costs.

You're essentially answering the question
"How long will it take to recoup my investment if my MARR is zero?"

A more realistic way to determine payback period—one that takes the time value of money (your MARR) into account—is to sum the present equivalents of the net cash flows:

$$-P+\sum_{t=1}^{t=n_p} NCF_t\left(P\,|\,F,i\%,t\right)\geq 0$$

This is just the present value of all the cash flows from Year 0 through Year t.

So instead of asking "How long until I get my money back" you're asking "How long until the present worth becomes greater than zero?" When the present worth is exactly equal to zero, you've earned exactly your MARR and when it's greater than zero, you've earned more than your MARR, so this is the same as asking "How long until the rate of return on this investment exceeds my MARR?"

As with the no-return payback period, if the cash flows are simple, we can solve this problem algebraically. Let's look at the Pigs-R-Us example again:

Pigs-R-Us Example 5

Pigs-R-Us is trying to decide whether to automate their meat packing process. The machine costs \$200,000, has a useful life of 10 years and a salvage value of \$10,000. The machine costs \$9000 per year to operate and maintain but will save the company \$50,000 per year in labor costs. How long will it take for Pigs-R-Us to break even if their MARR is 14% per year?

$$PW = -\$200K + \$41K\,(P|A,14\%,n) \geq 0$$

$$\$41K\,(P|A,14\%,n) \geq 200$$

$$(P|A,14\%,n) \geq 4.88$$

Looking down the P|A column in the 14% table, we find that (P|A,14%,9) = 4.9464 is the first interest rate factor greater than 4.88 so the payback period is 9 years.

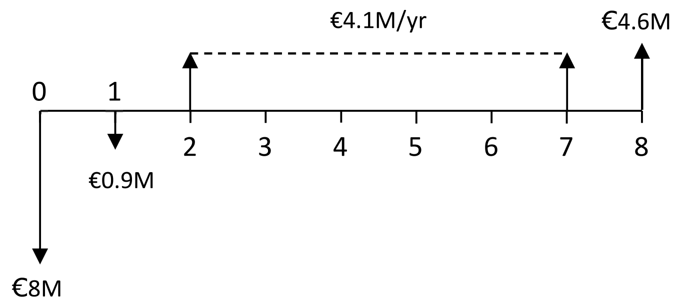
Obviously, it takes longer to recoup our investment with the time value of money included. In this case, it takes nearly twice as long!

If the cash flows aren't simple, we can find our answer by calculating the present worth one year at a time. Let's look at the Lockheed-Martin example again:

Lockheed-Martin Example 5 (REPRISE)

Lockheed Martin has secured a satellite launch contract from a European communications company that will pay them €5M per year for the next 8 years. To land that contract, they will have to invest €13M in a satellite tracking system. Of that amount, €8M will be paid up front and the remaining €5M will be paid during the first year of operation. The annual operating costs for the satellite tracking system are estimated at €0.9M per year. At the end of the contract, it is estimated that the *equipment will have a salvage value of €0.5M. How long will it take Lockheed-Martin to break even on their initial investment? Assume their MARR is 15% per year.*

Let's again draw the ***net*** cash flow diagram to make our job easier:



To find the payback period with interest we can keep a running total of the calculated present worth values and just add in each new year as we go along:

$$\text{Year 0: PW} = -€8.00^{M}$$
$$\text{Years 0–1: PW} = -€8.00^{M} - €0.9^{M}(1.15)^{-1} = -€8.78^{M}$$
$$\text{Years 0–2: PW} = -€8.78^{M} + €4.1^{M}(1.15)^{-2} = -€5.68^{M}$$
$$\text{Years 0–3: PW} = -€5.68^{M} + €4.1^{M}(1.15)^{-3} = -€2.99^{M}$$
$$\text{Years 0–4: PW} = -€2.99^{M} + €4.1^{M}(1.15)^{-4} = -€0.64^{M}$$
$$\text{Years 0–5: PW} = -€0.64^{M} + €4.1^{M}(1.15)^{-5} = +€1.40^{M}$$

So the payback period is between 4 and 5 years instead of between 3 and 4 years.

Again, it takes longer to recoup our investment with the time value of money included because we're trying to recoup our initial investment <u>and</u> earn a 15% return on that investment.

Another way we could have found this answer (which is not mentioned in your textbook) is to calculate the <u>future</u> worth of all the cash flows up to a given point in time. As with the present worth, as soon as the future worth exceeds zero, you've earned your MARR. This is actually a bit simpler because all you have to do is multiply the previous year's result by (1+i) and add in the next cash flow in the series:

$$\text{Year 0: FW} = -€\ 8.00^{M}$$
$$\text{Year 1: FW} = -€\ 8.00^{M}(1.15) - €0.9^{M} = -€10.10^{M}$$
$$\text{Year 2: FW} = -€10.10^{M}(1.15) + €4.1^{M} = -€7.52^{M}$$
$$\text{Year 3: FW} = -€\ 7.52^{M}(1.15) + €4.1^{M} = -€4.54^{M}$$
$$\text{Year 4: FW} = -€\ 4.54^{M}(1.15) + €4.1^{M} = -€1.12^{M}$$
$$\text{Year 5: FW} = -€\ 1.12^{M}(1.15) + €4.1^{M} = +€2.81^{M}$$

The biggest problem with the payback period methods is that they completely ignore all of the cash flows that occur beyond the breakeven point.

What would happen if, instead of having a €0.5M salvage value, Lockheed-Martin’s satellite tracking facility had a €2M disposal cost? So even if the original investment had already been recouped, the company would have to spend money later on to decommission the facility. The payback period loses its meaning if there are negative cash flows beyond the calculated payback year.

Or what if Pigs-R-Us had achieved payback in 4 years but they had to spend $60,000 to refurbish the automated meatpacking equipment in Year 5?

The payback period also gives us no information about the amount of wealth generated by a project (in either absolute or relative terms). The cash flows could be nearly zero beyond the breakeven point or they could climb at an arithmetic or geometric rate.

Payback period can, however, be used in conjunction with measures of absolute and relative worth to give a more complete picture of the project and provide more information to make our investment decision.