Process Valuation

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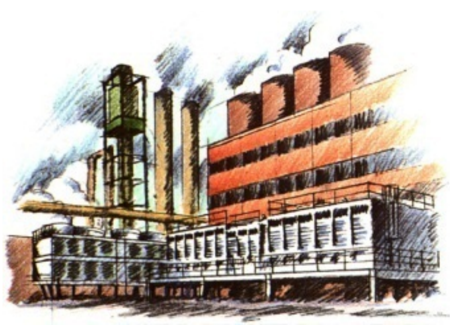
Session 1: A different approach to Innovation

Existing Products/Technology

Existing Market Needs

Superior Business Models To Provision Products to Market



Business Model Innovation

The Goal

- What's the goal of any company?
  - Ways to measure it? Metrics?

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Maximize Shareholder Value ⟸ Increase Earnings ⟸ Sales – Operating Expenses – Capital Expenses

Throughput: The rate at which the system generates revenue/sales

- Production is <u>not</u> Sales; Sales = Min {Production, Demand}
- Capacity utilization is not the goal, only a possible means to achieve the goal

Operating Expense: The rate at which the system generates costs

Inventory: The level of capital invested in system

- It costs money to make money… just don't take too much
- Money costs money
  - Debt: Interest, shareholder risk increases
  - Equity: Dilution of shareholding

$$ Going in the System = **Operating Expense** → $$ Sitting in System= **Inventory** → $$ Coming from the System = **Throughput**

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  - How do you evaluate a company?

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The classic profit formula

Revenue model	Cost structure	Resource velocity
Price	Direct, indirect costs	Rate of value output
Volume (market size)	Economies of scale and scope	Lead times, turns, throughput, utilization
Ancillary sales		

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What is wrong with that?
What is missing?

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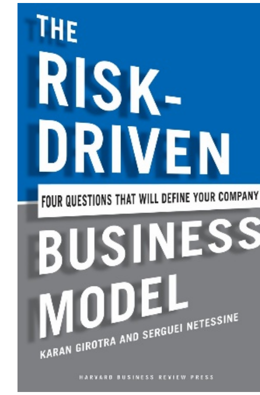
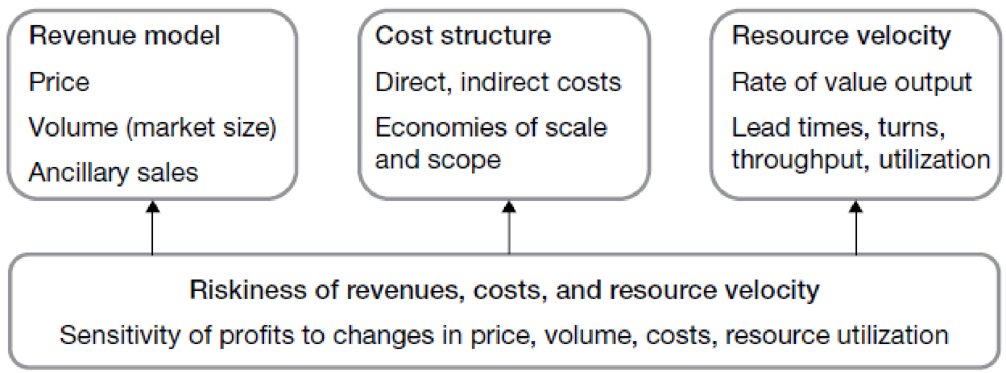
  - How do you evaluate a company?



The new profit formula



BUSINESS MODELS AND INEFFICIENCIES

VIDEO

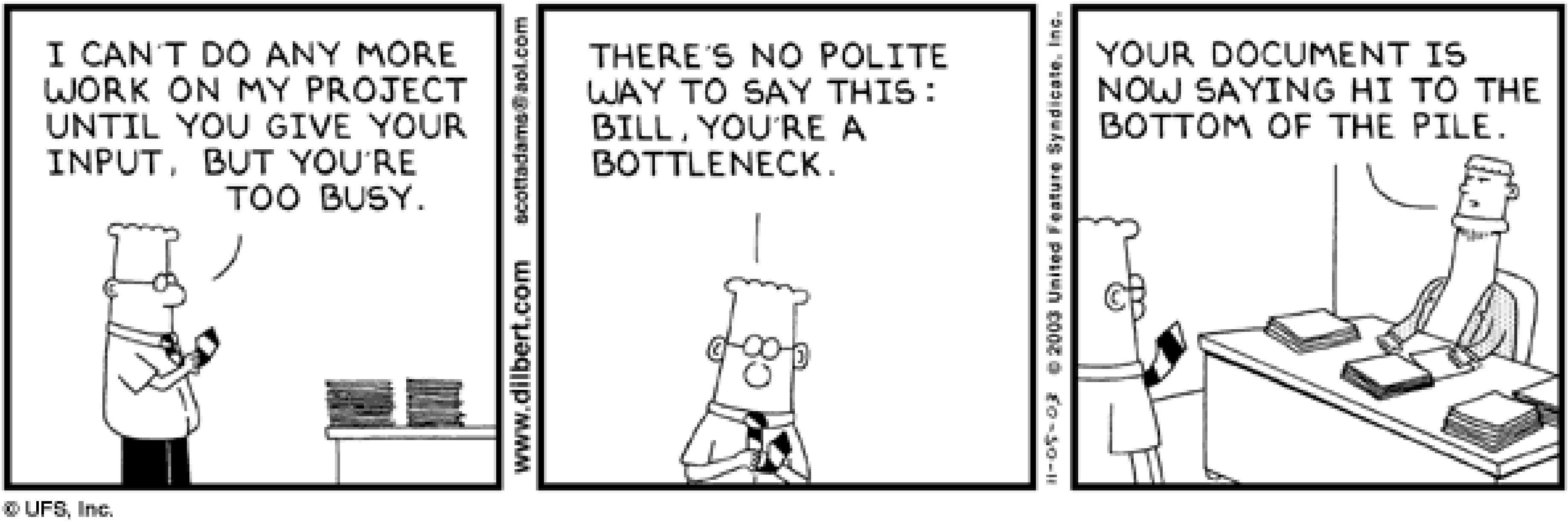
What inefficiencies do you observe at this process?

Business Models And Inefficiencies

Two Kinds of Inefficiencies

- Information Inefficiency: Decisions Made with Poor Information
- Incentive Inefficiency: Decisions Made with "Bad" Intentions

MANAGING PROCESSES



- The **Bottleneck Step** determines the performance of the whole process

- A general approach to **Manage Change**
  - Identify the goal
  - Identify the obstacles to achieve it (bottlenecks)
  - Manage the bottlenecks

Bottleneck drives System Capacity

- Find the bottleneck
  - Symptoms
    - The resource with minimum capacity
    - The resource which is always busy
    - The resource with longest wait
    - The resource with most inventory

- Improve bottleneck performance
  - Investments in improving bottleneck capacity improve system capacity
  - Lost Capacity at bottleneck is lost cost capacity for whole system
  - Always utilize the bottleneck fully
  - Some strategies:
    - Offload work to non-bottleneck steps (contract out steps, etc.)
    - Create Inventory Buffer before bottleneck to avoid starving
    - Quality check before bottleneck
    - Yield improvements at/after the bottleneck

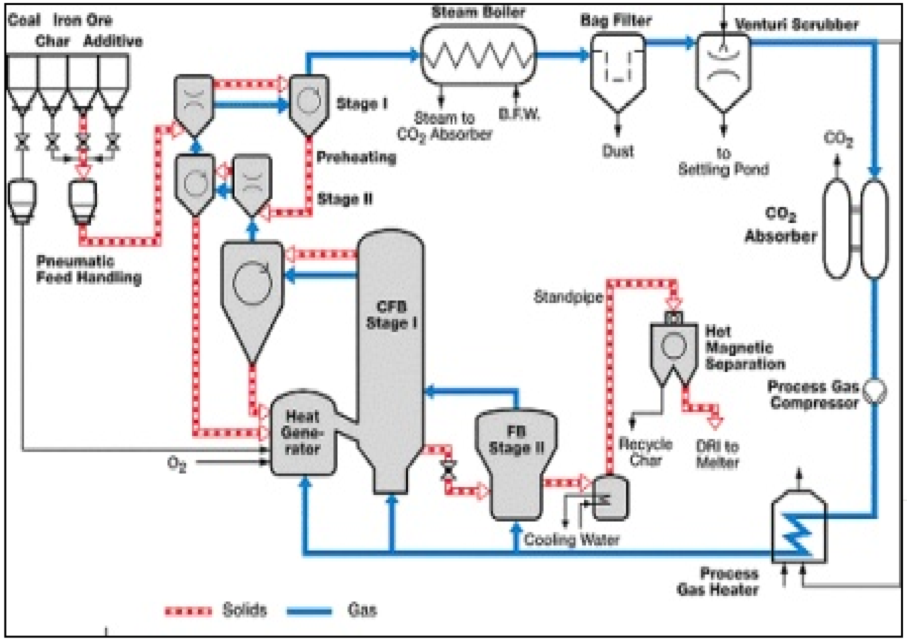
Key in any process analysis: Find and improve the bottleneck

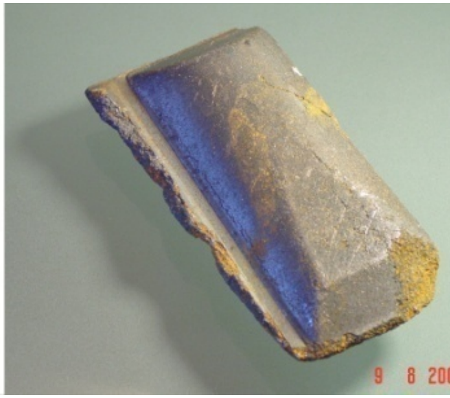
Pumping Iron at Cliffs & Associates

PUMPING IRON AT CLIFFS & ASSOCIATES

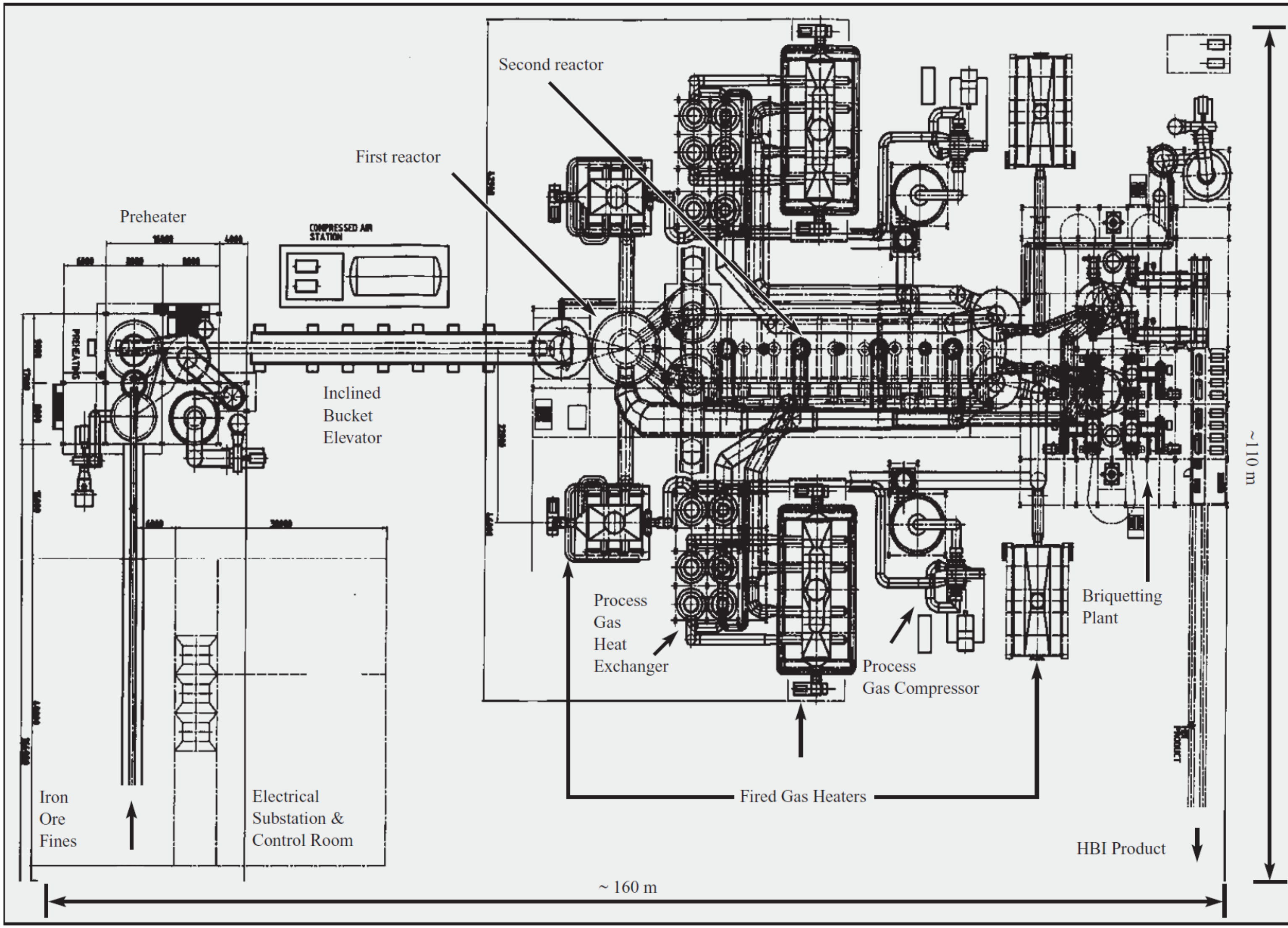
In

Out

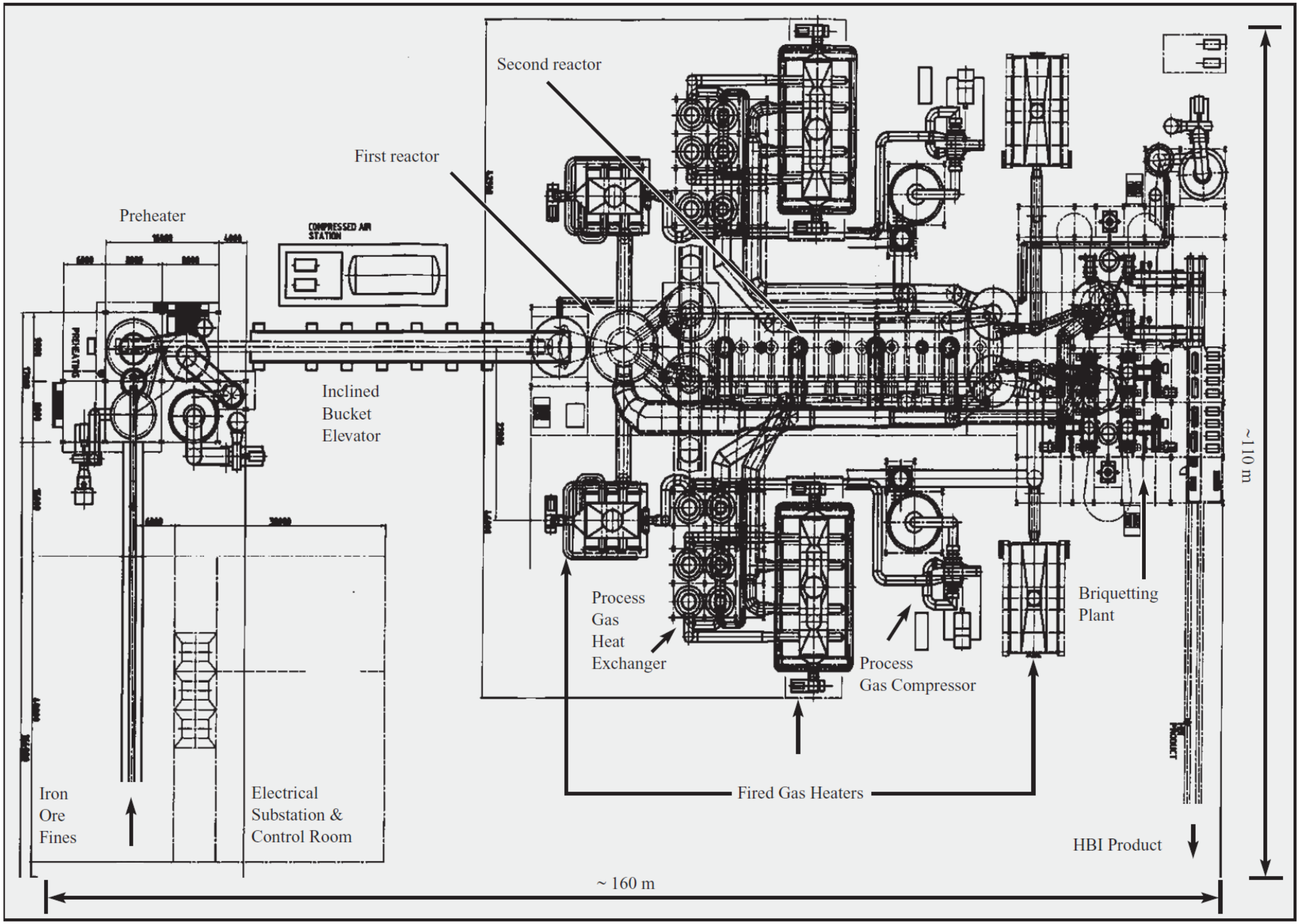




THE CIRCORED PLANT



The Circored Plant



Everything should be made as simple as possible but not *simpler*!

DISCLAIMER

The following analysis presents **one solution** to the valuation of the plant based on a set of assumptions from our experience interacting with the folks at the plant.

Alternate internally consistent and credible assumptions exist.

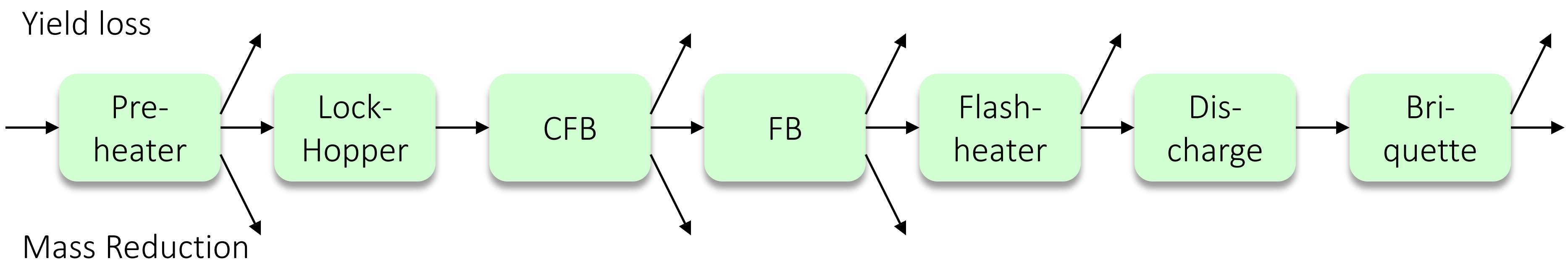
The goal of the exercise is to illustrate how the simple concepts that we have learned in the last session can be useful in supporting financially significant decisions. It is not for all of us to get the exact same number.

Loads of context specific definitions

- Design Load
- Machine Availability
- Units of inflow
- Yield

- I did not expect you to know the specific context meanings before-hand. Calculations are different with different interpretations, alternate interpretations are correct.

How much is Circored plant worth?



Value = Expected Net Present Value of Future Earnings

Future Earnings = Sales * Margin

= Capacity * (Price – Per Unit Costs)

Why are Sales = Capacity?
For commodities (and similar products), it is a very good assumption that, small players can sell whatever they produce.

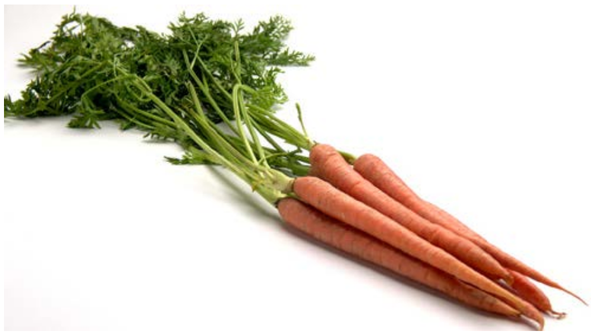
What is the system capacity?

What is the per unit cost?

Remember: System Capacity = Bottleneck Capacity!

Per unit cost depends on flow rates through each step

Mass Loss, Yield Loss and total Resulting Loss



For this variety of carrots, 20% of the weight of a fresh carrot is inedible (leaves, peels, etc.)
10 % of the carrots are rotten.

If you start with 1 Kg of carrots, what weight of diced carrots will you have for your mirepoix?*

900 grams of fresh (not-rotten) carrots
Of these 900 grams, 20% of the weight is inedible, 80% is fine, thus I will 720 grams of diced carrots for mirepoix.

Resulting Quantity = (1- Yield Loss)*(1-Mass Loss): Why “multiply”?

* Mirepoix is a mix of Carrots, onions and celery; traditionally in the ratio 1:2:1. Mirepoix derives its name, as many other elements of French cuisine do, from the patron of the chef who established it, in this case one of the house of Lévis, seigneurs of Mirepoix since the eleventh century and a famous name in Languedoc. The particular member of the house of Lévis whose chef is credited by the Dictionnaire de l'Académie française with giving a name to an old technique is Charles-Pierre-Gaston François de Lévis, duc de Lévis-Mirepoix (1699-1757), maréchal de France and ambassador of Louis XV.

Flow Rates through other Steps when Bottleneck is Fully Utilized

	Preheater	Lock-Hopper	CFB (1st)	FB (2nd)	Flash heater	Discharge	Briquette	Final o/p
Size [tons]	n/a	n/a	n/a	400	n/a	n/a	n/a	
Reaction time [hours]	n/a	n/a	n/a	4	n/a	n/a	n/a	
Inflow (tons/hr)				100.000				
Mass Redn. [%]	0.076	0	0.15	0.1	0	0	0	
Yield Loss [%]	0.05	0	0.07	0.01	0.07	0	0.03	
Resulting Loss (outflow / inflow)	0.8778	1	0.7905	0.891	0.93	1	0.97	
Inflow (tons/hr)	144.113	126.502	126.502	100.000	89.100	82.863	82.863	80.377

Bottleneck utilized at 100%

Joint Events: Probability of a perfect date

Assume that the perfect date requires two things: No rain and she likes the wine

Probability of no rain: 90% (forecast)
Probability she likes the wine: 80% (estimate)

Probability of a perfect date: 0.9*0.8 = 0.72

Probability of two joint independent events → multiply the probabilities

Operating Expenses

	Preheater	**Lock-Hopper**	**CFB (1st)**	**FB (2nd)**	**Flash heater**	**Discharge**	**Briquette**	**Final**
Inflow [tons/hr]	144.113	126.502	126.502	100.000	89.100	82.863	82.863	80.377
Availability	0.9	1	0.99	0.99	1	0.97	0.99	0.8471
				Electricity				
Variable Costs	Iron ore			Water and sewer				
($ per ton, Ex. 11)	Natural gas	Magnesium oxide	Hydrogen	Operating costs		Nitrogen		
	$26.50	$1.50	$8.08	$4.25		$3.51		
	$10.86			$2.52				
				$1.83				
$ / ton of input to step	$37.36	$1.50	$8.08	$8.60	$0.00	$3.51	$0.00	Total
$ / ton of final output	$66.98	$2.36	$12.72	$10.70	$0.00	$3.62	$0.00	$96.38

We care about output! (Not costs per input…)

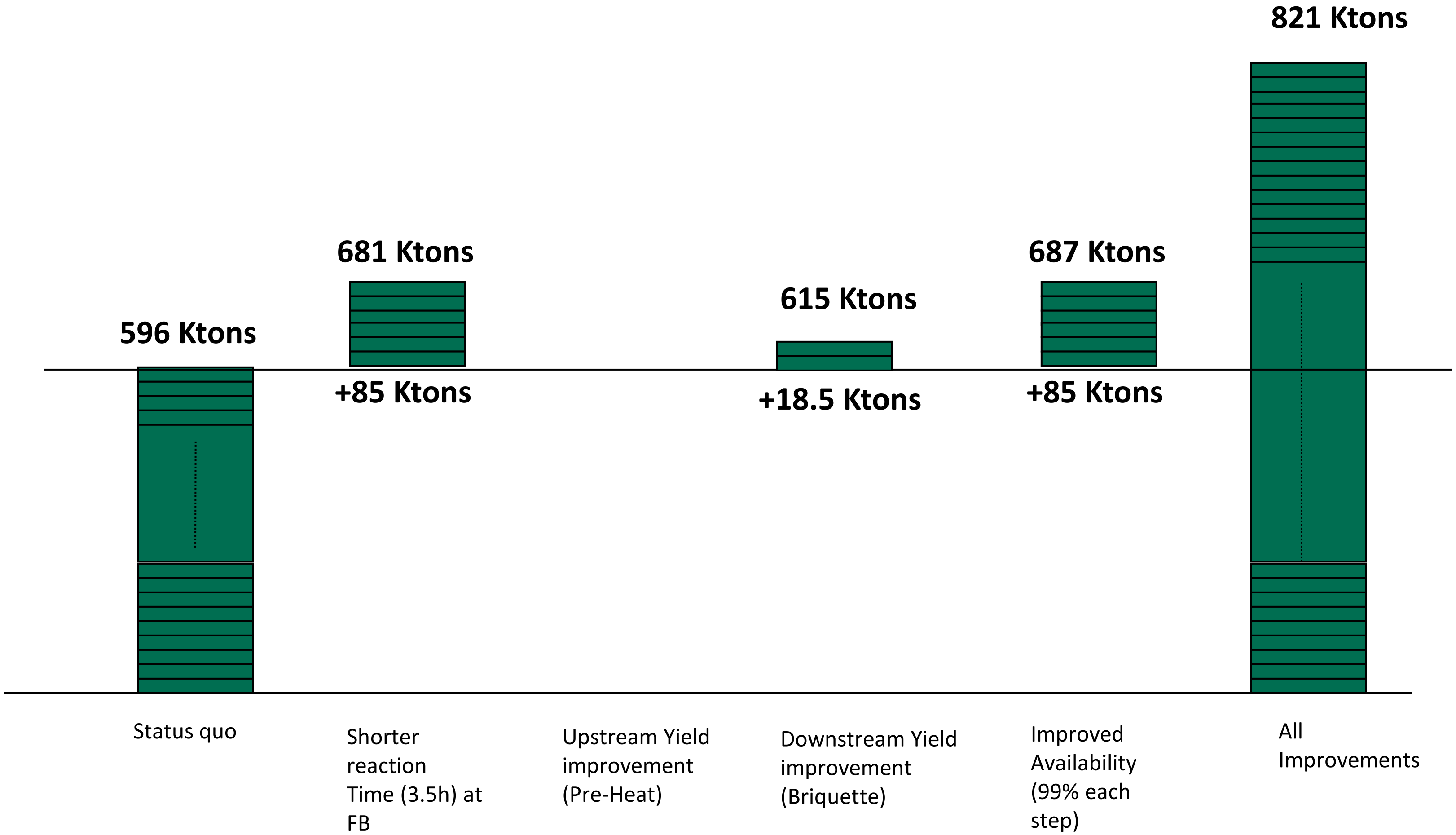
PUTTING EVERYTHING TOGETHER…

Inflow [tons per hour]	144.113	126.502	126.502	100	89.1	82.863	82.863	80.377
$ / ton of final output	$66.98	$2.36	$12.72	$10.70	$0.00	$3.62	$0.00	$96.38
Availability	0.9	1	0.99	0.99	1	0.97	0.99	0.8471

[Assumes: If one operation fails, the whole system stops]

Total output per hour	68.09	= *(Final output) × (Availability)*
Total output per year	596,426	= *(Output per hour) × (365 days/year) × (24 hours/day)*
Total variable cost per year	$57,483,866	= *Output per year (tons/year) * Unit Variable Cost ($/ton)*
Total fixed cost per year	$20,790,000	*(from Exhibit 12)#*
Total cost per year	$78,273,866	= *(Total variable cost per year) + (Total fixed cost per year)*
Total cost per ton	$131.24	= *(Total cost per year) / (Total output per year)*
Price	$126.42	*(based on historical data)*
EBIT	**($2,873,734)**	= *(Price-Cost)*Annual Output (Assumes Plant is operational)*

IMPROVEMENTS: IMPACT ON CAPACITY



VALUING OPERATIONAL IMPROVEMENTS

Scenario	Capacity	Capacity Increase	Total Cost	Variable Cost	Cost Reduction	EBIT	EBIT Increase
	(1000T/yr)	(1000T/yr)	($/T)	($/T)			
Base/current	596.426	-	131.24	96.38	-	$ (2,873,734)	
FB speedup	681.629	85.203	126.88	96.38	4.36	$ (314,267)	$ 2,559,467
Yield (preheat)	596.426	0	127.89	93.03	3.35	$ (876,158)	$ 1,997,576
Yield (briq.)	614.872	18.446	127.3	93.49	3.94	$ (541,771)	$ 2,331,963
Uptime 99%	687.062	90.636	126.21	96.38	5.03	$ 149,335	$ 3,023,068
All	821.281	224.855	115.55	90.24	15.69	$ 8,923,612	$ 11,797,346

126.42 Price $/T FOB (avg. is 126.42 from historical data)

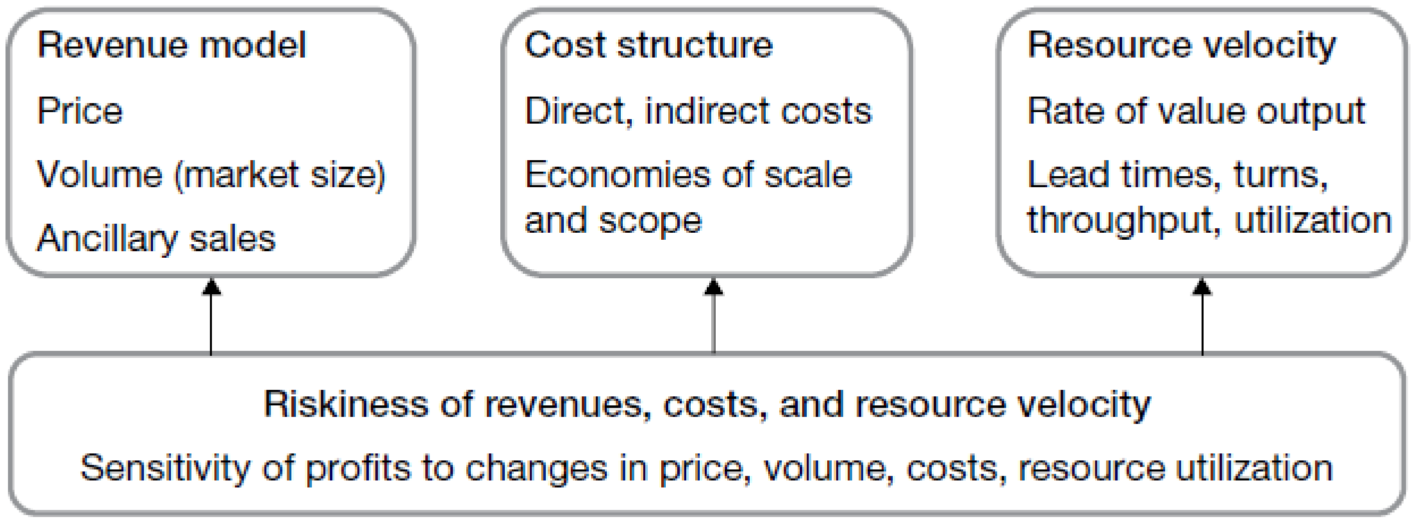
These numbers ignore costs of improvements

What is missing?

If we put all improvements together, the plant is barely profitable on average

The New Profit Formula: Business Models

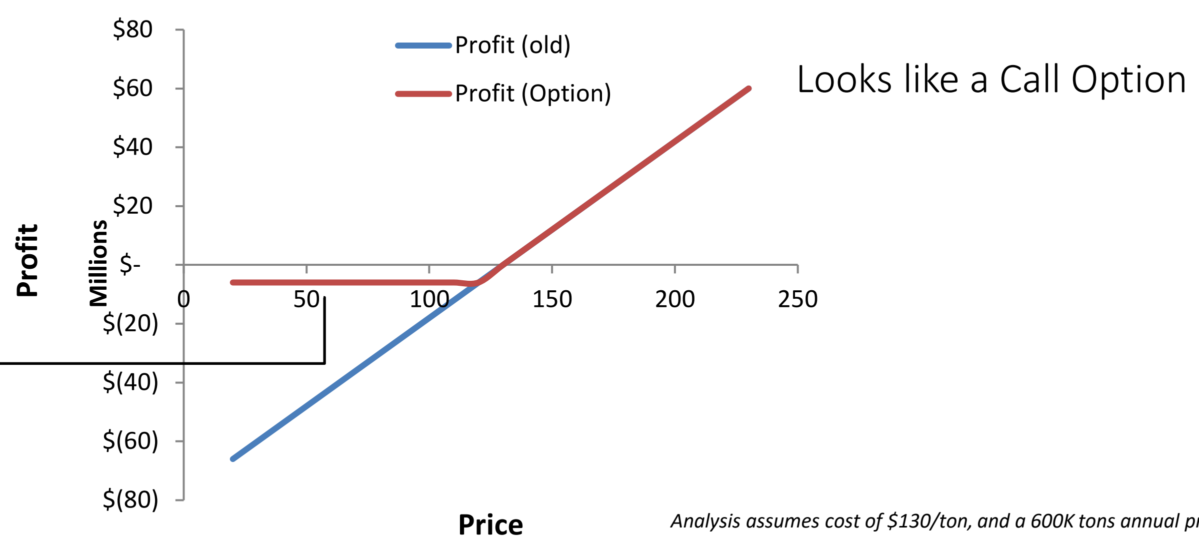
The new profit formula



Never ignore RISKS in the business model

Real Options: A Business Model Innovation

- Our initial analysis assumes that the plant produces under all contingencies, or all values of price. An alternate strategy could be a contract.
  - If price is so low that losses are higher than $6MM, put plant in cold idle at a cost $6MM
  - If price is high enough for profits to be higher than -$6MM, produce
- Under this strategy, we can no longer just use the average value of price to compute EBIT, but must consider each possible value of price independently, incorporating the strategy defined above.



The option to idle limits downside losses.

How to evaluate the plant now? How much would you pay for this option?

Analysis assumes cost of $130/ton, and a 600K tons annual production

Valuation with Cold Idle Option: Base Case

Base Case

Fully Loaded Cash Cost 119.28 ($/ton) (fully loaded cost reduced by $7.135 M of depreciation)

Annual Volume 596,426 (tons)

Idling Costs 6 ($ million)

Price Intervals		Mid point	Count	Probability	Profit if run ($ million)	Run?	Profit
70	80	75	1	7.1%	(26.407)	0	(6.000)
80	90	85	1	7.1%	(20.443)	0	(6.000)
90	100	95	0	0.0%	(14.478)	0	(6.000)
100	110	105	3	21.4%	(8.514)	0	(6.000)
110	120	115	1	7.1%	(2.550)	1	(2.550)
120	130	125	1	7.1%	3.414	1	3.414
130	140	135	0	0.0%	9.379	1	9.379
140	150	145	3	21.4%	15.343	1	15.343
150	160	155	4	28.6%	21.307	1	21.307
					Expected EBIT*, 1 year		**7.294**
					Discount Rate		11%
					Perpetuity Valuation		**65.656**

- **This time we are using cash cost, so you may call it EBITDA**
- **For decision to operate plant or not, using cash cost may make more sense – use common sense**

Prices: Alternate Approaches

- Futures Markets
  - Find a commodity that tracks the price of DRI,
  - Futures Price at time t is a good predictor of the expected spot price at time t (typically for metals, futures prices are slightly lower than expected future price)

Quotes for Gold Futures

Contract	Last	Change	Open	High	Low	Volume
Cash (GCY00)	576.8	-13.14	589.85	595.43	576.16	
September '06 (GCU06)	579.3	-9.8	579.3	579.3	579.3	
October '06 (GCV06)	580.4	-10.1	588.5	596	578	1234
November '06 (GCX06)	583.2	-10.2	583.2	583.2	583.2	
December '06 (GCZ06)	586	-10.3	596.2	601.8	584	38207
February '07 (GCG07)	591.8	-10.4	602.6	606	591.8	676
April '07 (GCJ07)	597.4	-10.5	607.2	607.2	595	52
June '07 (GCM07)	602.9	-10.6	612	613.7	602.9	153
August '07 (GCQ07)	608.3	-10.7	618	618	607	6
October '07 (GCV07)	613.7	-10.8	613.7	613.7	613.7	1065
December '07 (GCZ07)	619.1	-10.9	624	627	618	1737
February '08 (GCG08)	624.4	-11	624.4	624.4	624.4	202
April '08 (GCJ08)	629.7	-11	629.7	629.7	629.7	450
June '08 (GCM08)	635.1	-11.1	635.1	635.1	635.1	177
December '08 (GCZ08)	651.2	-11.4	651.2	651.2	651.2	2
June '09 (GCM09)	667.4	-11.7	667.4	667.4	667.4	226
December '09 (GCZ09)	683.9	-12	683.9	683.9	683.9	2
June '10 (GCM10)	700.6	-12.3	700.6	700.6	700.6	
December '10 (GCZ10)	717.7	-12.6	717.7	717.7	717.7	50
June '11 (GCM11)	735.8	-12.9	735.8	735.8	735.8	

- Use Prediction Markets

What Happened?

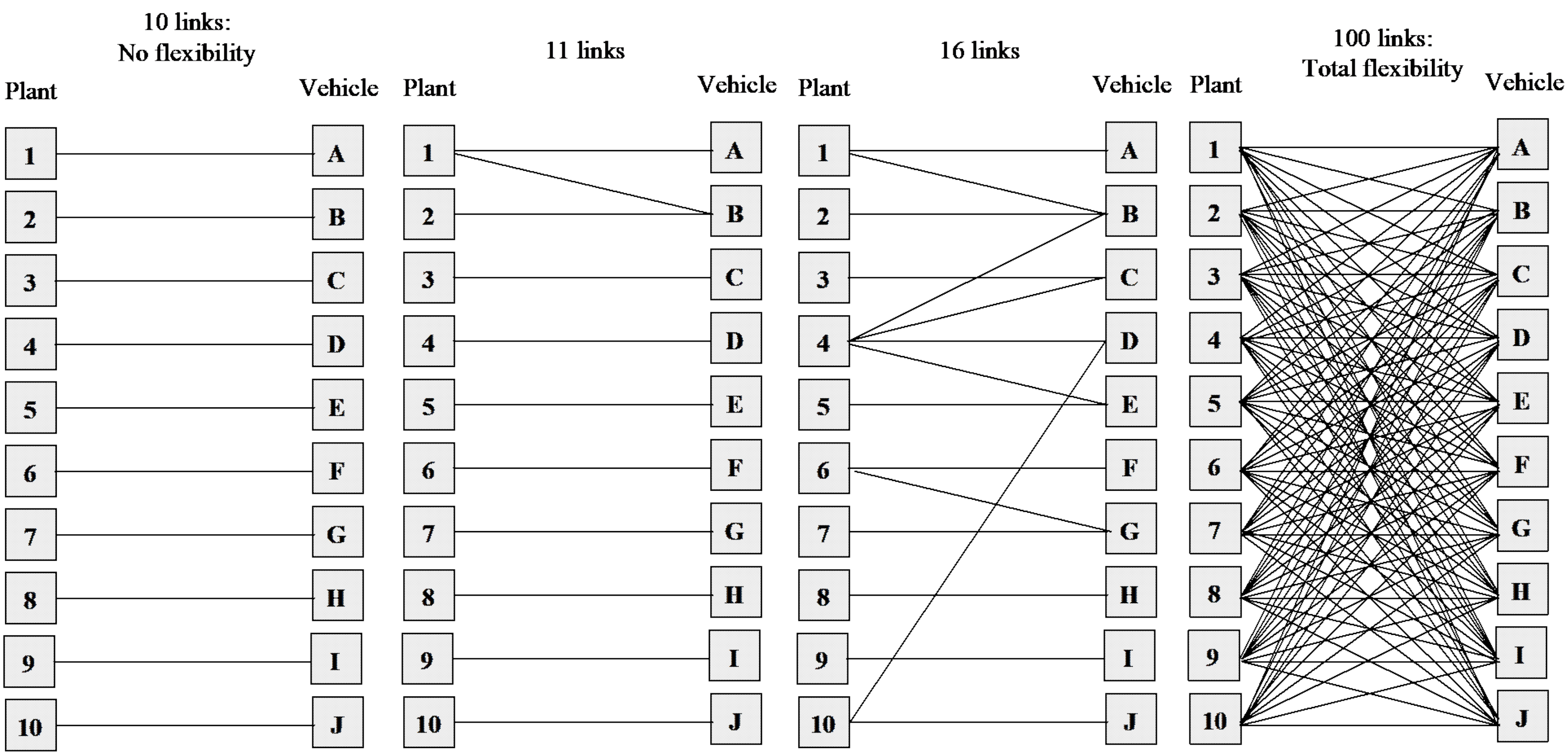
- Plant was put in cold-idle mode in 2002
- CAL made strategic decision to sell the plant in 2003
- Price of HBI recovered in 2003 and reached $200 in 2004

- July 2004 - International Steel Group Inc. buys plant from CAL for "a song"
  ($8 million in cash, plus assumed liabilities, plus up to $10 million in payments contingent upon production and shipments).
- June 2005 – Now part of Mittal Steel (merged with ISG) plant produces 1100 tons per day ~ 400,000 tons/year.

- Potential capacity reportedly 1,000,000 tons per year but "trade sources" doubt it can produce more than 600K tons per year.

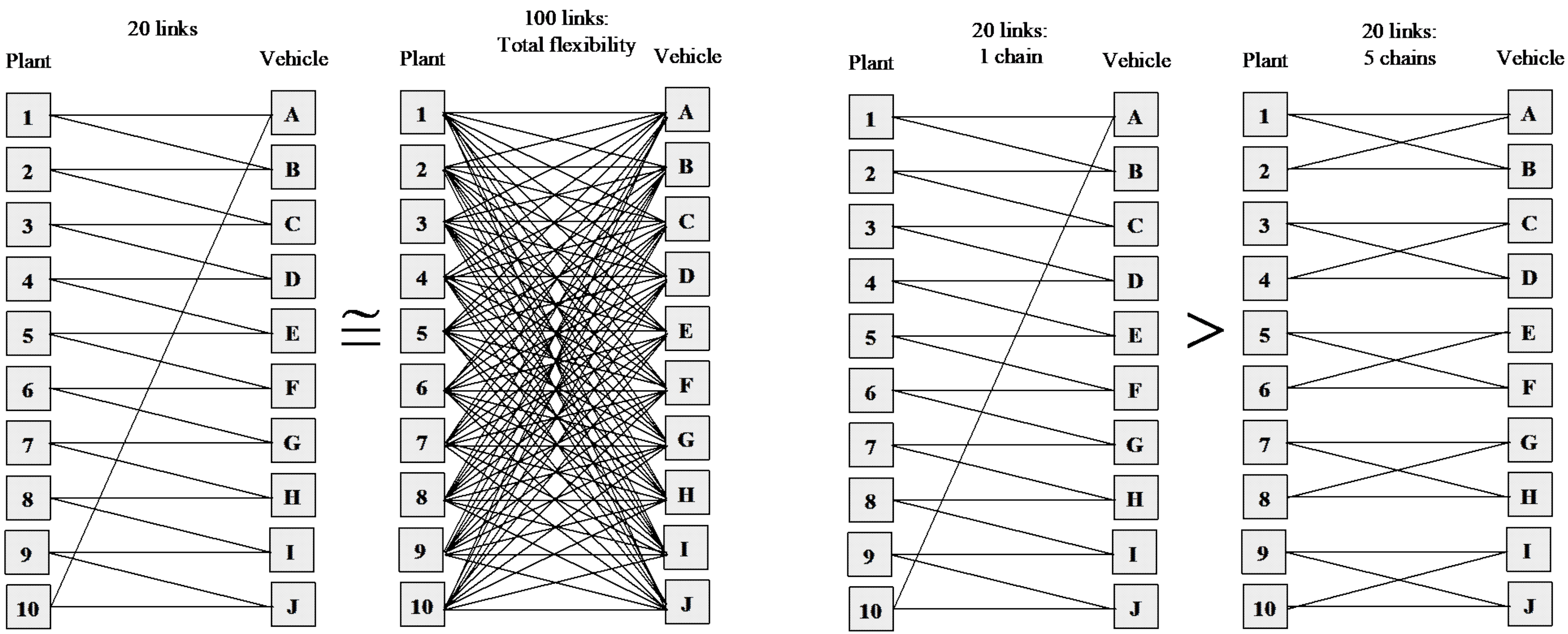
Four Possible Capacity Configurations: No Flexibility to Total Flexibility

- The more links in the configuration, the more flexibility constructed
- In the 16 link configuration plant 4 is flexible enough to produce 4 products but plant 5 has no flexibility (it produces a single product).



CHAINING: HOW TO ADD FLEXIBILITY

- A chain is a group of plants and products connected via links.
- Flexibility is most effective if it is added to create long chains.
- A configuration with 20 links can produce nearly the results of total flexibility as long as it constructs one large chain:
- Hence, a little bit of flexibility is very useful as long as it is designed correctly



Business Model Innovation: GroupOn

Nov '08 — **Founded**

Dec '10 — **Declined Google's $6B take-over**

Nov '11 — **IPO $16B**

42 Million
active customers

16 Billion dollars
of market capitalization

GROUPON

LetsGroop

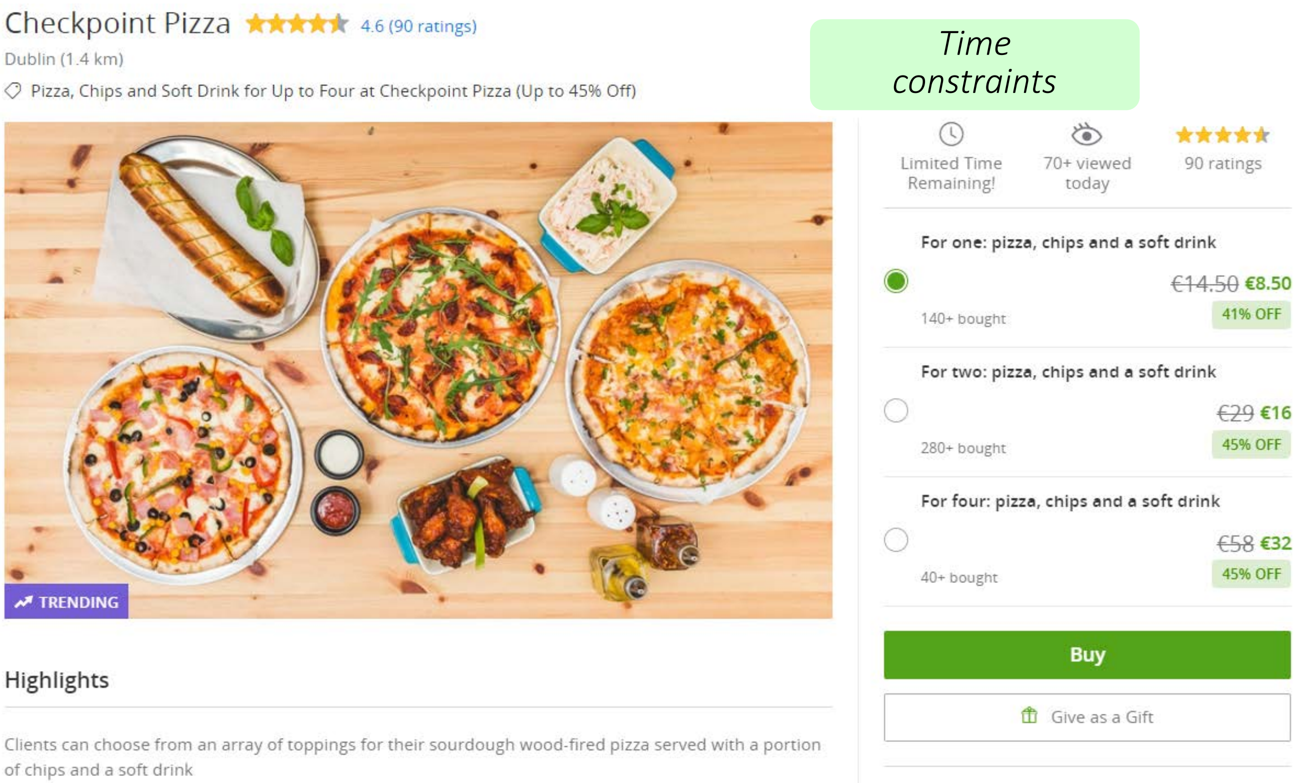
livingsocial

ihergo 愛合購

Business Model Innovation: GroupOn

Nov '08	Dec '10	Nov '11	Jan'23
Founded	**Declined Google's $6B take-over**	**IPO $16B**	**$243M**

Similarities of GroupOn with Circored's Real Option BMI



Time constraints

Activation Threshold

- Demand risk, daily seasonality (few show up on Mon or Tue).
  - **Option 1**: Shut down on Mon and Tue.
  - **Option 2**: Happy Hour: Offer to all customers a discount to induce sales.
  - **BMI Option**: Shutdown or Happy Hour in real-time

Flexibility in discount offers as a way to deal with demand uncertainty

Realizing Business Model Innovation

Method I: Transfer to other Industry-Market

Pick your favorite Industry-Market

What are the consequential decisions made in this industry?
Are they made with perfect, ok or poor information (information risk)?

What is being decided?
Could we make a half-decision, i.e. decide on something more diversified?
Would it be possible to develop an alternate organization with a lot more flexibility?

Method II: Resolve pain points of an Industry

Think of industries characterized by high Information Risk.

- Frequent dramatic departures from budgeted performance metrics (sales, resource utilization, etc.);
- Wide variations in year-to-year performance;
- High exposure to prices and actions out of the control of the firm (for instance, energy prices, partners' behavior);
- Vulnerability of business performance to a few high-impact decisions subject to significant uncertainty;
- Expensive, frequently underutilized assets;

What are the critical decisions in these industries?

Can you build flexibility in these industries?

Key Lessons

- Process flow analysis is needed to understand economics of production and value of improvement, which is essential for good business decisions
- The impact of levers for improvement depends on where (in the system) they are used
  - Improvement at the bottleneck
    - Improves the whole system
    - May shift the bottleneck
  - Yield (and quality) improvement before the bottleneck
    - Use less inputs per unit output– No Change in Capacity, but costs go down
  - Yield (and quality) improvement after the bottleneck
    - Produce more outputs per unit input – Increase in Capacity, and costs go down
- With Information Risks, flexibility can be a powerful source of Business Model Innovation

NEXT: SESSION 2 – WAITING TIMES AND QUEUES

- *Session 2 (Queues) is held online via Zoom:*

  https://ucd-ie.zoom.us/j/64061594687

- *[Ops book] Chapters 2.3, 9.1-9.4, 9.10 and “Recipe 2”*

- *Read LiveOps Case, try the related questions posted and contribute to the discussion*