

# The Real Numbers: The Cost of Flexibility



# Introduction

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# Agenda

**1. Flexibility and Adaptability**

**2. Cost Estimating and Life Cycle Cost**

**3. Evaluation Methods**

**4. Option Examples**

**5. Matrix**



# Flexibility and Adaptability

**Flexibility** is generally used to mean the ability to deal with change

## **Flexibility:**

Ability to use a room or department for a variety of functions without any architectural renovation (may require changes in equipment and/or staff).

## **Adaptability:**

Requires limited construction, ideally pre-determined, to change the use of a room or department.



# Relevance to Healthcare Design

- Important to recognize opportunities early in the design
  - Lower costs
  - Expand possibilities
- Allow for changes in technology
- Allow for changes in reimbursement
- May reduce sf needed by creating flexible spaces
- Ability to adapt to future programmatic requirements
- Ability to adjust to departmental growth



# BIM and 3D Modeling

Future software programs will make some of the discussion today easier earlier in the design process:

- Design better buildings
- Design buildings better

There will always be a need to decide what aspects of flexibility are worth investigating



# Options to Promote Flexibility and Adaptability

- Location of Mechanical Floors
- Soft Space
- Shell Space
- Vertical Expansion
- Interstitial Floors
- Modularity of Key Rooms
- OR shielding
- Isolation Capacity



# Cost Estimating and Life Cycle Cost

Cost estimating helps to determine available and effective options for increasing flexibility / adaptability

**Life Cycle Cost (LCC)** is the cost of ownership over economic life

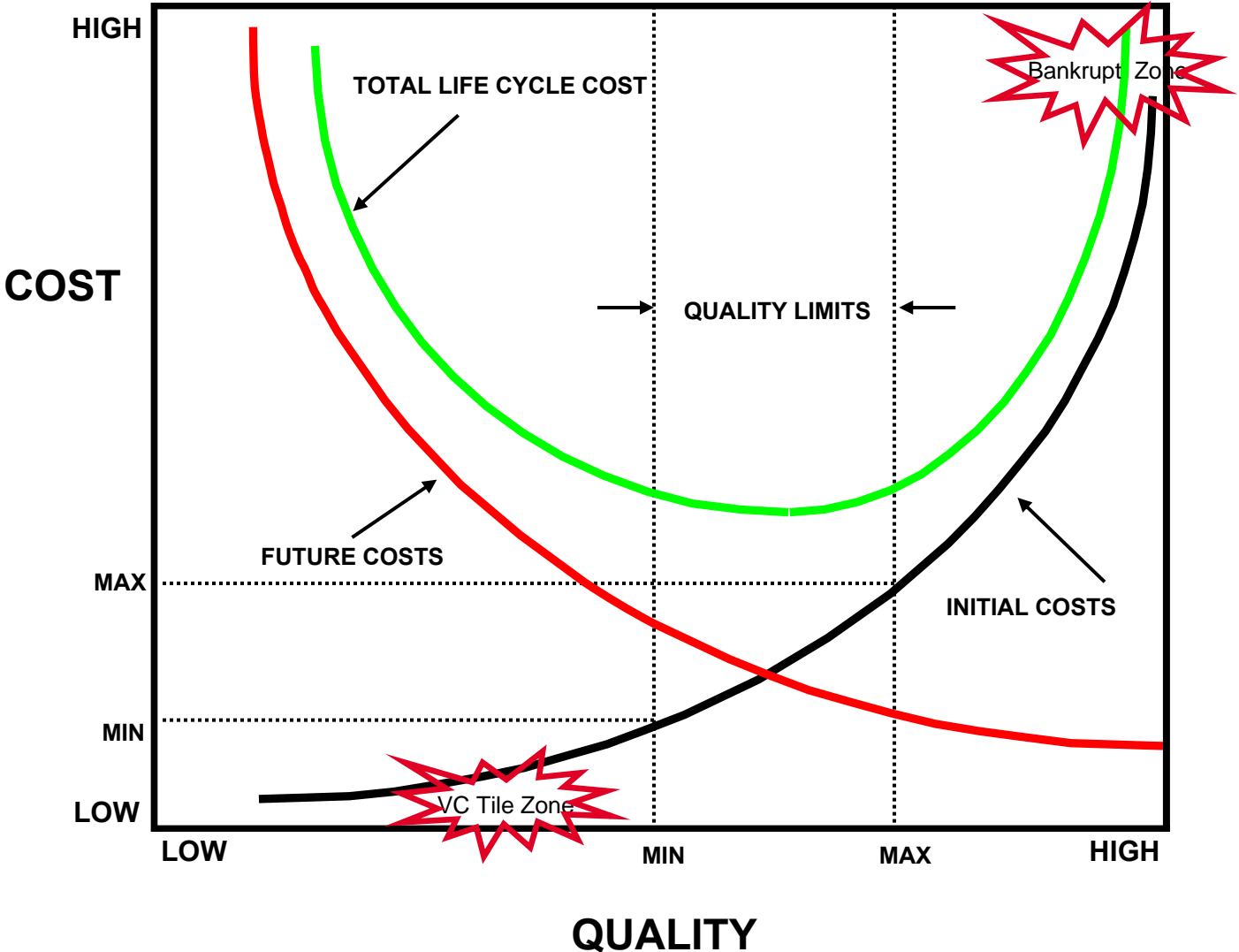
- Initial procurement is only a fraction of total cost of ownership, can be as little as 20%
- Design choices are a major factor in LCC

Determining Factors:

- Useful life
- Required maintenance
- Energy consumption



# Quality & Cost Relationship





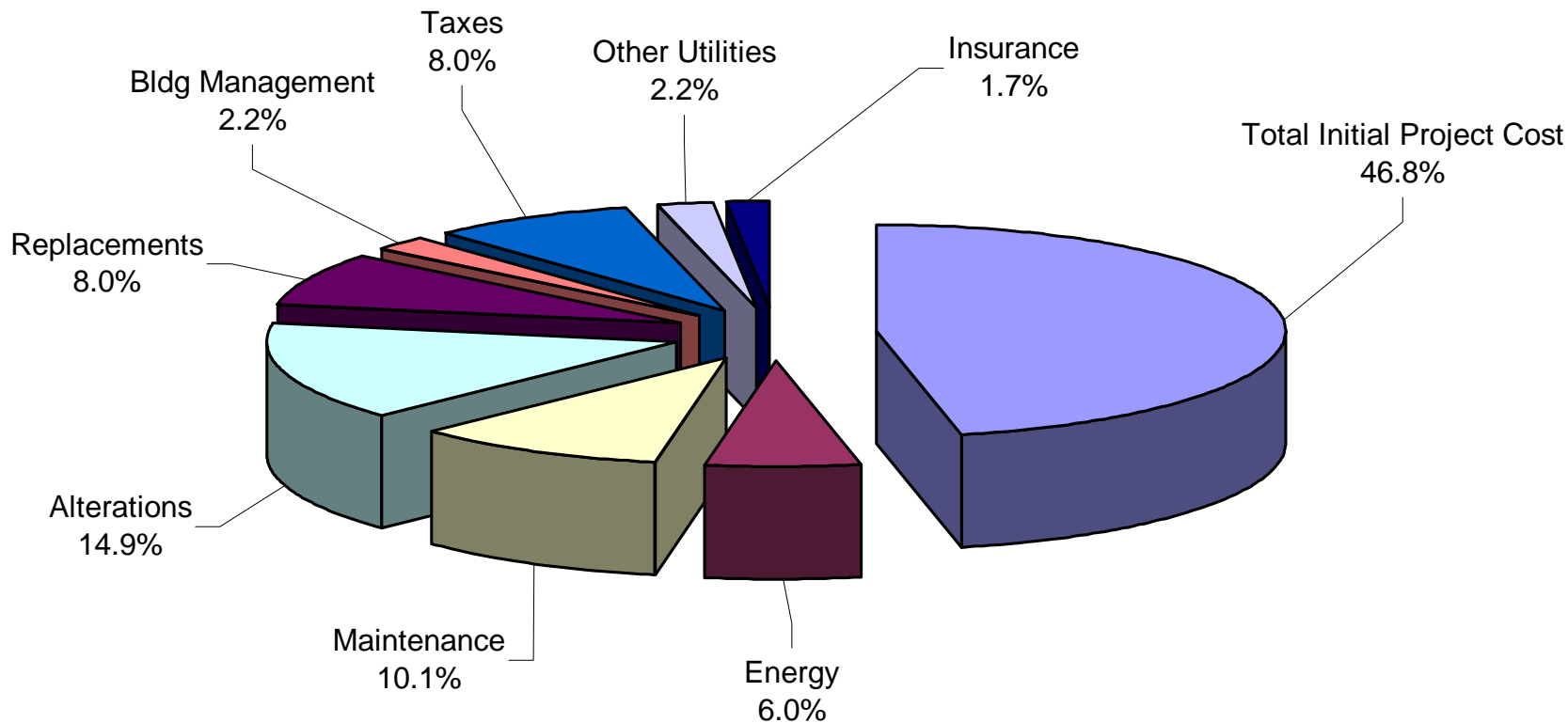
# Life Cycle Cost of a Hospital

Key Factors:	
Years	40
Discount Rate	8%
SF	400,000
Beds	200
FTE's	800

Item	Unit Cost	Unit	Differential Escalation (%/yr)	Present Worth Factor	Total Present Worth Cost	Percentage
Construction	\$500.00	Cost/SF			\$ 200,000,000	12.87%
Fees and Admin	\$60.00	Cost/SF			\$ 24,000,000	1.54%
<b>Total Initial Project Cost</b>	<b>\$560.00</b>	<b>Cost/SF</b>			<b>\$ 224,000,000</b>	<b>14.42%</b>
Energy	\$5.00	Cost/SF/Year	1.5%	14.311	\$ 28,622,970	1.84%
Maintenance	\$9.00	Cost/SF/Year	1.0%	13.440	\$ 48,383,016	3.11%
Alterations	\$15.00	Cost/SF/Year		11.925	\$ 71,547,680	4.60%
Replacements	\$8.00	Cost/SF/Year		11.925	\$ 38,158,763	2.46%
Bldg Management	\$2.00	Cost/SF/Year	1.0%	13.440	\$ 10,751,781	0.69%
Taxes	\$8.00	Cost/SF/Year		11.925	\$ 38,158,763	2.46%
Other Utilities	\$2.00	Cost/SF/Year	1.0%	13.440	\$ 10,751,781	0.69%
Insurance	\$1.75	Cost/SF/Year		11.925	\$ 8,347,229	0.54%
Staffing	\$200.00	Cost/SF/Year	1.0%	13.440	\$ 1,075,178,143	69.19%
<b>Grand Total</b>					<b>\$ 1,553,900,127</b>	

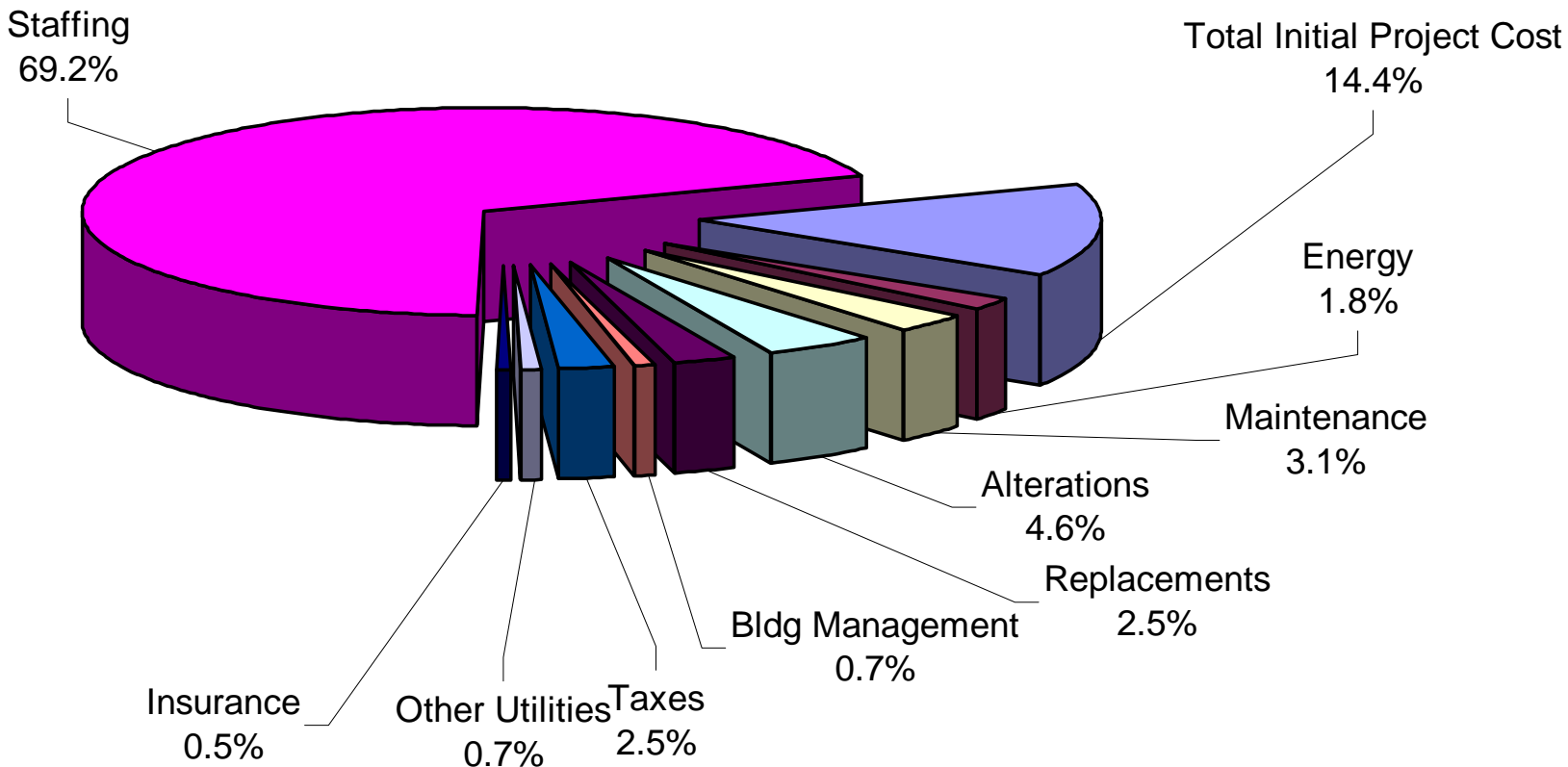


# Total Life Cycle Cost (Excluding Staffing)





# Total Life Cycle Cost (Including Staffing)





# Example of an LCC Analysis

Life Cycle Costing - General Purpose Worksheet

Life Cycle Costing - General Purpose Worksheet					Original Design Inexpensive System		Option 1 Effective System		Option 2 Extreme System		
Study Title: Hypothetical Example					Estimated Costs	Present Worth	Estimated Costs	Present Worth	Estimated Costs	Present Worth	
Discount Rate: 8.0%		Date: March 10, 2008									
Life Cycle (Yrs.) 30											
INITIAL / COLLATERAL COSTS	Initial/Collateral Costs										
	A.	Initial Construction			7,000,000	7,000,000	8,000,000	8,000,000	10,000,000	10,000,000	
	B.										
	C.										
	D.										
	E.										
	F.										
	G.										
	H.										
	I.										
	J.										
	Total Initial/Collateral Costs				\$7,000,000	\$7,000,000	\$8,000,000	\$8,000,000	\$10,000,000	\$10,000,000	
Difference							(\$1,000,000)		(\$3,000,000)		
REPLACEMENT / SALVAGE	Replacement/Salvage (Single Expenditures)										
	A.	Replacements	Occurrence Year-or-Cycle	Inflation/ Escal. Rate	PW Factor						
			8	2%	1.287	1,000,000	1,287,364				
	B.	Replacements	12	2%	0.757			450,000	340,779	200,000	
	C.	Complete Upgrade	20	2%	0.319	2,000,000	637,615				
	D.										
	E.										
	F.										
	G.										
	H.										
	I.										
	J.										
Total Replacement/Salvage Costs					\$1,924,978		\$340,779		\$151,457		
ANNUAL COSTS	Annual Costs										
	A.	Energy		Inflation/ Escal. Rate	PW Factor						
				2%	13.940	80,000	1,115,189	30,000	418,196	10,000	
	B.	Maintenance		2%	13.940	100,000	1,393,986	30,000	418,196	50,000	
	C.										
	D.										
	E.										
	F.										
	G.										
	H.										
	I.										
	J.										
Total Annual Costs					\$180,000	\$2,509,175	\$60,000	\$836,392	\$60,000	\$836,392	
Sub-Total Replacement/Salvage + Annual Costs (Present Worth)						\$4,434,153		\$1,177,170		\$987,849	
Difference								\$3,256,983		\$3,446,304	
LIFE CYCLE COSTS	Total Life Cycle Costs (Present Worth)						\$11,434,153		\$9,177,170		\$10,987,849
	Life Cycle Cost PW Difference								\$2,256,983		\$446,304
	Payback - Simple Discounted (Added Cost / Annualized Savings)								3.5 Yrs.		9.8 Yrs.
	Payback - Fully Discounted (Added Cost+Interest / Annualized Savings)								4.2 Yrs.		19.9 Yrs.
	Total Life Cycle Costs - Annualized					Per Year:	\$1,015,666	Per Year:	\$815,184	Per Year:	\$976,022



# Methodology

- 1. List of Available Options (pros and cons)**
- 2. Importance of Benefit (scale of 1-5; 5 highest)**
- 3. Capital Cost -- Initial**
- 4. Capital Cost -- Implementation**
- 5. Operational Cost**  
(Cost of systems, maintenance, etc.)
- 6. Total Cost**
- 7. Likelihood of Implementation**

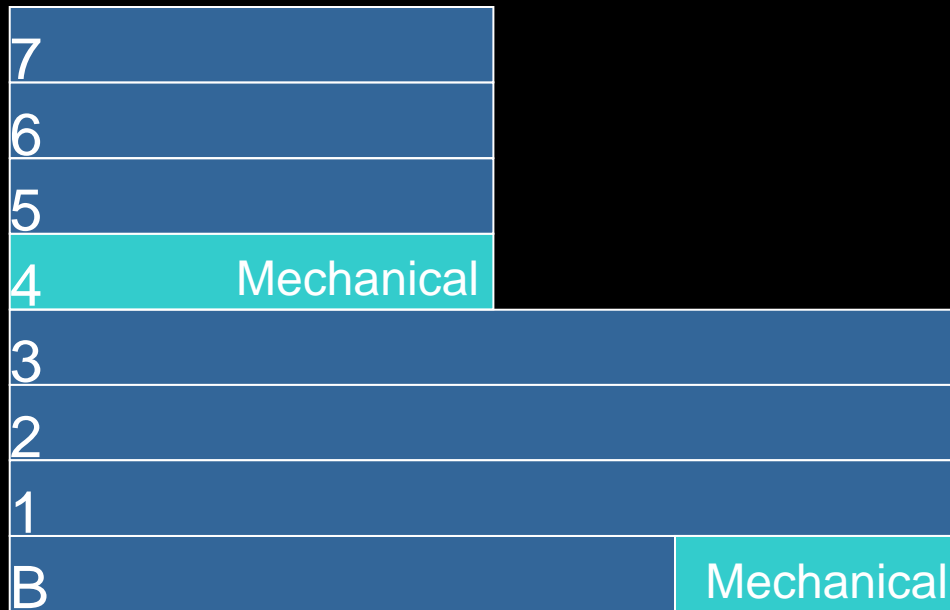


# Evaluation Matrix

<b>Flexibility/Adaptability Option</b> <i>(Description)</i>	<b>Importance of Benefit(s)</b> <i>(Rank 1-5)</i>	<b>Capital Cost Initial</b> <i>(Rank 1-5)</i>	<b>Capital Cost Implement</b> <i>(Rank 1-5)</i>	<b>Operational Cost</b> <i>(Rank 1-5)</i>	<b>Total Cost</b> <i>(Rank 1-5)</i>	<b>Likelihood of Implementation (Future)</b> <i>(Low - High)</i>
Location of Mechanical Floors						
Soft Space						
Shell Space						
Vertical Expansion						
Interstitial Floors						
Modularity of Key Rooms						
OR Shielding						
Isolation Capacity						



# “Baseline” Building A



Four floors at 40,000 sf  
(160,000 sf total)

Four floors at 60,000 sf  
(240,000 sf total)

“Baseline” Building Total : **400,000** gsf



# “Baseline” Building A

7	
6	
5	
4	Mechanical
3	
2	
1	
B	Mechanical

**\$350/sf**

**\$140 M**

Does not include site; no unusual conditions

**“Baseline” Building Total : 400,000 gsf**



# Estimate – Baseline Building A

	%	\$/SF	Sub-Total	Total
Shell Cost	21.05%	\$73.67	\$29,468,000	
Interior Costs	17.20%	\$60.19	\$24,076,000	
Systems Costs	39.14%	\$137.00	\$54,800,000	
Fixt & Furnish	4.09%	\$14.31	\$5,724,000	
<b>Trade Total</b>		<b>\$285.17</b>		<b>\$114,068,000</b>
Markups	15.61%	\$54.64	\$21,855,757	
<b>Marked Up Total</b>		<b>\$339.81</b>		<b>\$135,923,757</b>
Contingencies	2.91%	\$10.19	\$4,077,713	
<b>TOTAL COST</b>		<b>\$350.00</b>		<b>\$140,001,470</b>



# “Baseline” Building A.1: Location of Mechanical

7	Mechanical
6	
5	
4	
3	
2	
1	
B	

Four floors at 40,000 sf  
(160,000 sf total)

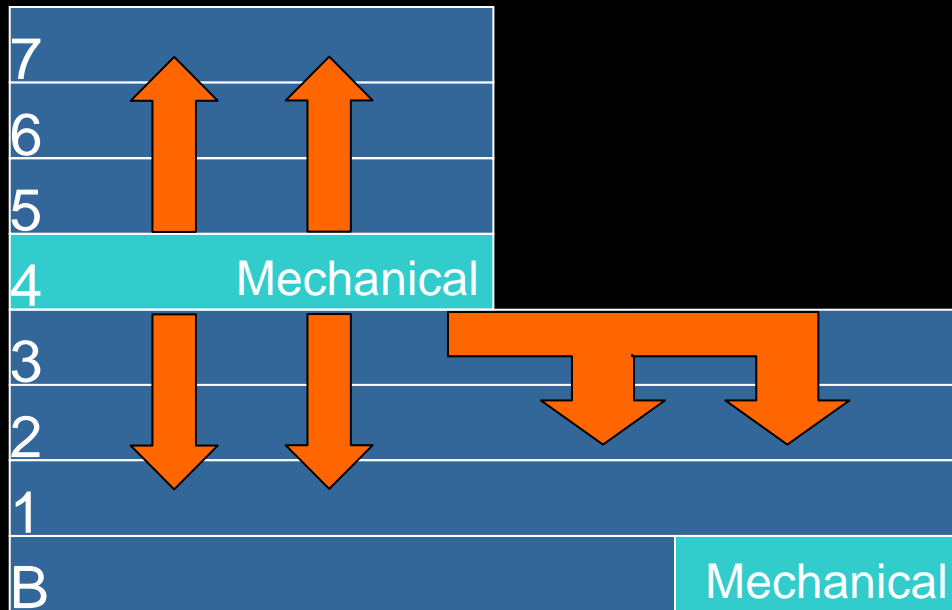
Four floors at 60,000 sf  
(240,000 sf total)

**\$350/sf; \$140 M**

“Baseline” Building Total : **400,000 gsf**



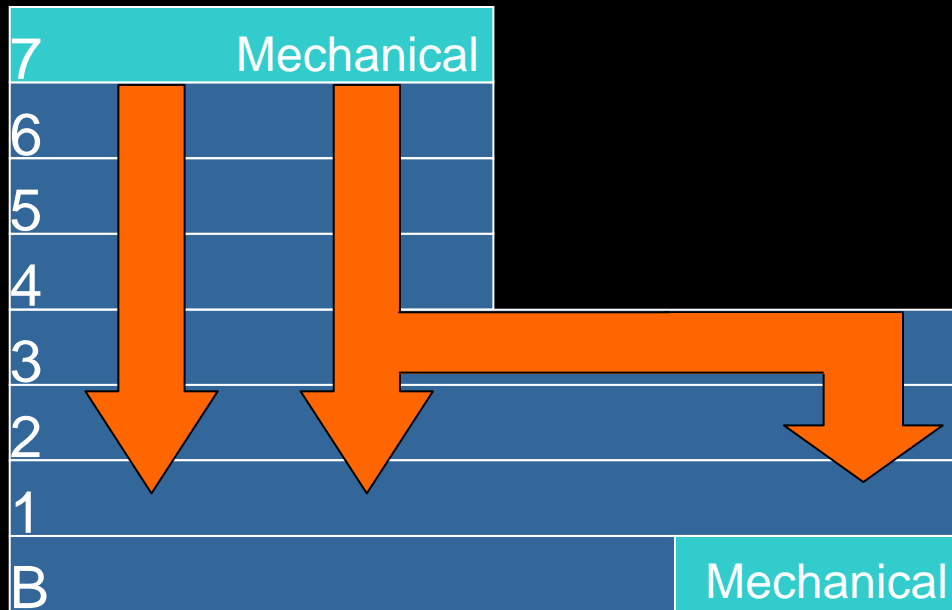
# “Baseline” Building A – Mechanical Shafts



Efficient size and distribution of mechanical shafts



# “Baseline” Building A.1 – Mechanical Shafts

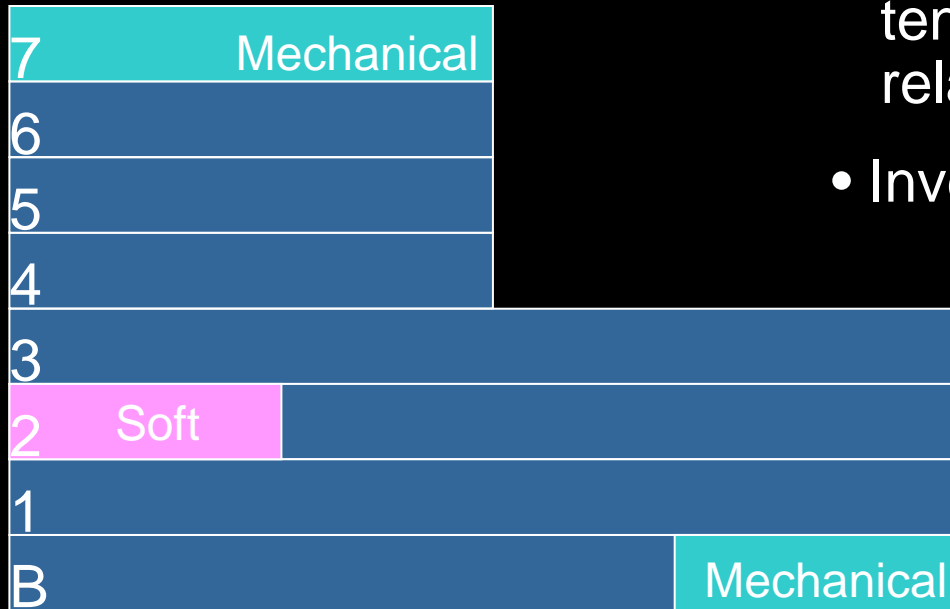


Larger shafts reduce useable square footage; approx. 1% of total building

Effectively raises the cost per square foot



# Option Example 1: Soft Space



- Cost to plan and build original tenant space may be high relative to length of time used.
- Invest in infrastructure?
  - Cost of new fit out
  - Disruption of adjacent areas
  - Cost of tenant relocation

Except for anticipated infrastructure to support a more intense future use, no additional first costs



# Option Example 2: Shell Space

- Space to accommodate future growth/new program
- Costs approx. **65%** of the price to fit-out space
- If space is fit-out after original construction is complete, disruption could be an issue.

7	Mechanical
6	Shell
5	
4	
3	
2	
1	
B	Mechanical

**Shell space has a premium; cost of original construction, though lower than fully fit-out space, has no ROI**



# Baseline Building B

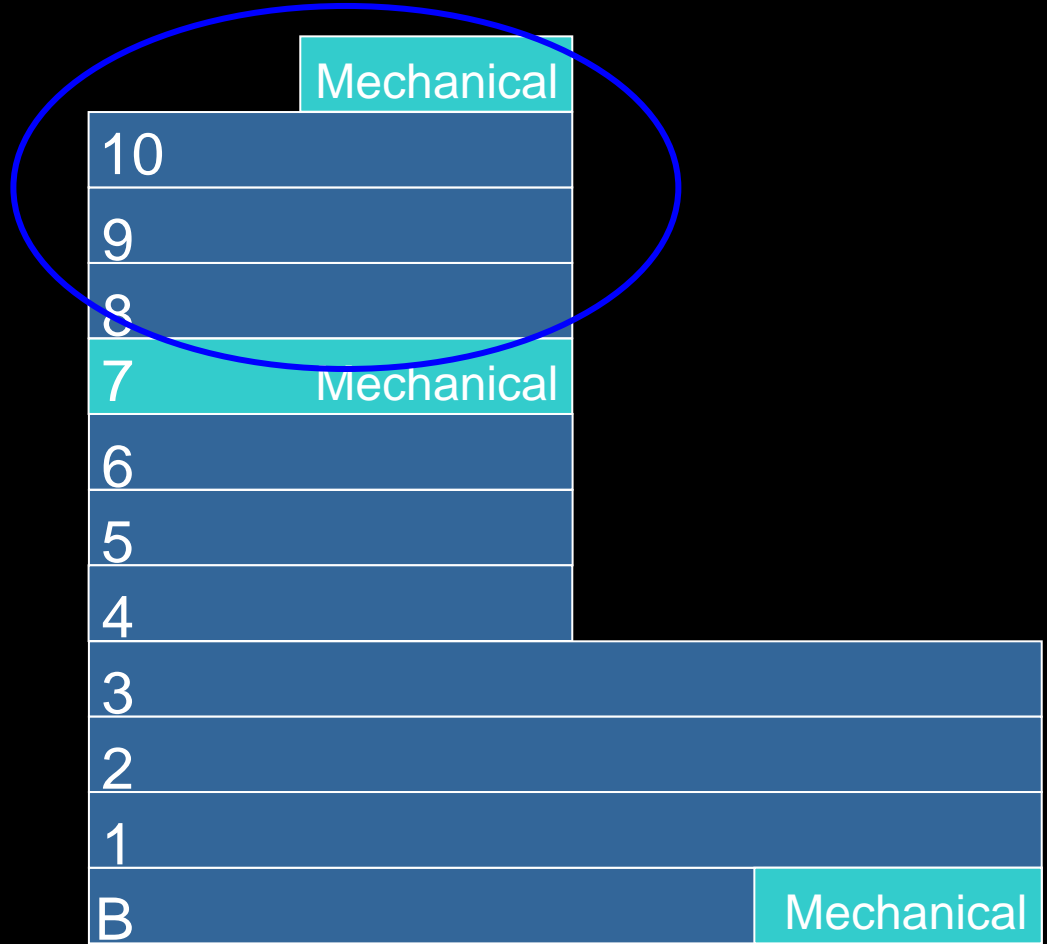
	Mechanical
10	
9	
8	
7	Mechanical
6	
5	
4	
3	
2	
1	
B	Mechanical

		\$ / SF	\$ M
SHELL + CORE		\$198	\$103 M
FIT OUT		\$152	\$ 79 M
<b>TOTAL</b>	<b>520,000</b>	<b>\$350</b>	<b>\$182 M</b>

Add'l 3 floors @ 40,000 sf  
+ 120,000 sf = **520,000 gsf**



# Baseline Building B Comparisons



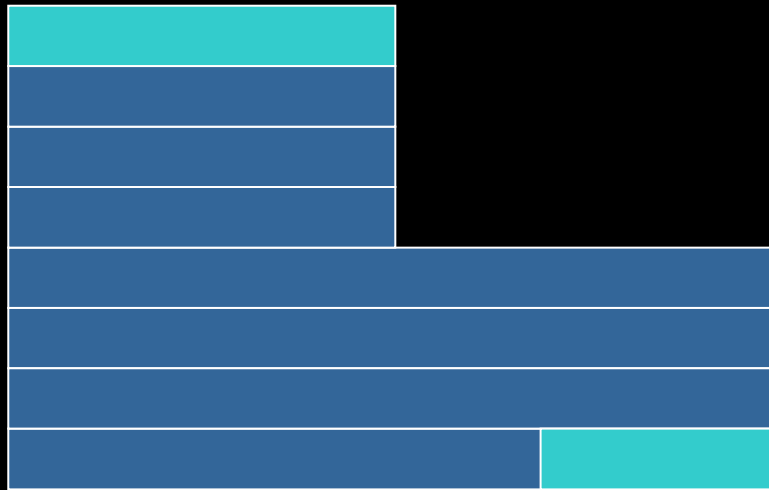
Compare costs of:

1. Full build-out at once
2. Base building w/ shell for future build-out
3. Base building w/ future vertical expansion

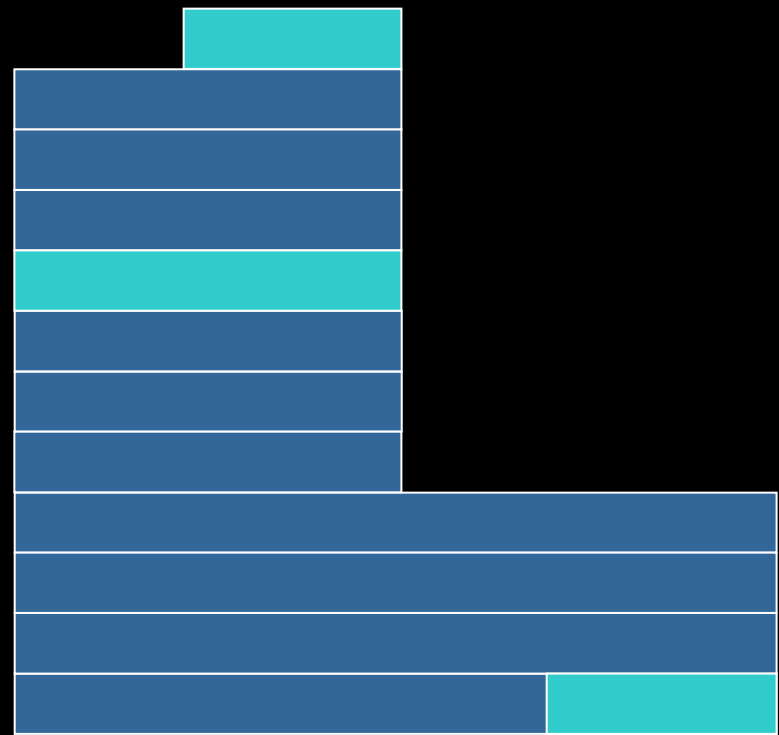


# Baseline Building A and B Comparisons

Additional cost for structural and foundation in Base Building A to support future vertical expansion is likely to be between 1 – 2% (\$1.185M; \$81M total). Cost would increase significantly with a taller base building.



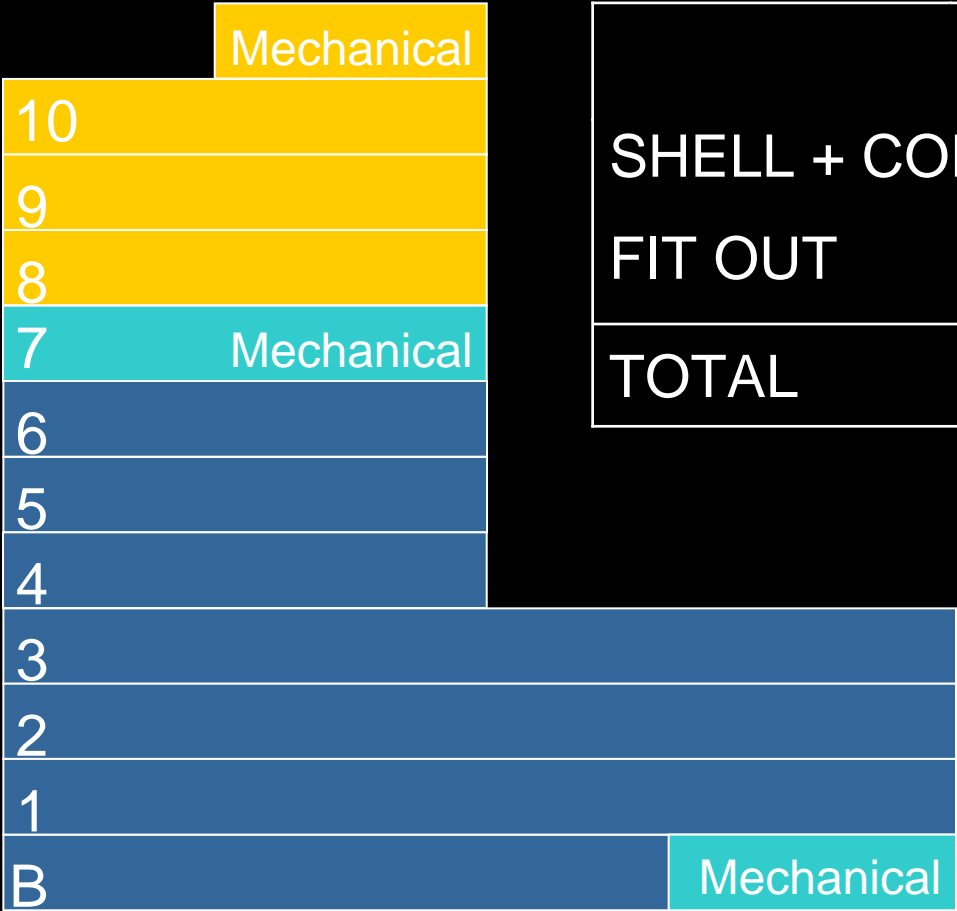
**Base Building A**



**Base Building B**



# Option Example 2B: Shell Space (120,000 sf)



		\$ / SF	\$ M
SHELL + CORE	520,000	\$198	\$103 M
FIT OUT	400,000	\$152	\$ 61 M
<b>TOTAL</b>		<b>\$315</b>	<b>\$164 M</b>

The cost of the fitting out the 120,000 sf on the upper floors will be a function of time and market conditions



# Shell Space – 5 years @ 5% Inflation

	Mechanical
10	
9	
8	
7	Mechanical
6	
5	
4	
3	
2	
1	
B	Mechanical

		\$ / SF	\$ M
SHELL + CORE	520,000	\$198	\$103 M
FIT OUT	400,000	\$152	\$ 61 M
FIT OUT (+5 yrs)	120,000	\$209	\$ 25 M
<b>TOTAL</b>	<b>520,000</b>	<b>\$363*</b>	<b>\$189 M*</b>

**\$ 7M (3.77%) more than if all built initially**

**\*Average of total construction**



# Shell Space – 10 years @ 5% Inflation

	Mechanical
10	
9	
8	
7	Mechanical
6	
5	
4	
3	
2	
1	
B	Mechanical

		\$ / SF	\$ M
SHELL + CORE	520,000	\$198	\$103 M
FIT OUT	400,000	\$152	\$ 61 M
FIT OUT (+10 yrs)	120,000	\$263	\$ 32 M
<b>TOTAL</b>	<b>520,000</b>	<b>\$376*</b>	<b>\$195 M*</b>

**\$13M (7.30%) more than if all built initially**

**\*Average of total construction**



# Shell Space – 5 years @ 5% Deflation

	Mechanical
10	
9	
8	
7	Mechanical
6	
5	
4	
3	
2	
1	
B	Mechanical

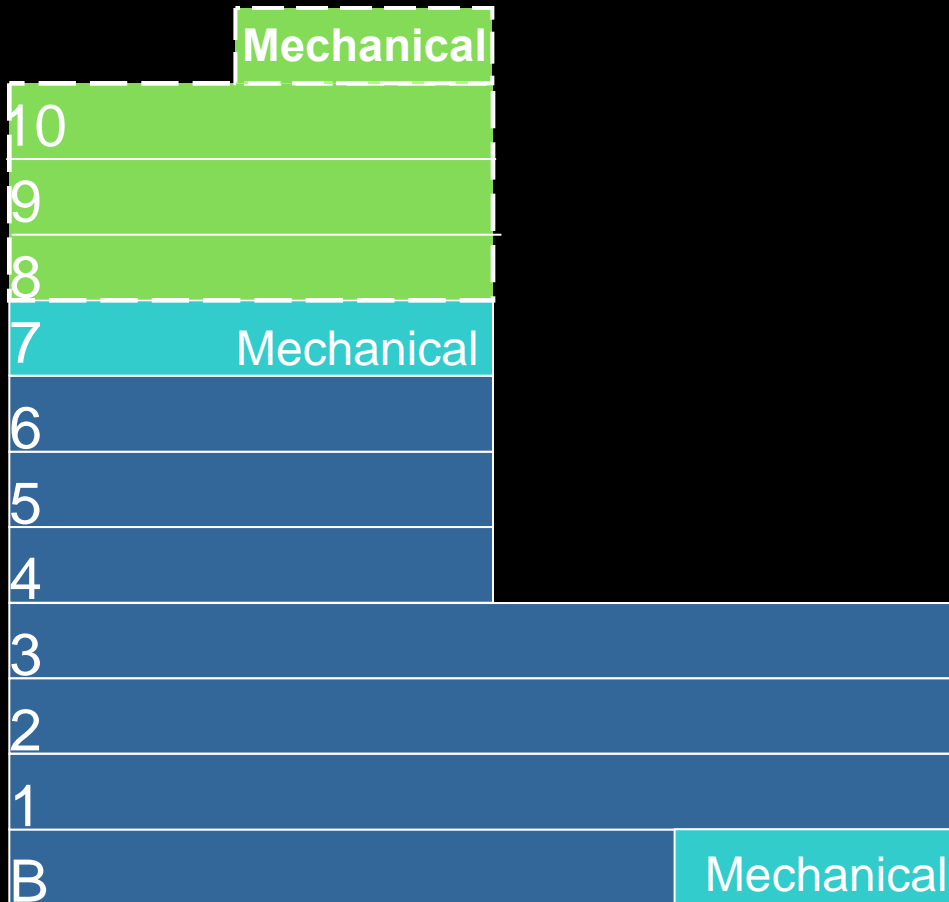
		\$ / SF	\$ M
SHELL + CORE	520,000	\$198	\$103 M
FIT OUT	400,000	\$152	\$ 61 M
FIT OUT (+5 yrs)	120,000	\$133	\$ 16 M
<b>TOTAL</b>	<b>520,000</b>	<b>\$346*</b>	<b>\$180 M*</b>

**\$ 2M (1.26%) less than if all built initially**

**\*Average of total construction**



# Option Example 3: Vertical Expansion



## Construction Issues:

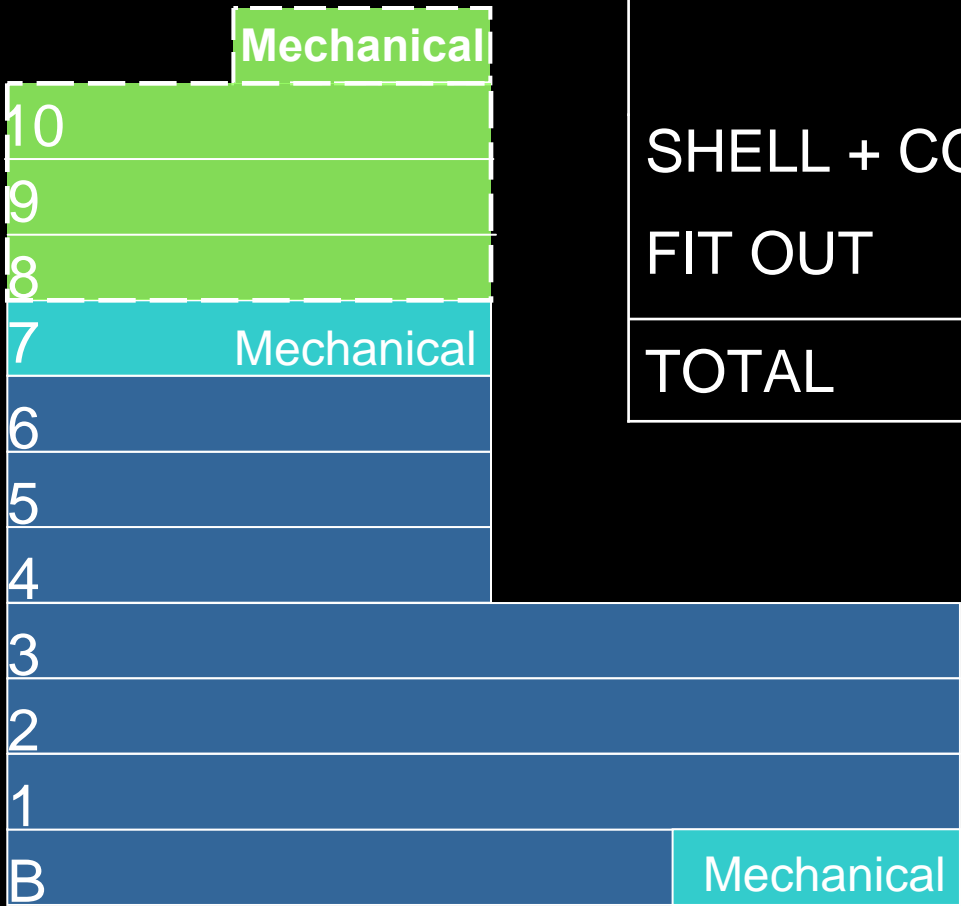
- Cost of moving people and materials
- Steel and concrete
- Exterior issues
- Foundations and steel
- Buffer to minimize disruption or vacate an occupied floor

## Capacity Issues:

- Requires additional mechanical
- Piping and shafts (min)
- Electrical (switchgear?)
- Sufficient elevators



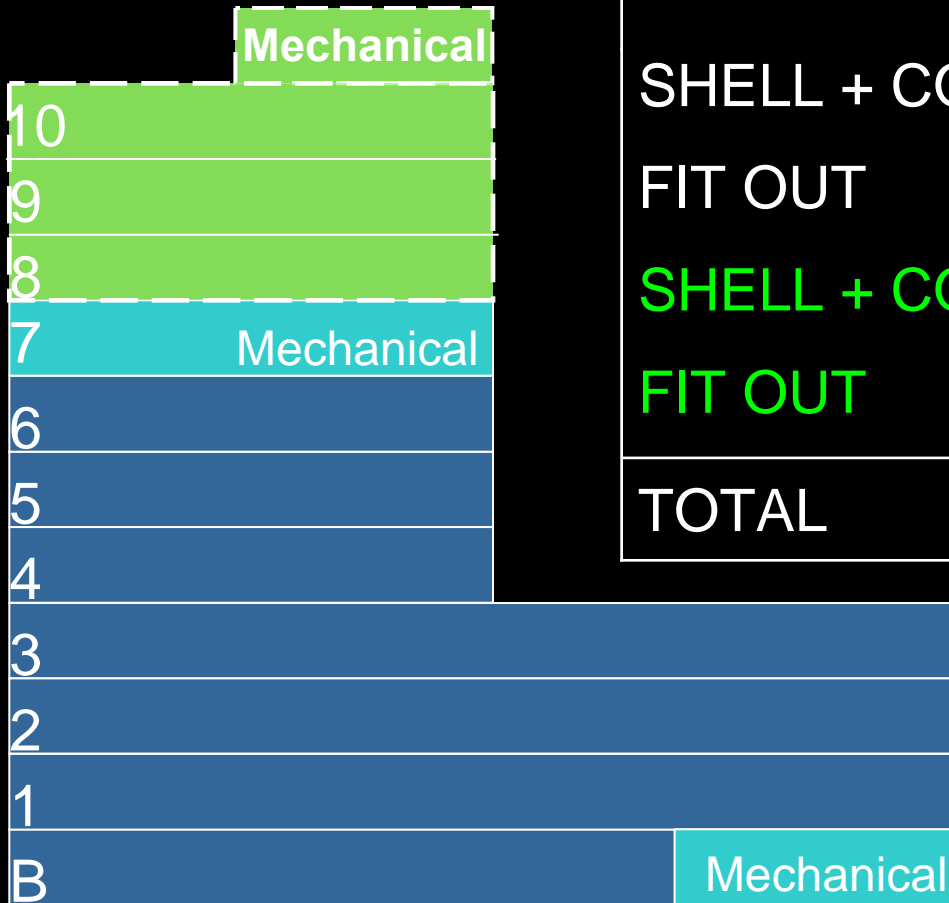
# Option Example 3: Vertical Expansion



		\$ / SF	\$ M
SHELL + CORE	400,000	\$198	\$ 79 M
FIT OUT	400,000	\$152	\$ 61 M
<b>TOTAL</b>		<b>\$350</b>	<b>\$140 M</b>



# Vertical Expansion – 5 years @ 5% Inflation



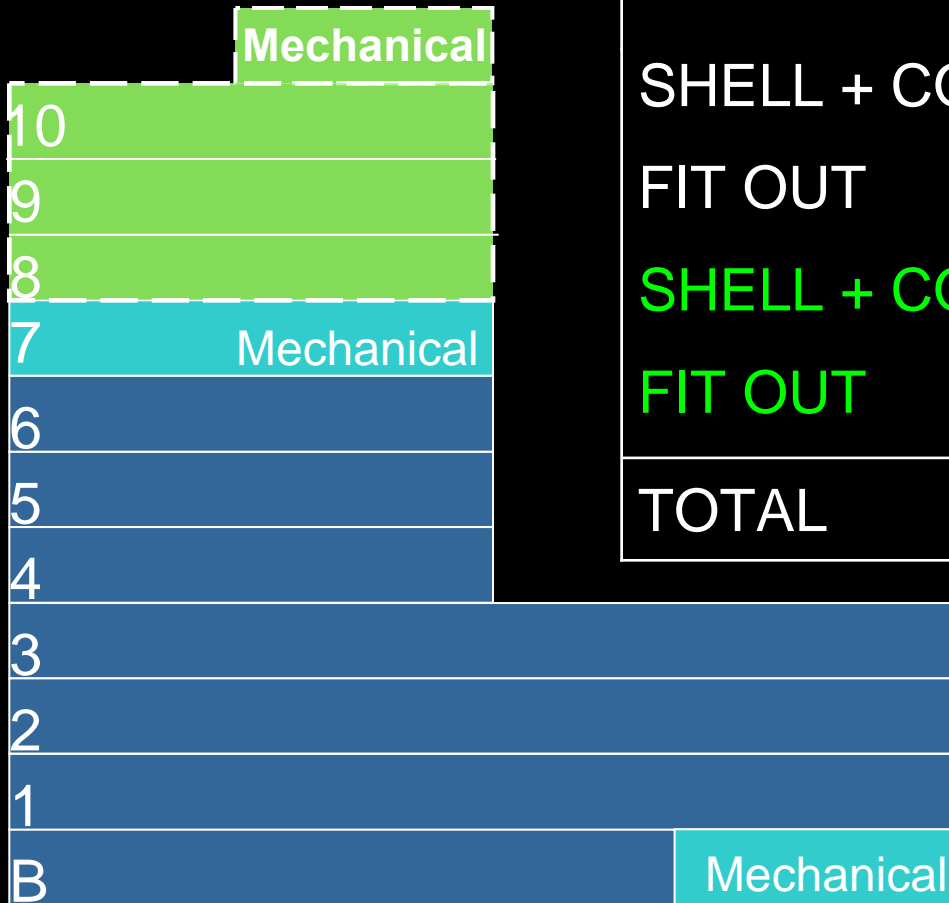
		\$ / SF	\$ M
SHELL + CORE	400,000	\$198	\$103 M
FIT OUT	400,000	\$152	\$ 61 M
SHELL + CORE	120,000	\$273	\$ 33 M
FIT OUT	120,000	\$209	\$ 25 M
<b>TOTAL</b>	<b>520,000</b>	<b>\$380*</b>	<b>\$198 M*</b>

**\$ 18M (8.68%) more than if all built initially; \$ 11M more than shell @ 5 yrs**

**\*Average of total construction**



# Vertical Expansion – 10 years @ 5% Inflation



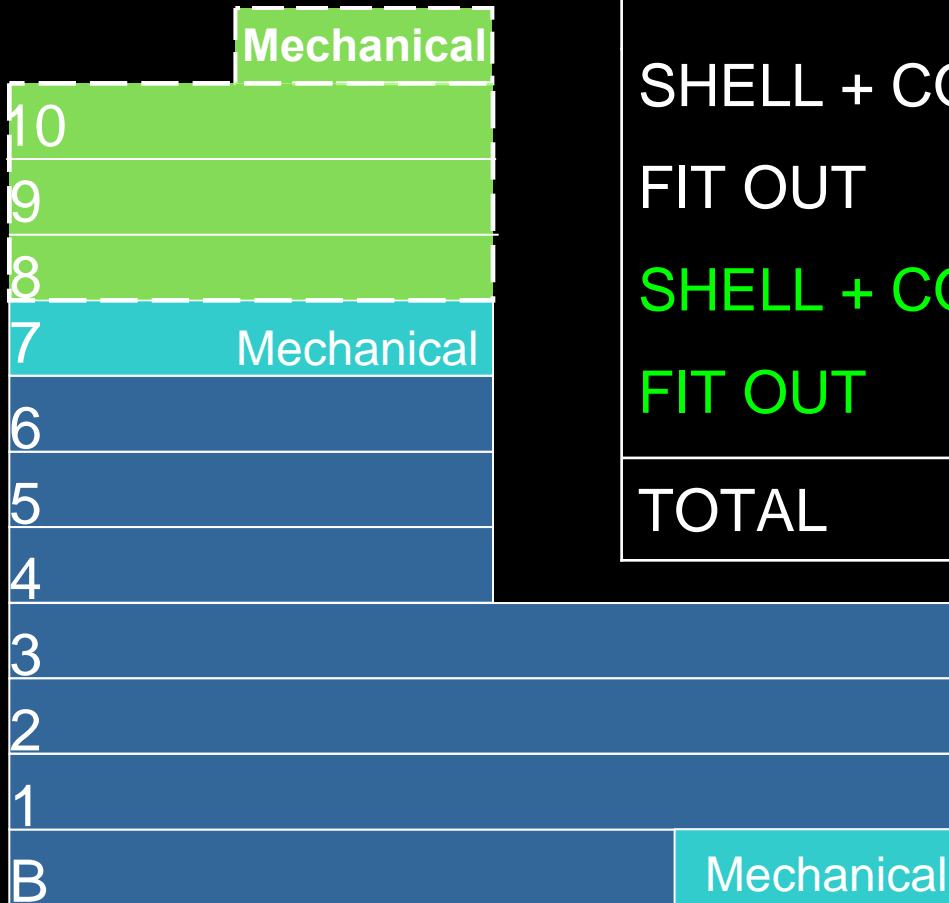
			\$ / SF	\$ M
SHELL + CORE	400,000		\$198	\$103 M
FIT OUT	400,000		\$152	\$ 61 M
SHELL + CORE	120,000		\$323	\$ 39 M
FIT OUT	120,000		\$247	\$ 25 M
<b>TOTAL</b>	<b>520,000</b>		<b>\$401*</b>	<b>\$208 M*</b>

**\$ 26M (14.51%) more than if all built initially; \$ 13M more than shell @ 10 yrs**

**\*Average of total construction**



# Vertical Expansion – 5 years @ 5% Deflation



		\$ / SF	\$ M
SHELL + CORE	400,000	\$198	\$103 M
FIT OUT	400,000	\$152	\$ 61 M
SHELL + CORE	120,000	\$153	\$ 18 M
FIT OUT	120,000	\$118	\$ 14 M
<b>TOTAL</b>	<b>520,000</b>	<b>\$332*</b>	<b>\$172 M*</b>

**\$ 10M (5.22%) less than if all built initially; \$ 8M less than shell @ 5 yrs**

**\*Average of total construction**



# Base, Shell and Vertical Expansion

	BASE BLDG B ALL @ ONCE		BASE BLDG B SHELL		BASE BLDG B VERT EXP	
	\$ / SF	\$ M	\$ / SF	\$ M	\$ / SF	\$ M
BASE	\$350	\$182 M	\$315	\$164 M	\$350	\$140 M
5 YRS / + 5%			\$363	\$189 M	\$380	\$198 M
10 YRS / + 5%			\$376	\$195 M	\$401	\$208 M
5 YRS / - 5%			\$346	\$180 M	\$332	\$172 M



# Base, Shell and Vertical Expansion

BASE BLDG B ALL @ ONCE	BASE BLDG B SHELL	BASE BLDG B VERT EXP
\$ / SF \$ M	\$ / SF \$ M	\$ / SF \$ M
\$350 \$182 M	\$315 \$164 M	\$350 \$140 M
	\$363 \$189 M	\$380 \$198 M
	\$376 \$195 M	\$401 \$208 M
	\$346 \$180 M	\$332 \$172 M



# Option Example 4: Interstitial Floors

7	Mechanical
6	
5	
4	
3A	
3	
2A	
2	
1A	
1	
B	Mechanical

## Interstitial floors:

- Add'l 4' exterior per 2.5 floors
- Steel and foundations
- MEP capacity
- Good for maintenance

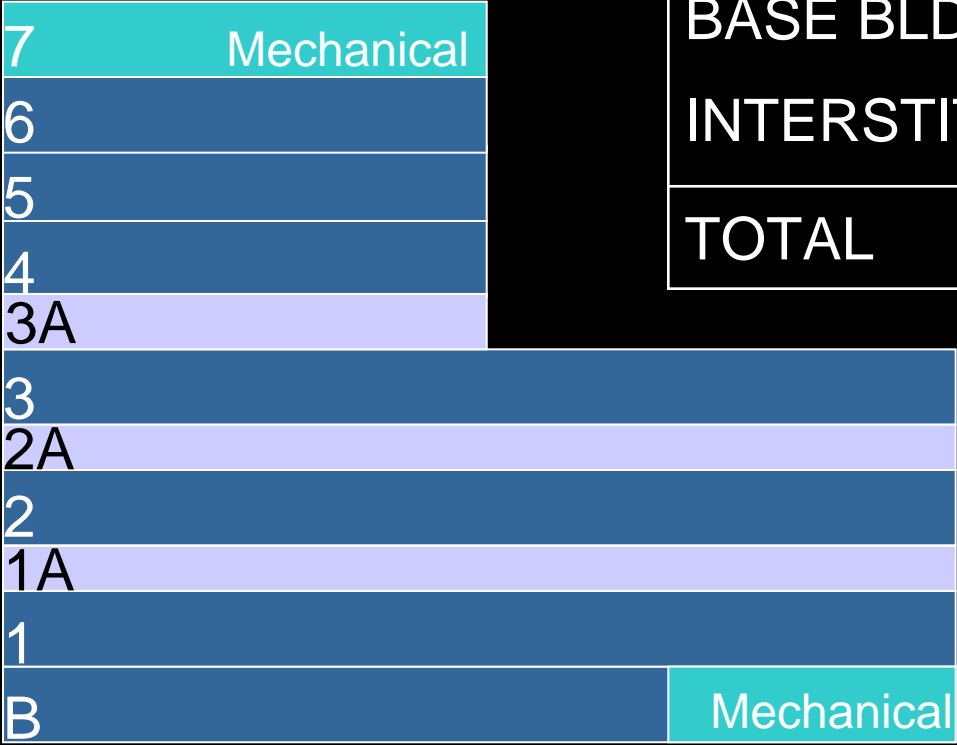
## Will also require:

- Lighting, sprinklers, fire-proofing, fire separation

**“Baseline” Building: 400,000 sf + 160,000 sf Interstitial Area**



# Option Example 4: Interstitial Floors



		\$ / SF	\$ M
BASE BLDG	400,000	\$350	\$140 M
INTERSTITIAL	160,000	\$ 77	\$ 12 M
<b>TOTAL</b>			<b>\$152 M</b>

The value of interstitial floors should be evaluated relative to the costs of renovation and disruption w/o interstitial areas

“Baseline” Building: 400,000 sf + 160,000 sf Interstitial Area



# Option Example 5A: Modular/Generic Room Space

5 Rooms @ 200 nsf = 1,000 nsf

5 Rooms @ 150 nsf = 750 nsf

5 Rooms @ 120 nsf = 600 nsf

---

15 rooms @ 2,350 nsf (total)

x 1.5 = 3,525 dgsf

3,525 dgsf. @ \$350/sf = \$1,233,750

= \$ **82,250** per room (average)



# Option Example 5A: Modular/Generic Room Space

Or:

10 Rooms @ 200 nsf = 2,000 nsf

5 Rooms @ 120 nsf = 600 nsf

---

15 Rooms @ 2,600 nsf (total)

x 1.5 = 3,900 dgsf

3,900 dgsf @ \$350/sf = \$1,365,000

= \$ 91,000 per room (average)

**+ \$131,250; 11% over original**

Note: Does not include cost of heating/cooling, cleaning, etc. additional space



# Option Example 5A: Modular/Generic Room Space

Or:

$$\begin{aligned} 15 \text{ Rooms @ } 200 \text{ nsf} &= 3,000 \text{ nsf} \\ &\times 1.5 = 4,500 \text{ dgsf} \end{aligned}$$

---

$$\begin{aligned} 4,500 \text{ dgsf @ } \$350/\text{s.f.} &= \$1,575,000 \\ &= \$ 105,000 \text{ per room} \end{aligned}$$

**+ \$341,250; 28% over original**

Note: Does not include cost of heating/cooling, cleaning, etc. additional space



# Option Example 5B: Modular/Generic Operating Rooms

## Fit-out:

- Shield all ORs?
  - Choice of imaging equipment (self-shielded?)
  - Changing technologies; vendor differences
  - Type of shielding?
  - Approximately \$25 / sf
  - Structural capacity?
  - MRI installation

**600 sf OR → \$ 66,000 per OR**

- Issue may be number of ORs; interchangeability of ORs



# Option Example 6: Infectious Isolation/Patient Rooms

- 48 Beds / floor (40,000 sf / floor)
- 6 - 8 air changes/hour for cooling load
- 12 (code minimum) – 15 (balancing)
  - Moving twice as much air
- Larger duct work → 20,000 – 40,000 cfm
  - Greater floor-to-floor height?
- Low exhaust air
- Chilled beams
  - Climate a major factor



# Isolation Capacity Estimate

<b>Isolation Rooms in lieu of Standard</b>	<b>Quantity</b>	<b>Unit</b>	<b>Unit Cost</b>	<b>Total Cost</b>
Exterior Envelope add 1' of height to floor	800	sf	\$90.00	\$72,000
Increase shafts & partitions height 1'	40,000	sf	\$0.50	\$20,000
Add gaskets to doors	40,000	sf	\$0.40	\$16,000
Change ceilings to GWB from ACT	40,000	sf	\$4.00	\$160,000
Increase HVAC from 1.25 to 2.5 cfm	40,000	sf	\$30.00	\$1,200,000
Increase pipes & electrical risers 1'	40,000	sf	\$1.00	\$40,000
Electrical - added costs due to eqpt/senors	40,000	sf	\$1.00	\$40,000
Trade Cost				\$1,548,000
Mark - Ups	18.00%	\$278,640		
Contingencies	3.00%	\$54,799		\$333,439
<b>Total Cost</b>				<b>\$1,881,439</b>



# Evaluation Matrix

Flexibility/Adaptability Option <i>(Description)</i>	Importance of Benefit(s) <i>(Rank 1-5)</i>	Capital Cost Initial <i>(Rank 1-5)</i>	Capital Cost Implement <i>(Rank 1-5)</i>	Operational Cost <i>(Rank 1-5)</i>	Total Cost <i>(Rank 1-5)</i>	Likelihood of Implementation (Future) <i>(Low - High)</i>
Location of Mechanical Floors	5	0	0	0	1	N/A
Soft Space	4	1	2	0	1	High
Shell Space	5	4	4	1	3	High
Vertical Expansion	4	2	5	0	4	???
Interstitial Floor	4	3	0	3	3	N/A
Modularity of Key Rooms	3	1	0	0	1	High
OR Shielding	4	2	0	0	1	???
Isolation Capacity	4	4	0	1	3	Moderate



# Conclusion

- The longer out the implementation, the greater the risk (of costs, regulations and needs changing)
- Likelihood of implementation a key factor
- Space that is built is very likely to be utilized
- Assess all costs – today and for the future
- Future costs extremely difficult to forecast; highly variable markets