Project Economics:

Selecting and prioritizing high-value projects
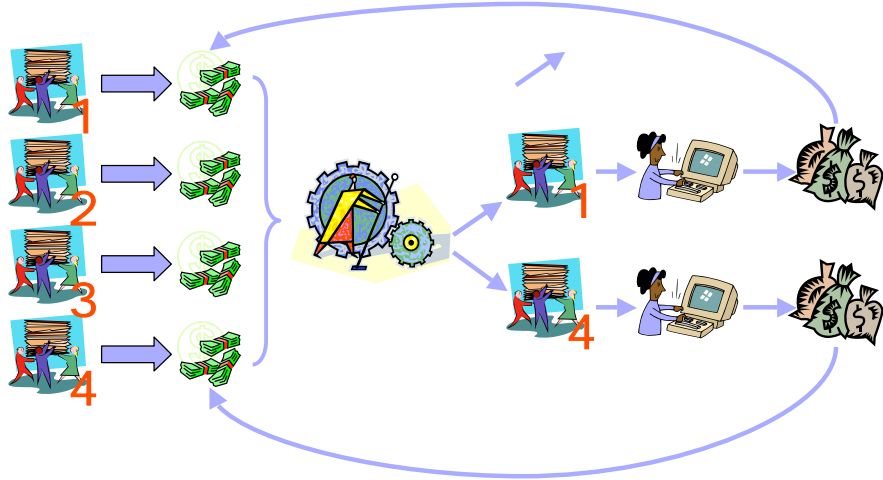
Mike Cohn
September 29, 2005

Mike Cohn—background

- Programming for 20 years
- Author of
  - *User Stories Applied*
  - *Agile Estimating and Planning*
  - Java, C++, database programming books
- Founding member and director of the Agile Alliance and the Scrum Alliance
- Founder of Mountain Goat Software
  - Process and project management consulting and training

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What we want to do

Today's agenda

❑ Net Present Value (NPV)

❑ Internal Rate of Return (IRR) and ROI

❑ Payback period

❑ Modeling return

❑ Prioritizing work

Which project would you rather do?

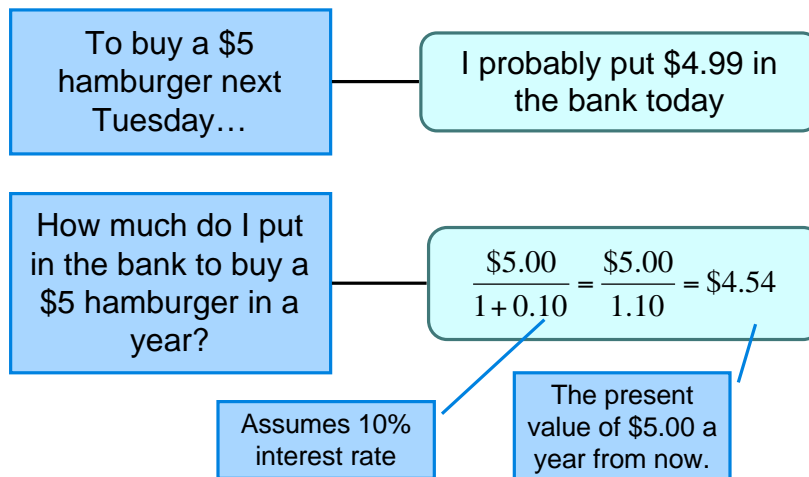| Year	Project A		Project B	
	Investment	Return	Investment	Return
0	$1,000		$1,000	
1		$200		$3,000
2		$300		$500
3		$500		$300
4		$3,000		$200
Total	**$1,000**	**$4,000**	**$1,000**	**$4,000**

The time-value of money

- A dollar today is worth more than a dollar a year from now

I'll gladly pay you on Tuesday for a hamburger today.

Calculating the value of future dollars

| To buy a $5 hamburger next Tuesday… | — | I probably put $4.99 in the bank today |

| How much do I put in the bank to buy a $5 hamburger in a year? | — | $\dfrac{\$5.00}{1+0.10} = \dfrac{\$5.00}{1.10} = \$4.54$ |

Assumes 10% interest rate

The present value of $5.00 a year from now.

Present value of one future payment

Present Value

Future Value in period t

$$PV = \frac{F_t}{\left(1 + i_t\right)}$$
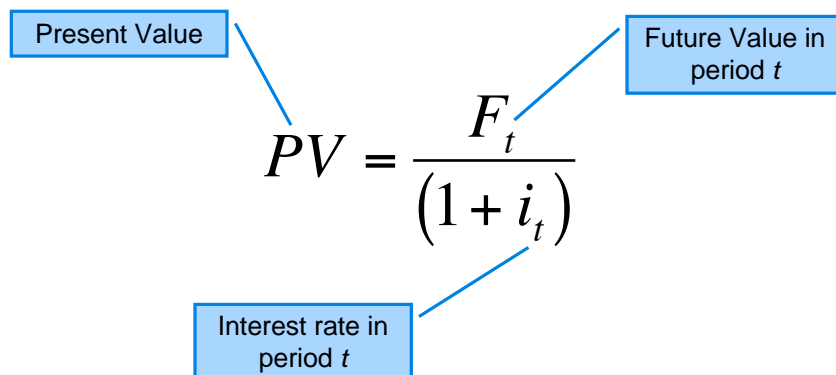
Interest rate in period t

Net present value (NPV)

- The present value of a stream of cash flows

$$NPV(i) = \sum_{t=0}^{n} F_t \left(1 + i\right)^{-t}$$

Future Value in period t

Interest rate per period

NPV example

- Assuming 12% annual discount rate (3% / quarter)

Quarter	Investment	Return	$(1+i)^{-t}$	Discounted value
0	200		1.000	−200
1	600		0.971	−583
2		100	0.943	94
3		300	0.915	275
4		500	0.888	444
44	800	900		30

Discount rate sensitivity

- NPV is highly sensitive to the chosen discount rate:

Quarter	Net Investment	Discounted value (3%)	Discounted value (6%)
0	–200	–200	–200
1	–600	–583	–566
2	100	94	89
3	300	275	252
4	500	444	396
Total	100	30	–29

Do the project under these conditions

But not under these conditions

Comparing NPVs

- Highest NPV brings the most present-value dollars to the company

Project	NPV
Jabberwock 1.0	$2,100
Boojum 2.0	$1,253
Slithy Toves 3.0	$784
Bandersnatch 1.0	$385

- But comparing NPVs can be misleading
  - □ What if Bandersnatch required only a $5 investment and Jabberwork required $50,000?

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Return as a percentage

- Rather than expressing returns in dollars, we'd like to express return as a percentage
  - ☐ Allows for direct comparisons
- NPV = how much money a project will return
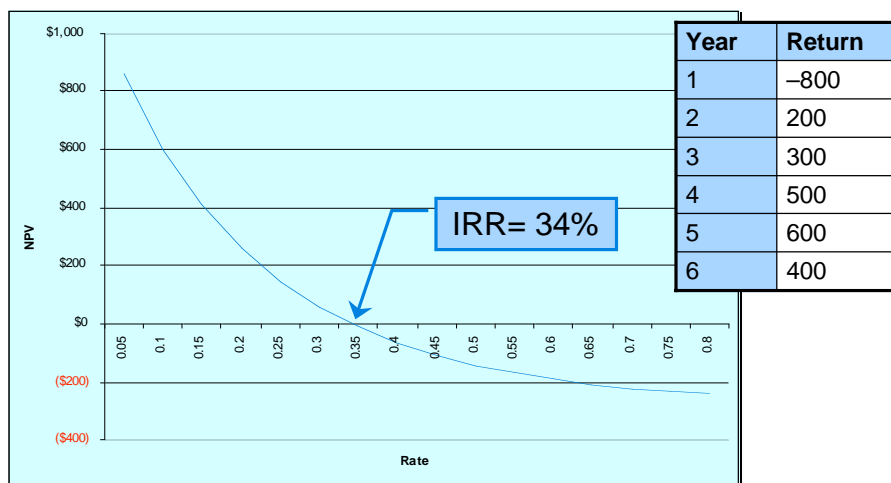- ROI = how quickly an investment will grow

Internal rate of return (IRR) and ROI

- IRR = Internal Rate of Return
  - Often called Return On Investment (ROI)
- The interest rate at which NPV is 0

$$0 = PV(i^*) = \sum_{t=0}^{n} F_t \left(1 + i\right)^{-t}$$

IRR is where NPV = 0

Year	Return
1	−800
2	200
3	300
4	500
5	600
6	400

IRR= 34%

Calculating IRR / ROI

- Use Excel's irr function

+IRR(**{**0, -200, -600, 100, 300, 500**}**)

Investment made on first day of project

Returns from five periods

Advantages and disadvantages

- Advantages
  - You don't need to guess at a discount rate like with NPV
  - Can be used to directly compare projects
- Disadvantages
  - Calculation is hard to do by hand (but easy in Excel); may lead to numbers being distrusted
  - Cannot use in all circumstances
    - e.g., once cash flow turns positive, it stays positive

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An example

Quarter	Net Cash Flow	Running Total
1	−200	−200
2	−200	−400
3	100	−300
4	300	0
5	500	500

Payback Period =
4 quarters

Advantages and disadvantages

- Advantages
  - Calculation is very easy
  - Measures the duration of financial risk
    - Longer payback period = greater risk
- Disadvantages
  - Doesn't consider the time-value of money
  - Doesn't measure profitability at all

Discounted payback period

- Discount future cash flows and determine when the investment is paid back

Quarter	Net Cash Flow	$(1+i)^{-t}$	Discounted Cash Flow	Running Total
1	−200	0.971	−194	−194
2	−200	0.943	−189	−383
3	100	0.915	92	−291
4	300	0.888	266	−25
5	500	0.863	432	407

Payback Period = 5 quarters

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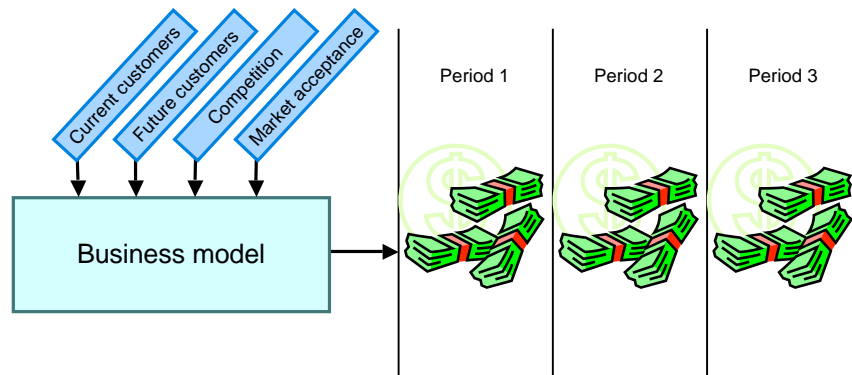# Today's agenda

☑ Net Present Value (NPV)

☑ Internal Rate of Return (IRR) and ROI

☑ Payback period

❑ Modeling return

❑ Prioritizing work

Need a business model

- These formulas assume you have a model of the returns a project will generate

Sources of return

New revenue

Incremental revenue

Retained revenue

Operational efficiency

New revenue

- Money we'll make selling products or services to new customers
- The first thing most people think of when they think of the return on a project

  - In addition to selling books, Amazon decides to sell music CDs

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Incremental revenue

- Sometimes worth distinguishing from new revenue
- Typically comes because new product or service:
  - Encourages existing customers to buy or license more
  - Includes optional, add-on modules that are sold separately
  - Includes features that justify a higher price
  - Encourages use of consulting services

> - On our eCommerce site we can add gift wrapping and charge $5 per box

Retained revenue

- Revenue you'll lose if the project is not performed
  - Revenue you'll lose is different from revenue you won't get
- Customers who will stay with you who otherwise would leave

> - We're losing customers because our eCommerce site doesn't offer gift wrapping
> - Our competitors have added features we don't have

Operational efficiency

- Most applicable for internally used software
    - But also a factor on commercial products
- Anything that takes a long time
    - Or will take a long time as the company grows
- Anything that improves accuracy or reduces rework

> - An eCommerce site with third-party sellers. It takes 2 hours of manual time to add each seller.
> - Our commercial software has usability issues, we get a lot of tech support calls.
> - We spend 16 hours training new employees how to use our internal software

An example: WebPayroll

- Offers web-based payroll system to small companies
- Calculates payroll taxes, prints checks, etc.
- We tell customers they need to enter payroll data 3 days before they want checks
- Our goal: Next-day service
    - Enter data by 5pm, we print checks and overnight them to the company

Facts about WebPayroll

- Average customer – pays $400/year in fees
- Overnight delivery will appeal to smaller customers, paying an average of $200/year
- We think we'll make another $100/year per customer that uses the over night service
- Average new customer is then worth $75/quarter
- New feature will take four months to deliver

WebPayroll: new revenue

- Sales says 50 new customers/quarter this year; 100 next year

Quarter	New Customers	Revenue per Customer	New Revenue
1	0	0	0
2	50	$50	$2,500
3	50	$75	$3,750
4	50	$75	$3,750
5	100	$75	$7,500
6	100	$75	$7,500
7	100	$75	$7,500
8	100	$75	$7,500

WebPayroll: incremental revenue

- We estimate we'll sign up 100 existing members per quarter until we have 400

Quarter	Customers	Revenue per Customer	Incremental Revenue
1	0	0	0
2	100	$16	$1,600
3	200	$25	$5,000
4	300	$25	$7,500
5	400	$25	$10,000
6	400	$25	$10,000
7	400	$25	$10,000
8	400	$25	$10,000

Retained revenue

How many customers will we keep who would have left?

How much is each retained customer worth?

We estimate 20/quarter this year; 40/quarter next year.

Our model already says $400 per year

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WebPayroll: retained revenue

- We estimate we'll sign up 100 existing members per quarter until we have 400

Quarter	Retained Customers	Revenue per Customer	Incremental Revenue
1	20	$100	$2,000
2	20	$100	$2,000
3	20	$100	$2,000
4	20	$100	$2,000
5	40	$100	$4,000
6	40	$100	$4,000
7	40	$100	$4,000
8	40	$100	$4,000

Operational efficiency

We use payroll clerks today.

- We can avoid hiring one in the middle of this year and another in the middle of next year.
- Average salary is $20,000 / year.
- Fully-burdened labor cost is $30,000 / year.

WebPayroll: operational efficiency

Quarter	Payroll Clerks Not Needed	Fully Burdened Labor Cost	Operational Efficiencies
1	0	0	0
2	0	0	0
3	1	$7,500	$7,500
4	1	$7,500	$7,500
5	1	$7,500	$7,500
6	1	$7,500	$7,500
7	2	$7,500	$15,000
8	2	$7,500	$15,000

All the numbers for WebPayroll

Q	Dev. Cost	New Revenue	Incr. Revenue	Retained Revenue	Oper. Efficiencies	Net Cash Flow
1	−90,000	0	0	$2,000	0	−88,000
2	−30,000	$2,500	$1,600	$2,000	0	−23,900
3	0	$3,750	$5,000	$2,000	$7,500	18,250
4	0	$3,750	$7,500	$2,000	$7,500	20,750
5	0	$7,500	$10,000	$4,000	$7,500	29,000
6	0	$7,500	$10,000	$4,000	$7,500	29,000
7	0	$7,500	$10,000	$4,000	$15,000	36,500
8	0	$7,500	$10,000	$4,000	$15,000	36,500

WebPayroll - NPV

Quarter	Net Cash Flow	Present Value Factor (12% / year)	Present Value
1	−88,000	0.971	−85,448
2	−23,900	0.943	−22,538
3	18,250	0.915	16,701
4	20,750	0.888	18,436
5	29,000	0.863	25,016
6	29,000	0.837	24,287
7	36,500	0.813	29,677
8	36,500	0.789	28,813
		NPV (12%) =	$34,944

WebPayroll - ROI

+IRR({0, -88000, -23900, 18250, 20750, 29000, 29000, 36500, 36500})

10%

WebPayroll - Payback Period

Quarter	Net Cash Flow	Running Total
1	−88,000	−88,000
2	−23,900	−111,900
3	18,250	−93,650
4	20,750	−72,900
5	29,000	−43,900
6	29,000	−14,900
7	36,500	21,600
8	36,500	58,100

Payback Period = 7 quarters

WebPayroll - Discounted Payback Period

Quarter	Net Cash Flow	Present Value Factor (12% / year)	Present Value	Running Total
1	−88,000	0.971	−85,448	−85,448
2	−23,900	0.943	−22,538	−107,986
3	18,250	0.915	16,701	−91,285
4	20,750	0.888	18,436	−72,849
5	29,000	0.863	25,016	−47,833
6	29,000	0.837	24,287	−23,546
7	36,500	0.813	29,677	6,131
8	36,500	0.789	28,813	34,944

Payback Period = 7 quarters

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Project (theme) comparison matrix

Theme	Story Points	Cost	3-Year Return	NPV	IRR	Payback
Theme A	25	$150	$1,085	$448	133%	2
Theme B	32	$192	$2,109	$940	172%	4
Theme C	90	$540	$2,537	$883	89%	2
Theme D	48	$288	$1,360	$443	76%	4
Theme E	55	$330	$900	$191	48%	2
Theme F	79	$474	$1,365	$331	56%	4
Theme G	90	$540	$5,964	$2,519	139%	5
Theme H	50	$300	$2,415	$1,023	146%	2
Theme I	15	$90	$1,600	$747	221%	1
Theme J	30	$180	$640	$182	65%	2
Theme K	75	$450	$516	($104)	5%	4
Theme L	40	$240	$171	($110)	-12%	5
Theme M	80	$480	$1,025	$142	36%	3
Theme N	18	$108	$185	$7	24%	2
Theme O	35	$210	$423	$50	33%	3
Theme P	24	$144	$188	($19)	12%	5
Theme Q	15	$90	$102	($20)	5%	5
Theme R	6	$36	$155	$53	90%	1
Theme S	65	$390	$410	($105)	2%	4
Theme T	12	$72	$1,505	$748	355%	1

Today's agenda

- ☑ Net Present Value (NPV)
- ☑ Internal Rate of Return (IRR) and ROI
- ☑ Payback period
- ☑ Modeling return
- ☑ Prioritizing work
- ❑ Economic Value Added (EVA)

Which would you prefer?

Year	Investment	Return	Discounted value
0	200		−200
1	600		−545
2		200	165
3		400	301
4		600	410
Total	800	1,200	131

Project A

Revenue	$201
Cost	$1
Return	$200

Project B

Revenue	$100,200
Cost	$100,000
Return	$200

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Valuing the capital used

- Other measures don't consider the value of the money used

Year	Investment	Return	Discounted value
0	200		−200
1	600		−545
2		200	165
3		400	301
4		600	410
Total	800	1,200	131

- How much does it cost to run this business?
- Is it shipping a CD or is there a multi-million dollar data center supporting it?

Buying a sandwich shop

- Makes a profit of $5k / month
- Cost is $100k
- **Should you buy it?**

- **What if it cost $1000k?**

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Economic Value Added (EVA)

- We want a measure that considers the cost of the capital tied up in a project
  - Other measures just consider the return
- EVA includes the cost of capital and the amount of capital needed

Calculating EVA

	Y0	Y1	Y2	Y3	Y4
Earnings	0	$300	$600	$500	$500
Cumulative Capital Invested	$1000	$1200	$1400	$1600	$1800
Cost of Capital	15%	15%	15%	15%	15%
Capital Charge	$150	$180	$210	$240	$270
Economic Profit	−$150	$120	$390	$260	$230
PV of EP at 10%	−$150	109	322	195	157
EVA	634				

Determining your cost of capital

| Best approach | — | ▪ Ask your company or department controller |

| Second best | — | ▪ Ask your company or department controller |

| Third best | — | ▪ Capital Asset Pricing Model ▪ CAPM |

CAPM

$$\text{Cost of Capital} = r_f + (\beta * (r_m - r_f))$$

- r_f = risk-free rate of return (e.g., government bonds)
- β = How much the company's stock moves relative to the overall stock market; >1 is more volatile
- r_m = overall stock market return

Calculating CAPM, an example

$$\text{Cost of Capital} = r_f + (\beta * (r_m - r_f))$$

- r_f = 1.7
- β = 1.5
- r_m = 10.5

1.7 + (1.5 * (10.5 - 1.7))
1.7 + 1.5*8.8
1.7 + 13.2
14.9

Where to go next
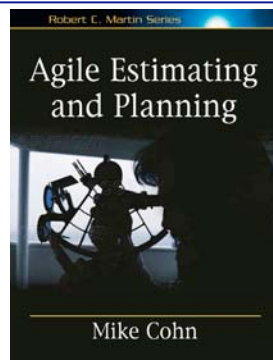
- *Agile Estimating and Planning* by Mike Cohn

- *Return on Software* by Steve Tockey
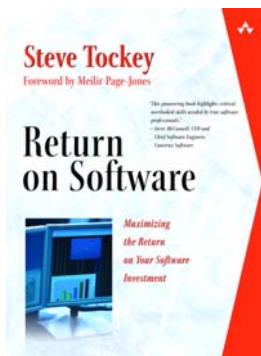
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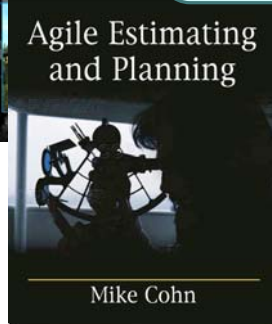
- mike@mountaingoatsoftware.com
- (303) 810–2190 (mobile)
- (720) 890–6110 (office)
- www.mountaingoatsoftware.com