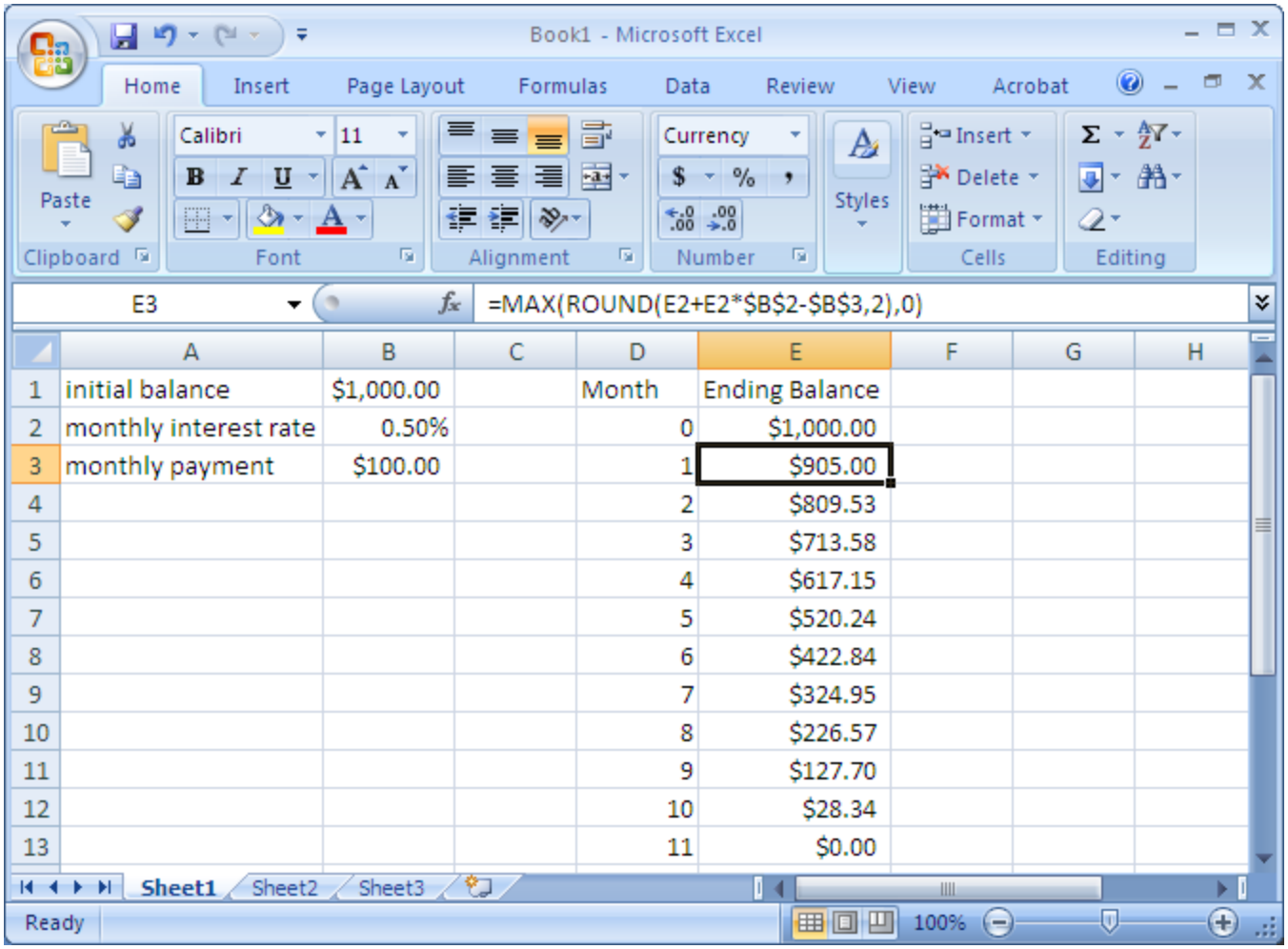
# General Principle : Decompose Complex Problems

# Example:

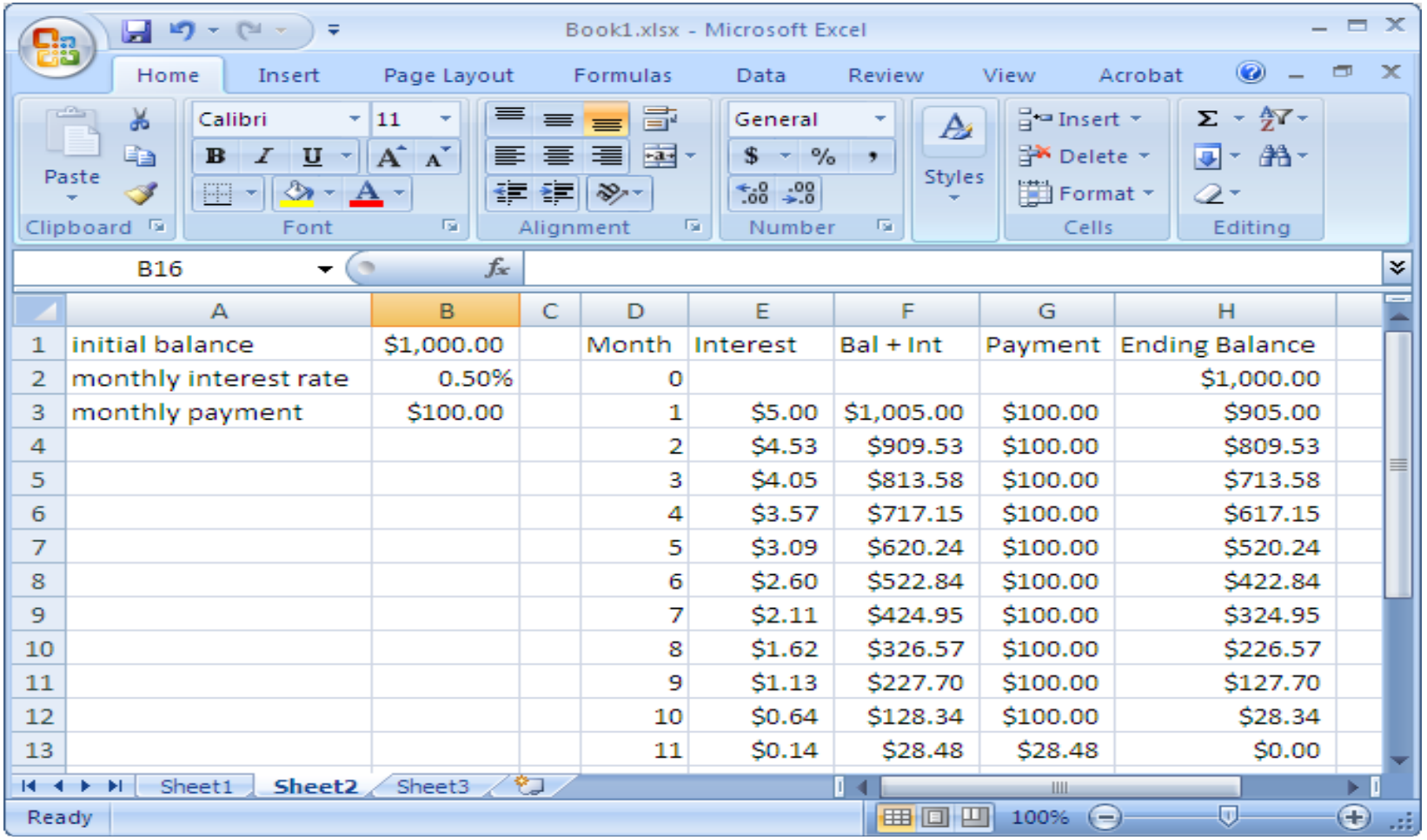
- You given the initial balance of a loan, a monthly interest rate for that loan, and a standard monthly payment amount.
- On the last month, only the remaining balance is paid
- You are asked to calculate the balance owed at the end of each month.

# A Monolithic Solution



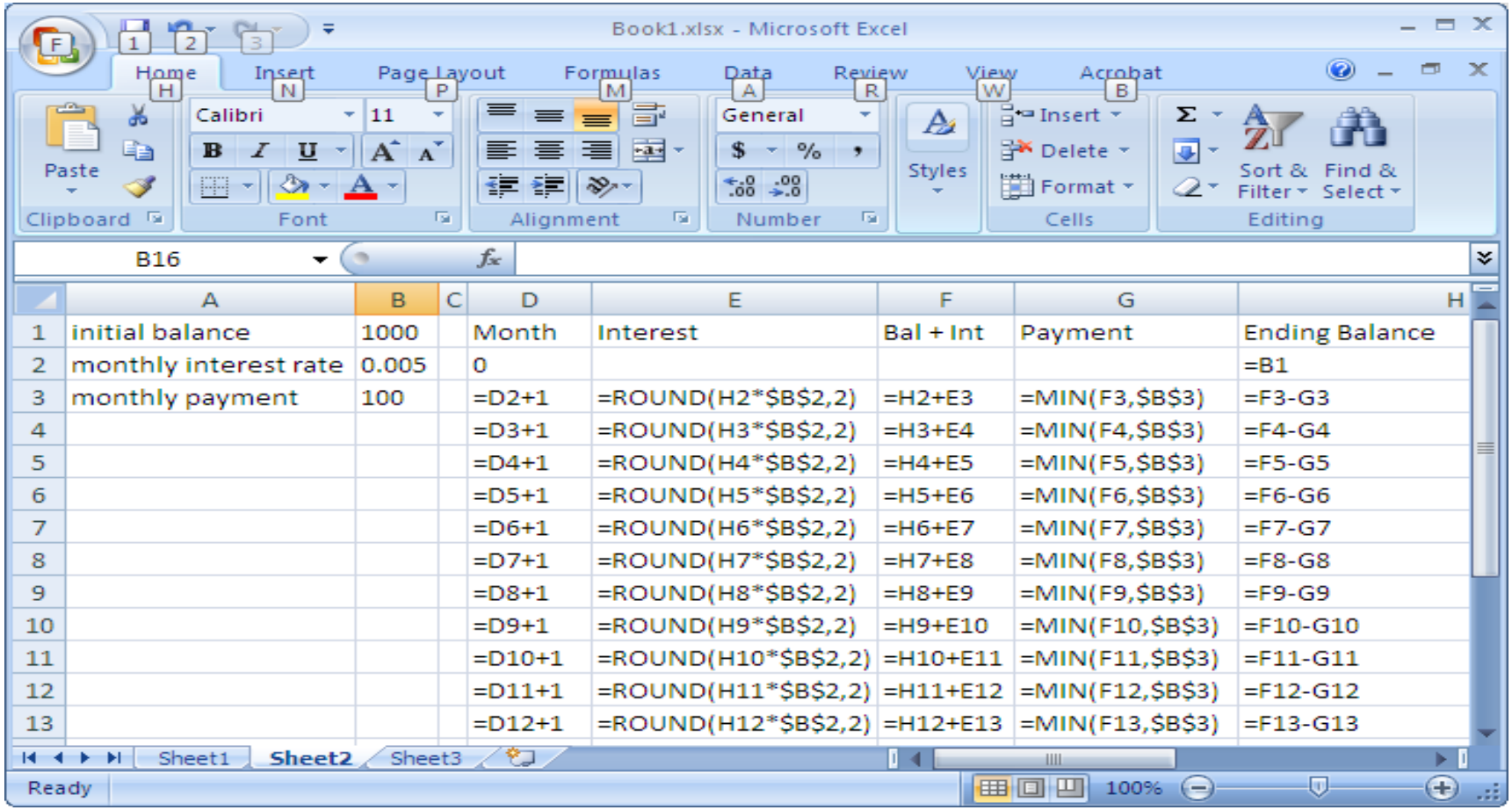

| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 | initial balance | $1,000.00 | | Month | Ending Balance | | | |
| 2 | monthly interest rate | 0.50% | | 0 | $1,000.00 | | | |
| 3 | monthly payment | $100.00 | | 1 | $905.00 | | | |
| 4 | | | | 2 | $809.53 | | | |
| 5 | | | | 3 | $713.58 | | | |
| 6 | | | | 4 | $617.15 | | | |
| 7 | | | | 5 | $520.24 | | | |
| 8 | | | | 6 | $422.84 | | | |
| 9 | | | | 7 | $324.95 | | | |
| 10 | | | | 8 | $226.57 | | | |
| 11 | | | | 9 | $127.70 | | | |
| 12 | | | | 10 | $28.34 | | | |
| 13 | | | | 11 | $0.00 | | | |

# Breaking the Problem into Smaller Parts




| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 | initial balance | $1,000.00 | | Month | Interest | Bal + Int | Payment | Ending Balance |
| 2 | monthly interest rate | 0.50% | | 0 | | | | $1,000.00 |
| 3 | monthly payment | $100.00 | | 1 | $5.00 | $1,005.00 | $100.00 | $905.00 |
| 4 | | | | 2 | $4.53 | $909.53 | $100.00 | $809.53 |
| 5 | | | | 3 | $4.05 | $813.58 | $100.00 | $713.58 |
| 6 | | | | 4 | $3.57 | $717.15 | $100.00 | $617.15 |
| 7 | | | | 5 | $3.09 | $620.24 | $100.00 | $520.24 |
| 8 | | | | 6 | $2.60 | $522.84 | $100.00 | $422.84 |
| 9 | | | | 7 | $2.11 | $424.95 | $100.00 | $324.95 |
| 10 | | | | 8 | $1.62 | $326.57 | $100.00 | $226.57 |
| 11 | | | | 9 | $1.13 | $227.70 | $100.00 | $127.70 |
| 12 | | | | 10 | $0.64 | $128.34 | $100.00 | $28.34 |
| 13 | | | | 11 | $0.14 | $28.48 | $28.48 | $0.00 |

# Showing Formulas




| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 | initial balance | 1000 | | Month | Interest | Bal + Int | Payment | Ending Balance |
| 2 | monthly interest rate | 0.005 | | 0 | | | | =B1 |
| 3 | monthly payment | 100 | | =D2+1 | =ROUND(H2*$B$2,2) | =H2+E3 | =MIN(F3,$B$3) | =F3-G3 |
| 4 | | | | =D3+1 | =ROUND(H3*$B$2,2) | =H3+E4 | =MIN(F4,$B$3) | =F4-G4 |
| 5 | | | | =D4+1 | =ROUND(H4*$B$2,2) | =H4+E5 | =MIN(F5,$B$3) | =F5-G5 |
| 6 | | | | =D5+1 | =ROUND(H5*$B$2,2) | =H5+E6 | =MIN(F6,$B$3) | =F6-G6 |
| 7 | | | | =D6+1 | =ROUND(H6*$B$2,2) | =H6+E7 | =MIN(F7,$B$3) | =F7-G7 |
| 8 | | | | =D7+1 | =ROUND(H7*$B$2,2) | =H7+E8 | =MIN(F8,$B$3) | =F8-G8 |
| 9 | | | | =D8+1 | =ROUND(H8*$B$2,2) | =H8+E9 | =MIN(F9,$B$3) | =F9-G9 |
| 10 | | | | =D9+1 | =ROUND(H9*$B$2,2) | =H9+E10 | =MIN(F10,$B$3) | =F10-G10 |
| 11 | | | | =D10+1 | =ROUND(H10*$B$2,2) | =H10+E11 | =MIN(F11,$B$3) | =F11-G11 |
| 12 | | | | =D11+1 | =ROUND(H11*$B$2,2) | =H11+E12 | =MIN(F12,$B$3) | =F12-G12 |
| 13 | | | | =D12+1 | =ROUND(H12*$B$2,2) | =H12+E13 | =MIN(F13,$B$3) | =F13-G13 |

# Comparison

- The Monolithic solution calculates the monthly balance with on complex formula
- The Solution with intermediate results, performs the same calculation by breaking up the complex formula into three simpler formula.

# Dividing the solution into a number of smaller parts has many advantages.

1. It is easier to catch mistakes.
   - there are more results that can be checked
2. It is easier to verify correctness
   - verification can be done step by step
3. It is easier to reuse the parts
   - For example, if we were asked to find the total amount paid for the loan, it would be easier to make the necessary changes to the solution broken into parts than to the monolithic solution.