Financial Analysis for Technical Professionals

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Caveats

- I am not a lawyer, accounting, or financial professional
- None of this constitutes legal, accounting, or financial (or tax!) advice
- Please seek professional help for anything formal or with legal implications, and to sanity-check any LLM output you use
- These are just a fellow engineer's experiences learning about financial considerations, and I hope something in here helps with analyzing risk or decisions on spending

Why Should Engineers Care about Finance?

Or, Storytime

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Long, long ago in an office tower far, far away. . .

- Most telecom traffic was voice, and transport costs were astronomical
- WilTel had saved big by stuffing fiber down old petroleum pipelines, but . . .
- The last mile called for expensive DS-1 or DS-3 leases that took weeks or even months to provision to trunk switches.
- Order too soon, you pay big bucks for idle circuits. Wait too long, you block voice calls and callers get a fast busy.

Long, long ago in an office tower far, far away. . .

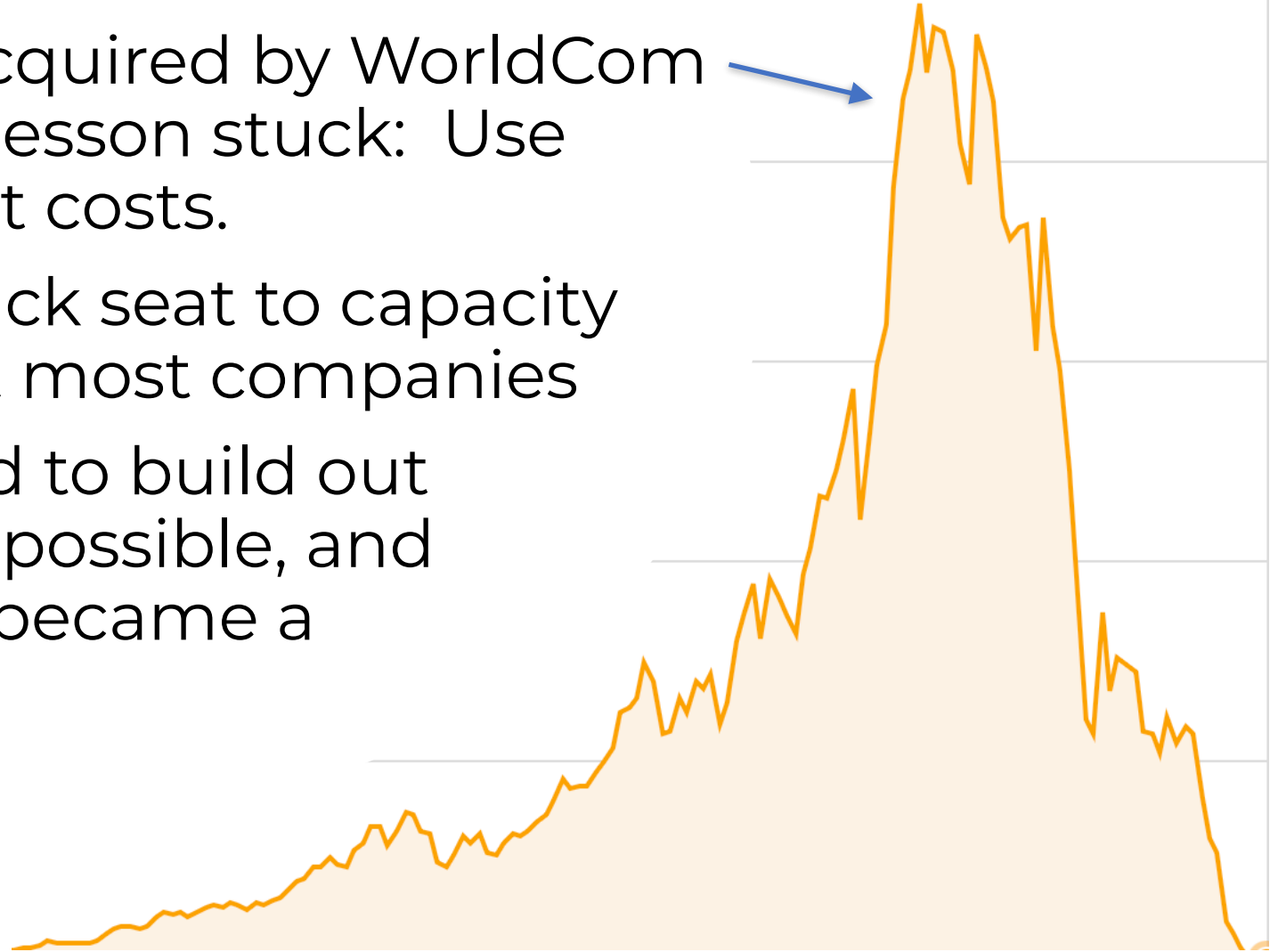
The first operators: yet another job lost to automation

An entire Traffic Engineering department was formed, using SQL reports and spreadsheets to, among other things:

- ➡ Predict peak lines required
- ➡ Compare provider costs, and
- ➡ Identify T-3 channels that could be groomed to use each to its fullest capacity

Long, long ago in an office tower far, far away. . .

- Although WilTel was acquired by WorldCom and its fraudsters, the lesson stuck: Use data and analysis to cut costs.
- For a while, it took a back seat to capacity and revenue growth at most companies
- Engineering teams had to build out networks as quickly as possible, and bandwidth eventually became a commodity



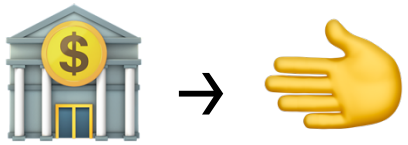
The Cycle of Financial Thinking

- Financial concerns come back again from time to time because:
  - Markets correct, easy money runs out
  - Everything costs money - rack space, people, equipment, transit, initial setup for peering
  - Securing funds for new ventures draws scrutiny again (for a while)
- You could say all engineering decisions are financial

Types of Financial Decisions

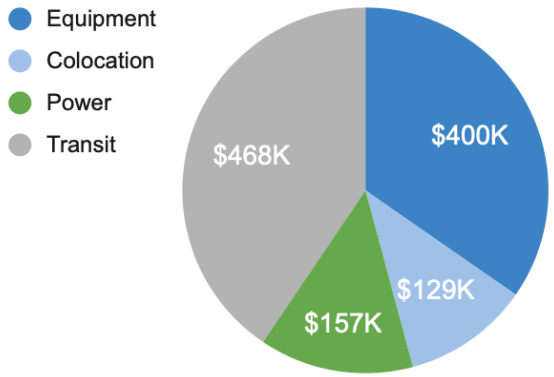
External:

- Debt or investment for start-ups or acquisitions



Internal:

- Budgeting, management buy-in for expenditures



- Not exhaustive, of course. And is the distinction all that important?

Types of Financial Decisions

- Really the same considerations, after all:
  - ➡ Someone has to allocate a finite resource (money, debt, shares, rack space, work hours)
  - ➡ They need it to return a benefit (profit, cost savings)
  - ➡ There's always a risk it won't, so how to assure them?

Personal Considerations

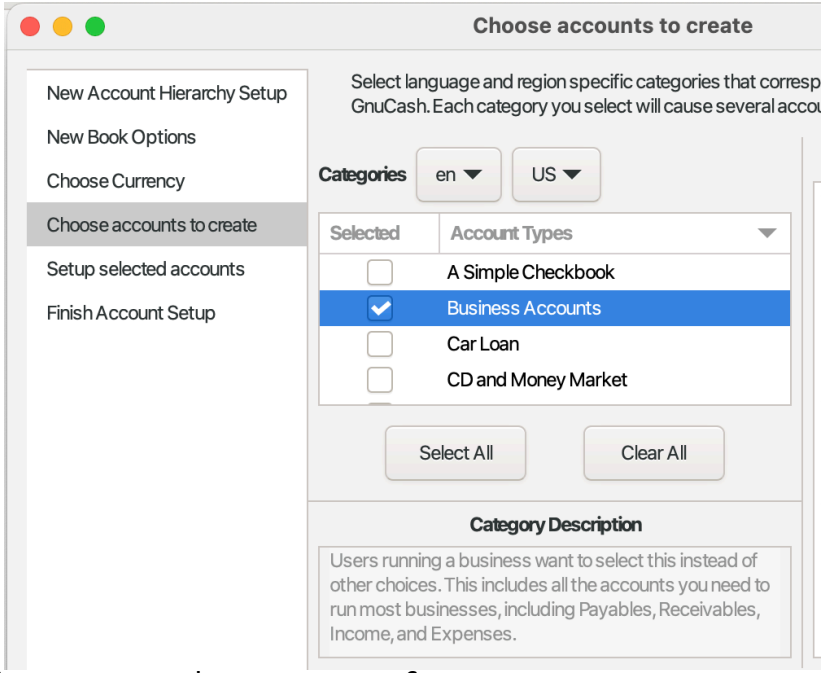
- Managing your own personal finances
- Positioning for your next career move
- Not the focus of this, but lots of good engineering-to-management resources out there, such as:
  - Hazel Weakly episode on Packet Pushers (D2C241, 4/24/2024)
  - *An Elegant Puzzle: Systems of Engineering Management* by Will Larson (for large companies)

Where to begin?

Dive In

- Like any new technology or discipline, it starts with thinking through the details somewhere
- It can help, though, to have a roadmap and understand some basic concepts first

One way to get going is to install GnuCash*, and check only Business Accounts, adding any additional accounts needed for your company's budget



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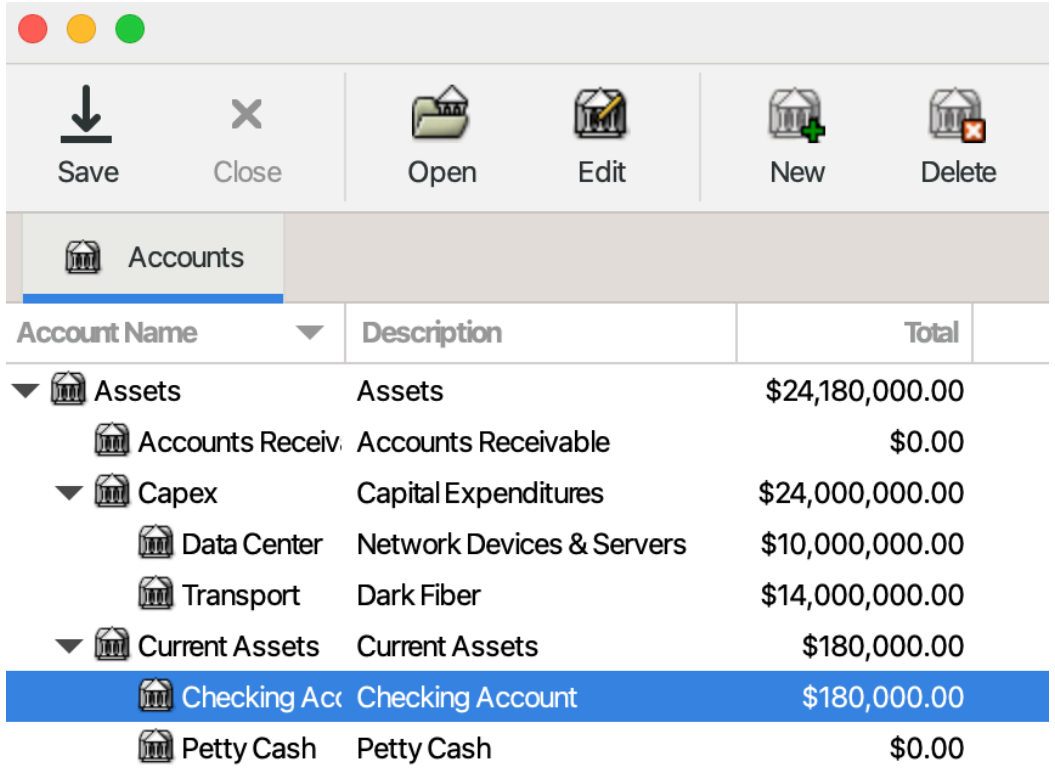
* Or QuickBooks, etc.— whatever accounting software you have or prefer

GnuCash Example

- Great for understanding double-entry bookkeeping and income statements
  - ➡ Add specific assets, expenses and liabilities
  - ➡ Look up unfamiliar terms
  - ➡ Generate reports
- It'll only get you so far in financial modeling, though



Detailed Modeling with Sheets

D3 | fx =C3*(1+$B$11)

	A	B	C	D	E	F	M	N
1								**Year end Total**
2	**Month**	**1**	**2**	**3**	**4**	**5**	**12**	**2026**
3	New York	$5,000	$5,100	$5,202	$5,306	$5,412	$6,217	$67,060
4	San Francisco		$5,000	$5,100	$5,202	$5,306	$6,095	$60,844
5	Dallas			$5,000	$5,100	$5,202	$5,975	$54,749
6	Chicago				$5,000	$5,100	$5,858	$48,773
7								$233,452
8								
9	**Assumptions**							
10	Market Entry	$5,000						
11	Growth Rate/mo	2.00%						
12								

- More flexible
- Assumptions each get a cell, in case they change
- Reference cells rather than constants in formulas

Detailed Modeling with Sheets

D3 | fx =if(LT(D$2,$B$12),$B9*D$2,$B9*$B$12)

	A	B	C	D	M	N
1						**Year end Total**
2	**Month**	**1**	**2**	**3**	**12**	**2026**
3	Colocation	$550.00	$1,100.00	$1,650.00	$2,200.00	$23,100
4	Power	$672.00	$1,344.00	$2,016.00	$2,688.00	$28,224
5	Transit	$3,000.00	$6,000.00	$9,000.00	$12,000.0(	$126,000
6						$179,350
7						
8	**Assumptions**					
9	Colo per rack	$550				
10	Power per rack	$672				
11	Transit per DC	$3,000				
12	Ramp up months	4				
13						

- More flexible
- Assumptions each get a cell, in case they change
- Reference cells rather than constants in formulas

Detailed Modeling with Sheets

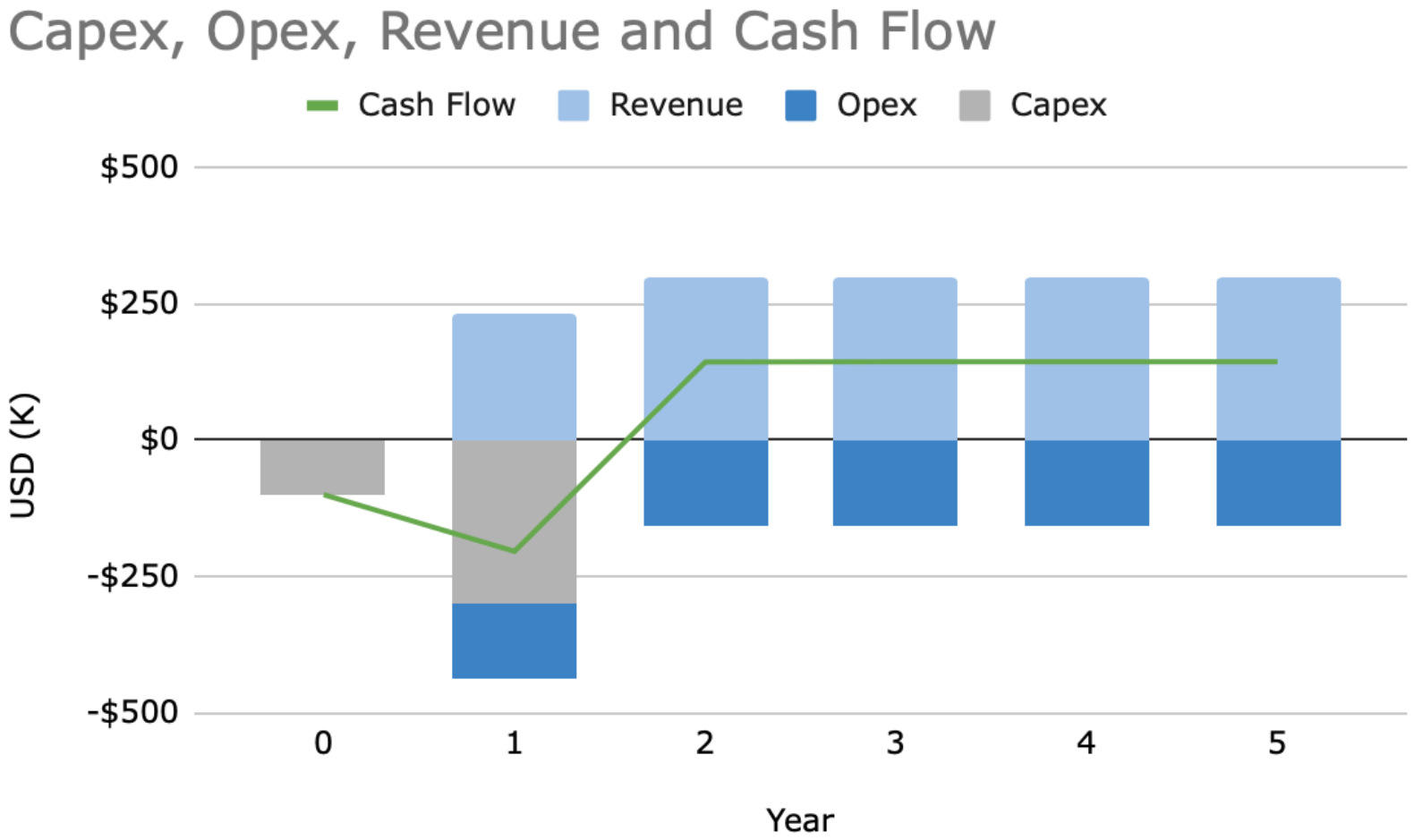
- Create multiple tabs to manage complexity*
- Create summary tab for analysis and charts
- Summarize years vertically, if possible

D4 | fx ='Monthly Sales'!N20

	A	B	C	D	E
1	**Year**	**Capex**	**Opex**	**Revenue**	**Cash Flow**
2	0	-$100,000			-$100,000
3	1	-$300,000	-$137,350	$233,452	-$203,898
4	2		-$156,683	$299,952	$143,269
5	3		-$156,683	$300,438	$143,755
6	4		-$156,683	$300,438	$143,755
7	5		-$156,683	$300,438	$143,755
8					
9	**Assumptions**			**Results**	
10	Capex Per DC	$100,000		NPV	$151,654
11	Discount Rate	8%		IRR	26%
12					

*Debt, taxes & other expenses not included in this simple example. Be sure to think it through for your case!

Detailed Modeling with Sheets



Analyzing Risk

Risk Identification

- Think of possibilities for negative returns, if assumptions are off or conditions change
- Even if the model is good, there could be a better way to invest the capital or allocate the budget. Why this?
- Learn some key metrics decision-makers often use to determine the potential of an investment
- Use Sensitivity Analysis to help evaluate the quality of the model or give conditions under which an investment is still a good use of capital

Commonly used metrics

- NPV - Net Present Value
  - The value of the investment in today's dollars, given an alternative investment at a certain interest rate (the discount rate)
  - Decide on yearly vs. monthly cash flows (divide rate by 12)
- IRR - Internal Rate of Return (a.k.a. ROI, essentially)
  - What the discount rate must be for NPV to be 0

Others to think about

- Net income - more detail than in our simple cash flow example; includes non-cash expenses as well as cash
- DSCR - Debt Service Coverage Ratio
- Consider other metrics your audience may look for in addition to or in lieu of these others
  - ➡ Talk to the finance or accounting department, potential investors, startup incubators, etc.

Net Present Value

Canonical Definition:

- The sum of all discounted cash flows, including the up-front investment (year 0, negative cash flow)
- r = the discount rate
- Because the exponent is 0, CF_0 is divided by 1, so not discounted

$$\sum_{t=0}^{N} \frac{CF_t}{(1+r)^t}$$

Net Present Value

De Facto Definition:

- To simplify this, you can start at Year 1, and add the initial investment (negative) separately

$$\left(\sum_{t=1}^{N} \frac{CF_t}{(1+r)^t} \right) + CF_0$$

- It seems the part in parentheses is what Excel went with way back when, and all others followed suit.

NPV Formula Caveat

- So, be careful
- Add the first negative cash flow separately from the Year 1-5 formula calculation as shown

E10 | fx =npv(B11,E3:E7)+E2

	A	B	C	D	E
1	**Year**	**Capex**	**Opex**	**Revenue**	**Cash Flow**
2	0	-$100,000			-$100,000
3	1	-$300,000	-$137,350	$233,452	-$203,898
4	2		-$156,683	$299,952	$143,269
5	3		-$156,683	$300,438	$143,755
6	4		-$156,683	$300,438	$143,755
7	5		-$156,683	$300,438	$143,755
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9	**Assumptions**			**Results**	
10	Capex Per DC	$100,000		NPV	$151,654
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12					

NPV Formula Caveat

Try it yourself

- If you are curious, create a series of discounted cash flows and sum that
- Compare to the sheet NPV if all 6 cash flows are included in the range

F2 =E2/(1+$F$12)^A2

	A	E	F
1	**Year**	**Cash Flow**	**Discounted CF**
2	0	-$100,000	-$100,000
3	1	-$203,898	-$188,795
4	2	$143,269	$122,830
5	3	$143,755	$114,117
6	4	$143,755	$105,664
7	5	$143,755	$97,837
8			$151,654
9			
10		NPV (sheet)	$140,420
11			
12		Discount Rate	8%
13			

NPV Formula Caveat

Try it yourself

- If you are curious, create a series of discounted cash flows and sum that
- Compare to the sheet NPV if all 6 cash flows are included in the range

F10 =npv(F12,E2:E7)

	A	E	F
1	**Year**	**Cash Flow**	**Discounted CF**
2	0	-$100,000	-$100,000
3	1	-$203,898	-$188,795
4	2	$143,269	$122,830
5	3	$143,755	$114,117
6	4	$143,755	$105,664
7	5	$143,755	$97,837
8			$151,654
9			
10		NPV (sheet)	$140,420
11			
12		Discount Rate	8%
13			

IRR

Year 0 is included

- This is basically the NPV function set to 0, and sheets calculate this one correctly for some reason
- It iterates through different discount rates, starting with a “guess” rate specified in the formula (default is 10%), until NPV approximates 0
- The point is to find out if this project’s rate of return (discount rate) is better than some alternative investment for the capital

IRR

- Numpy_financial has an IRR function if you don't want to demonstrate it iteratively

```
% python irr.py
The IRR is: 0.2648
```

```python
import numpy_financial as npf

# Define the cash flows
cash_flows = [-100000, -203898, 143269,
 143755, 143755, 143755]

# Calculate the IRR
irr_value = npf.irr(cash_flows)

# Print the result
print(f"The IRR is: {irr_value:.4f}")
```

IRR

- We get the same value as Sheets IRR
- Check it: input this as rate for NPV (B11)— it's close enough to 0 (E10)

E11 | =irr(E2:E7,0.03)

	A	B	C	D	E
1	**Year**	**Capex**	**Opex**	**Revenue**	**Cash Flow**
2	0	-$100,000			-$100,000
3	1	-$300,000	-$137,350	$233,452	-$203,898
4	2		-$156,683	$299,952	$143,269
5	3		-$156,683	$300,438	$143,755
6	4		-$156,683	$300,438	$143,755
7	5		-$156,683	$300,438	$143,755
8					
9	**Assumptions**			**Results**	
10	Capex Per DC	$100,000		NPV	-$15
11	Discount Rate	26.48%		IRR	26.48%

Sensitivity Analysis

- A couple of common ways to determine the impact of changes in model inputs:
  - Tornado Chart
  - Monte Carlo Simulation / distribution
- These are not comprehensive, nor foolproof. But they can help build a business case and show thoughtful consideration of risk

Tornado Chart

- Calculate the impact on a key metric by changing one variable at a time (in this example, we track NPV)
- Here we'll use a 50% variation for each of Capex, Opex, and Revenue, then calculate NPV to get low and high values
- Horizontal bars are shown in descending order of impact, so it looks vaguely like a tornado
- This example uses python and matplotlib, because sheets don't usually have a good way to chart it

Tornado Chart

F16 =E16*(1-$C$11)

	A	B	C	D	E	F	G	H	I	J
11	Flat	Variation	50%							
12										
13			**Δ Capex**			**Δ Opex**			**Δ Revenue**	
14	Year	Nominal	Low	High	Nominal	Low	High	Nominal	Low	High
15	0	-$100,000	-$50,000	-$150,000						
16	1	-$300,000	-$150,000	-$450,000	-$137,350	-$68,675	-$206,025	$233,452	$116,726	$350,178
17	2				-$156,683	-$78,342	-$235,025	$299,952	$149,976	$449,927
18	3				-$156,683	-$78,342	-$235,025	$300,438	$150,219	$450,657
19	4				-$156,683	-$78,342	-$235,025	$300,438	$150,219	$450,657
20	5				-$156,683	-$78,342	-$235,025	$300,438	$150,219	$450,657

- First calculate low & high versions of inputs

Tornado Chart

C9 | =C3+npv('Yearly Summary'!$B$11, C4:C8)

	A	B	C	D	E	F	G	H	I	J
1		CF, Δ Capex			CF, Δ Opex			CF, Δ Revenue		
2	Year	Nominal	Low	High	Nominal	Low	High	Nominal	Low	High
3	0	-$100,000	-$50,000	-$150,000	-$100,000	-$100,000	-$100,000	-$100,000	-$100,000	-$100,000
4	1	-$203,898	-$53,898	-$353,898	-$203,898	-$135,223	-$272,573	-$203,898	-$320,624	-$87,172
5	2	$143,269	$143,269	$143,269	$143,269	$221,610	$64,927	$143,269	-$6,707	$293,244
6	3	$143,755	$143,755	$143,755	$143,755	$222,096	$65,413	$143,755	-$6,464	$293,974
7	4	$143,755	$143,755	$143,755	$143,755	$222,096	$65,413	$143,755	-$6,464	$293,974
8	5	$143,755	$143,755	$143,755	$143,755	$222,096	$65,413	$143,755	-$6,464	$293,974
9	NPV	$151,654	$340,542	-$37,235	$151,654	$455,498	-$152,191	$151,654	-$416,907	$720,214

- Create low/high cash flows for each year, then calculate NPV for each set of cash flows

Tornado Chart

```
import matplotlib.pyplot as plt
import numpy as np

# Variables and their low/high impact values
variables = ["Capex", "Opex", "Sales"]
low_values = [-37, -152, -417]
high_values = [341, 455, 720]

# Calculate total impact
impact = np.abs(np.array(high_values) - np.array(low_values))
```

- Create a list for low and high results, then calculate impact

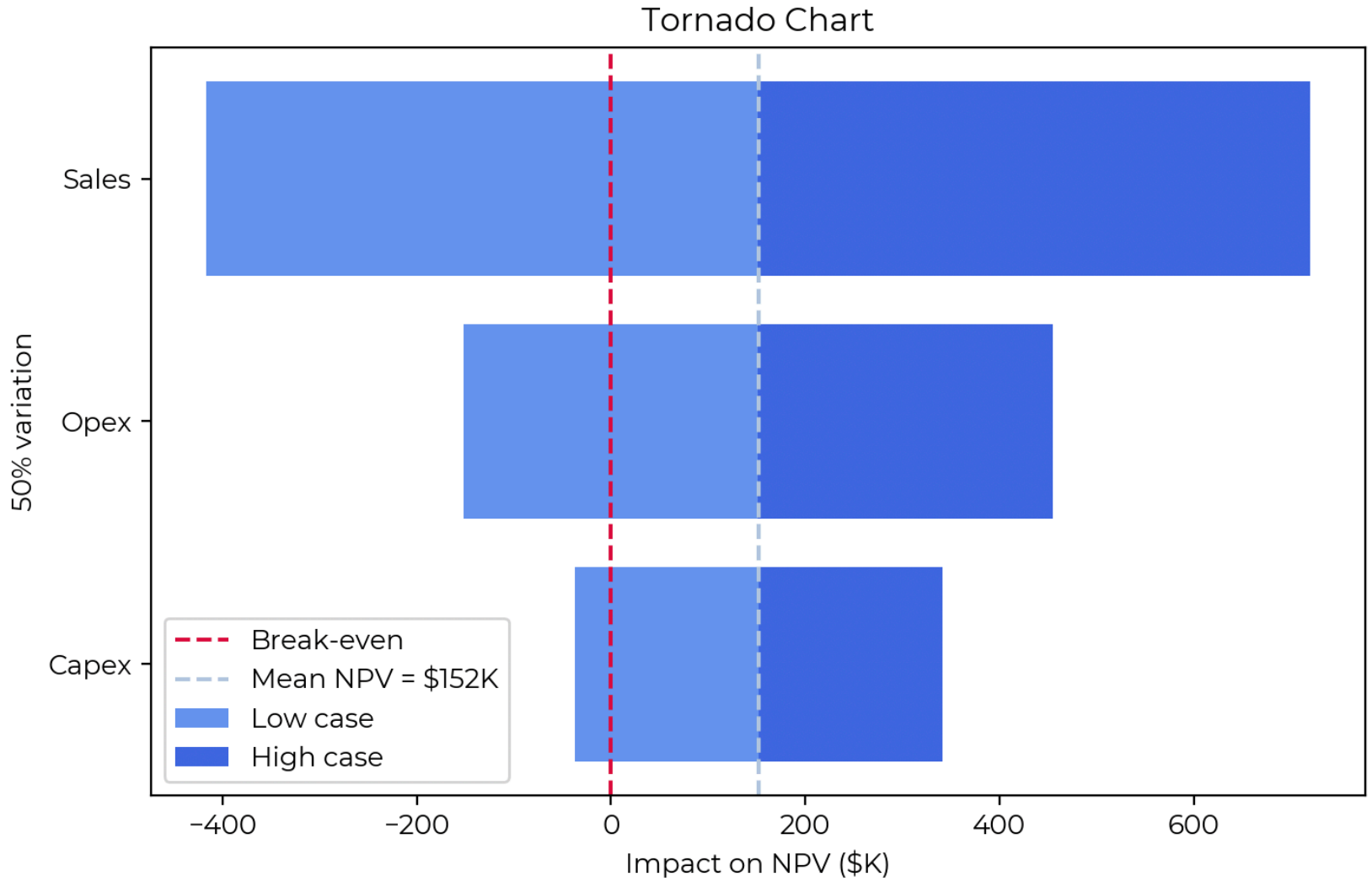
Tornado Chart

```
# Sort by impact
sorted_impact = np.argsort(impact)

variables = [variables[i] for i in sorted_impact]
low_values = [low_values[i] for i in sorted_impact]
high_values = [high_values[i] for i in sorted_impact]
mean_npv = (np.array(high_values) + np.array(low_values))/2
low_delta  = low_values - mean_npv
high_delta = high_values - mean_npv
```

- Reverse sort and plot (not shown), tweaking captions, fonts and colors as needed.

Tornado Chart



Monte Carlo Simulation

- Model many potential cash flow outcomes, assuming they are normally distributed (i.e. bell curve)
- It's as if we were rolling the dice in Casino Royale, hence the name
- We then calculate NPV from this and see how likely a positive value is, which indicates a good investment
- This example also uses python and matplotlib, for similar reasons

Monte Carlo Simulation

```
import matplotlib.font_manager as fm
import numpy as np
import matplotlib.pyplot as plt
import matplotlib as mpl

fm.fontManager.addfont("/Library/Fonts/Montserrat-Regular.ttf")
mpl.rcParams['font.family'] = 'Montserrat'

# Example cash-flow means:

cf_means = np.array([-100000, -203898, 143269, 143755, 143755,
143755])
```

- First list the cash flows from our model
- Also: font management in case it's of interest

Monte Carlo Simulation

```
# Example with same standard deviation applied to all CFs:
stddev = 0.40  # 40% standard deviation

cf_stds = np.abs(cf_means) * stddev

discount_rate = 0.08   # 8%
num_samples = 10000          # number of Monte Carlo runs
```

- Calculate the array of standard deviation values for all the cash flows
- Use our same NPV discount rate as before, and specify a sample size of 10k

Monte Carlo Simulation

```
# 42 = seed for reproducibility, leave blank for true randomness
rng = np.random.default_rng(42)

# Sample normally distributed cash flows for each year
cash_flows = rng.normal(
    loc=cf_means,
    scale=cf_stds,
    size=(num_samples, len(cf_means))
)
```

- Set up the random number generator
- Create the 10k normally-distributed cash flows

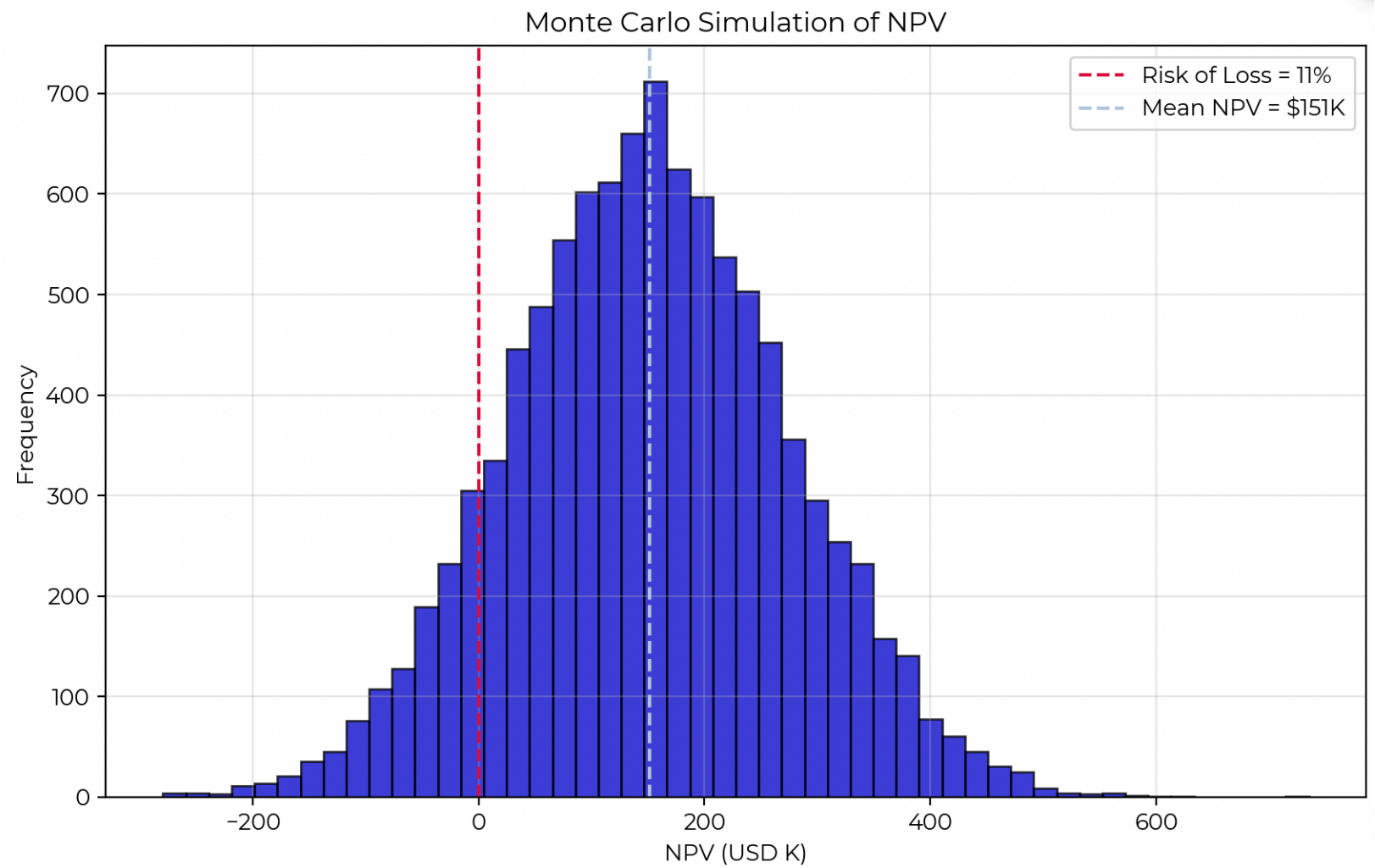
Monte Carlo Simulation

```
# Discount factors for each period
discount_factors = 1 / (1 + discount_rate) ** np.arange(0,
 len(cf_means))

# Compute NPV for every simulation
npvs = np.sum(cash_flows * discount_factors, axis=1)
```

- Create an array of discount factors to easily calculate the array of NPVs (then plot).

Monte Carlo Simulation



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Monte Carlo Simulation

Optional Summary Stats

```
Simulated Cash Flow Statistics Across All Years:
Mean: 45,034
Median: 105,070
5th percentile: -247,232
95th percentile: 226,491

Summary NPV Statistics Across All Years:
Mean NPV: 151,174
Median NPV: 149,943
5th percentile NPV: -50,702
95th percentile NPV: 357,194
Risk of loss: 11.17%
```

- Can use in a presentation: “Losses not to exceed $51k with 95% confidence” (a.k.a. Value at Risk/VAR)

Presenting to Decision Makers

Simplify Everything

- You have modeled everything down to the last dollar and cent, which is great for building your case, but
- Your audience is likely to have a far wider horizon, and much less time or patience for detail
- Round numbers to the nearest grouping when possible, e.g. €4m, $210k
- Never include anything beyond the decimal point, e.g. cents in USD

RIP

What's the upshot?

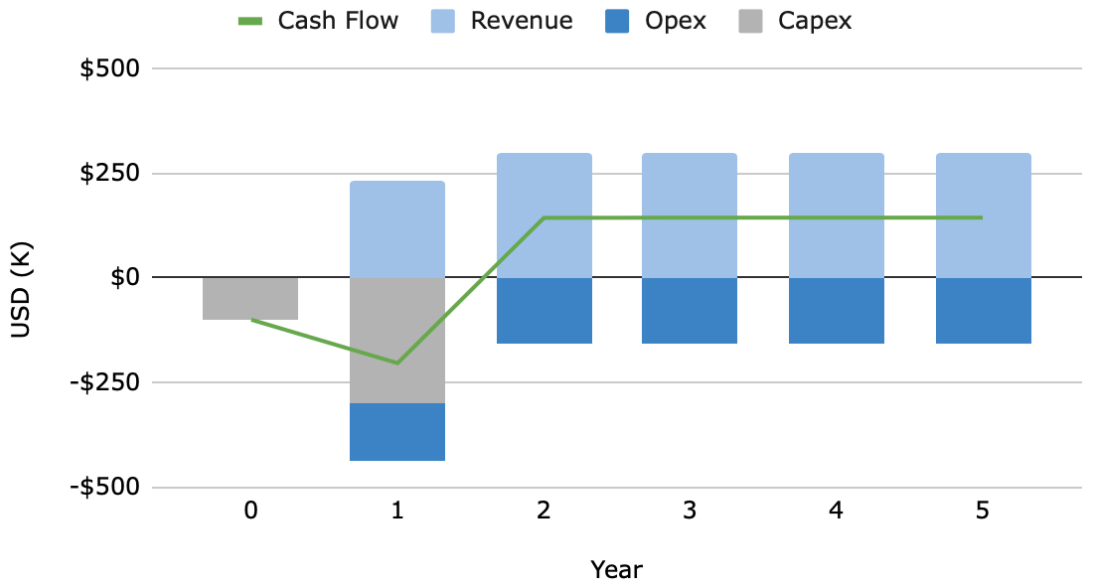
- Lead with your end goal (e.g. Want to allocate budget to automation, or fund a start-up to do *x*)
- Provide a quick problem statement, 2-3 slides of why
- Be very clear about the need (how much $ and when?)
- Provide an at-a-glance slide with graphs, ask, key metrics, risks, and any risk mitigation plans
- Keep back a set of detailed additional slides to draw from in case of questions, and/or a business plan

Enter 4 New US Markets in 2026

KEY SALES ASSUMPTIONS	
Market Entry / Pipeline	$5K
Market Entry Ramp Up (mo)	4
Monthly Escalation	2%
Monthly Sales Cap per Market	$6.2K
Total Sales over 5 years	$1.4M

BUDGET REQUESTS	
Capital Expenses in 2026	$400K
Operating Expenses over 5 years	$764K

USES OF BUDGET	
Network Equipment	$400K
Colocation	$129K
Power	$157K
Transit	$468K



KEY METRICS	
NPV @ 8%	$152K
IRR	26%
VAR (95th %ile)	$51K

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The Takeaway

- You can absolutely learn this! But…
- Get expert help if there's any question of legality (tax, financial reporting, or otherwise), model sanity, or of introducing any other risk (e.g. LLM use)
- This can mean outside professionals, or your own financial and legal department(s)
- External due diligence / auditing is usually required anyway for any formal investment or acquisition

Thank you

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https://github.com/barriejc/fa4tp.git