

Real Options Application Portfolio

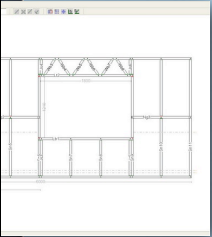
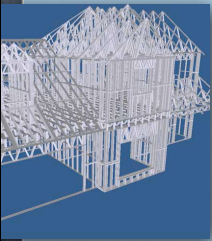
Analyzing the impact of developing a regional office for the sales strategy of Metalforming Technologies.



Juan F. Martin
Prof. Richard de Neufville
MIT - ESD 71
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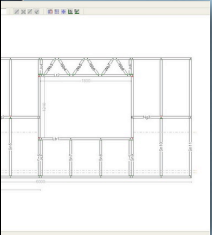
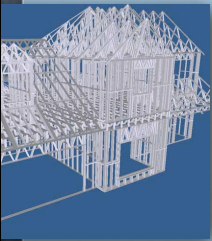
Problem Definition

- ❑ MetalForming Technologies is a New Zealand based entrepreneurial company focused on the design and production of Light Gauge Steel Framing systems.
- ❑ Their current strategy involves developing a plan to penetrate the US market.
- ❑ This application portfolio focuses on the design of a direct sales strategy under different uncertain scenarios.



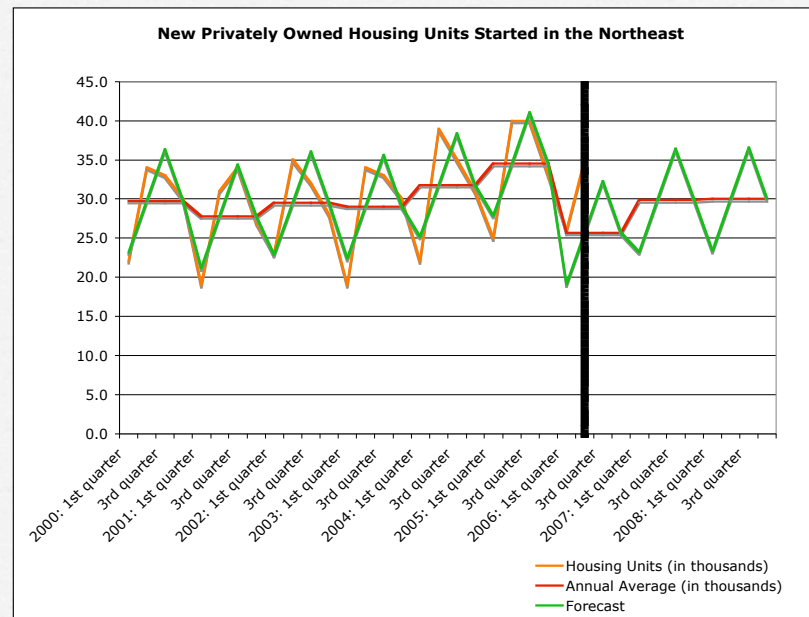
Accounting for Uncertainty

- The main concern for our sales strategy is the fluctuating demand for construction products, which is coupled to the overall wellness of the economy.
- We will focus on new residential housing from the Midwest and Northeast regions since they are currently the most attractive market for Light Gauge Steel Framing.
- The US Census Bureau and Steel Framing trade associations are amongst a number of resources that provide historical construction data up to date.



Modelling Uncertainty

- One way to estimate product demand is based on the historical trend of new privately owned housing units started in the Northeast of the US.



Model of quarterly housing starts = $ANNUAL_AVG + STD_DEV * SIN(QUARTER)$

Estimating Product Demand

- We need to find a correlation between housing starts and our product demand:

$$\text{Framing Potential Demand} = (2,500\text{ft}^2 * 7,6\$/\text{ft}^2) * \text{Housing Units Started}$$

- According to the Steel Framing Alliance, market penetration in the US is only about 1.5%, therefore

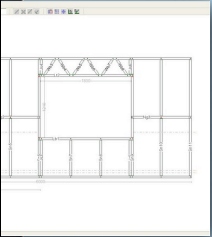
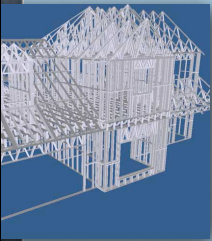
$$\text{Steel Framing Potential Demand} = (1.5\% * \$19,000) * \text{Housing Units Started}$$

- We estimate that only 0.2% of this projection will be transformed into actual sales, as expressed by:

$$\text{LGSF Demand} = (0.5\% * \$950) * \text{Housing Units Started}$$

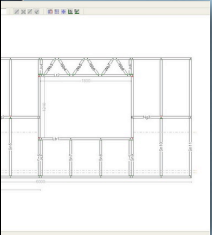
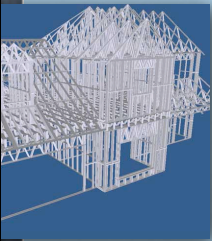
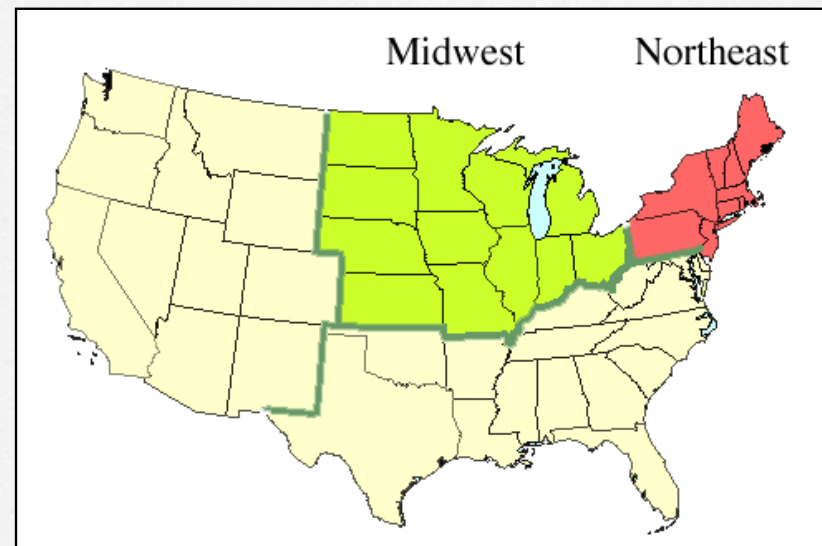
- Which gives us our final equation for estimating product demand:

$$\text{LGSF Demand} = (\$4.75) * \text{Housing Units Started}$$

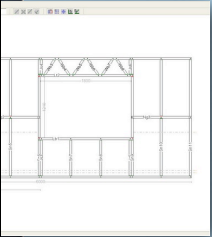
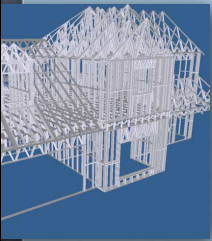


Two-Stage Decision Analysis

- The firm's objective is to service customers in the northern United States
- They have segmented the market into two regions: Northeast and Midwest.
- Housing starts in the Midwest were 356,917 for 2005, almost double than in the other region (189,417).

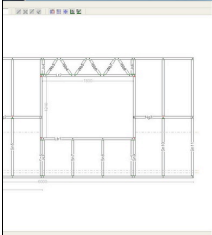
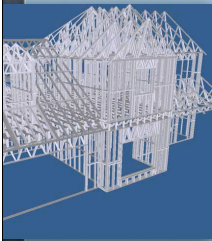


Alternative Designs



FIXED DESIGN	FLEXIBLE DESIGN
Central headquarters in the Midwest region servicing both regions.	Smaller headquarters in the Midwest and a regional office to service the Northeast area.
Two-year lease contract for an office (\$1,400,000)	Headquarters, two-year lease (\$1,000,000) for the Midwest region and a flexible one-year renewable contract for the regional office (\$700,000)
Average cost per sale (whole life cycle of the transaction) at 20% of the total benefits for transaction in the Midwest region and 50% for sales in the Northeast.	The revised cost for the Midwest is now 25% of the total benefits and 25% for the Northeast
25% decrease in demand expectations for the Northeast region.	The regional office allows capturing total demand expectations for the market

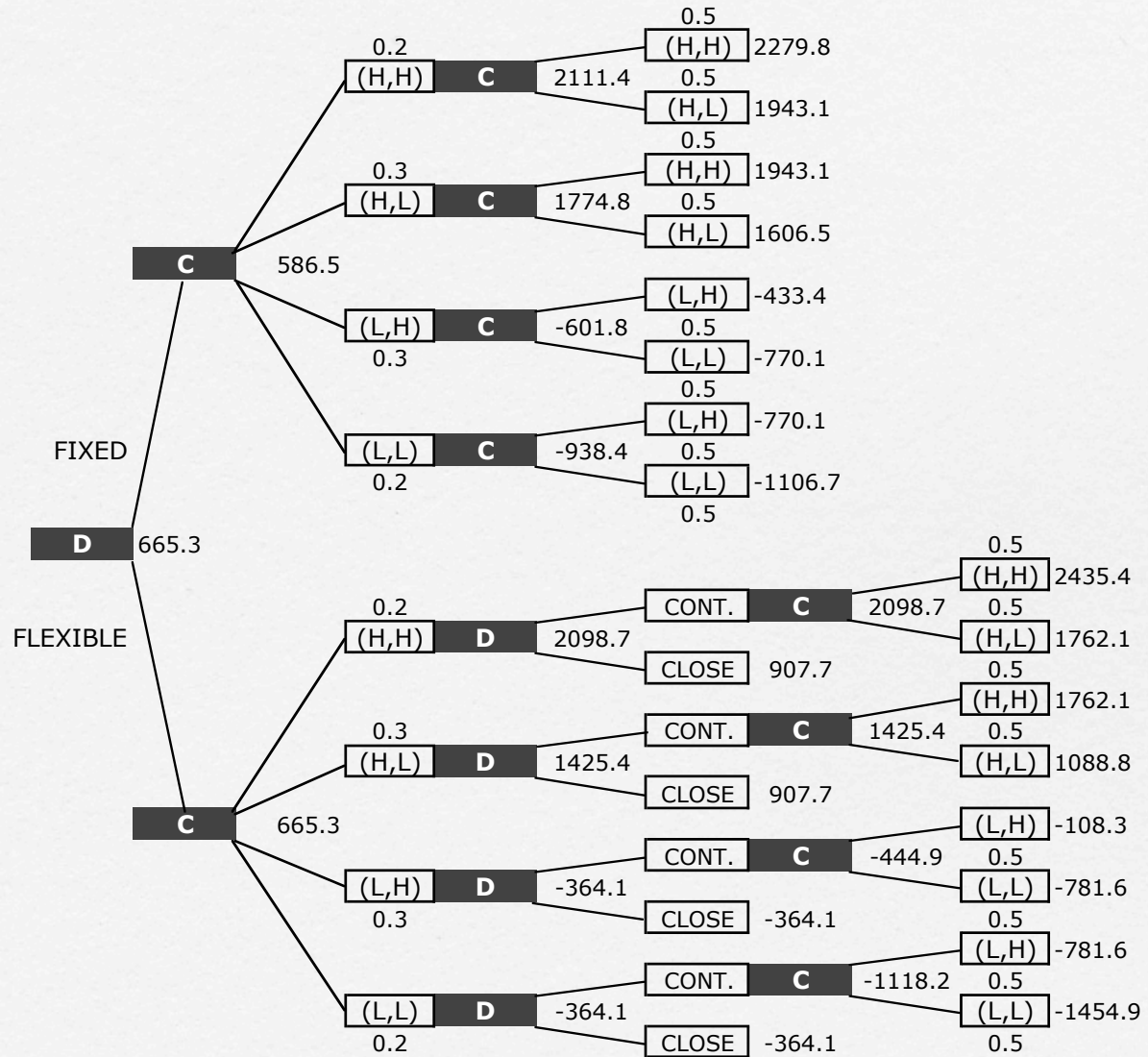
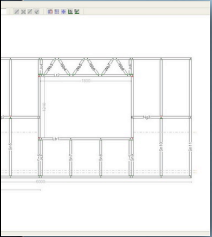
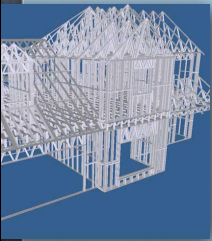
Cost/Benefit Model



FIXED DESIGN		Low MW Low NE	Low MW High NE	High MW Low NE	High MW High NE
Demand	MW	178.5	178.5	535.5	535.5
	NE	70.9	212.6	70.9	212.6
Benefits	MW	847.9	847.9	2543.6	2543.6
	NE	336.7	1010.0	336.7	1010.0
Fixed cost	MW	1400.0	1400.0	1400.0	1400.0
	NE	0.0	0.0	0.0	0.0
Variable cost	MW	169.6	169.6	508.7	508.7
	NE	168.3	505.0	168.3	505.0
Net Benefits	MW	-721.7	-721.7	634.9	634.9
	NE	168.3	505.0	168.3	505.0
Net Benefits	Total	-553.4	-216.7	803.2	1139.9

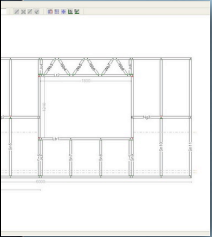
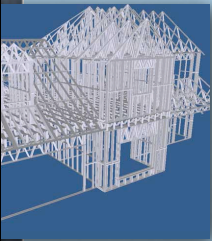
FLEXIBLE DESIGN		Low MW Low NE	Low MW High NE	High MW Low NE	High MW High NE
Demand	MW	178.5	178.5	535.5	535.5
	NE	94.5	283.5	94.5	283.5
Benefits	MW	847.9	847.9	2543.6	2543.6
	NE	448.9	1346.6	448.9	1346.6
Fixed cost	MW	1000.0	1000.0	1000.0	1000.0
	NE	700.0	700.0	700.0	700.0
Variable cost	MW	212.0	212.0	635.9	635.9
	NE	112.2	336.7	112.2	336.7
Net Benefits	MW	-364.1	-364.1	907.7	907.7
	NE	-363.3	310.0	-363.3	310.0
Net Benefits	Total	-727.4	-54.1	544.4	1217.7

2 stage Decision Analysis



Sensitivity Analysis

- The flexible design is the preferred choice in a vast range of the resulting scenarios. The outcomes vary in the range \$418,200 to \$1,035,600
- Flexibility is more relevant when there is more uncertainty (i.e. a larger volatility and a bigger difference in the outcome at the extremes)
- The call option implies that flexibility kicks in to reduce losses in the worst-case scenarios.

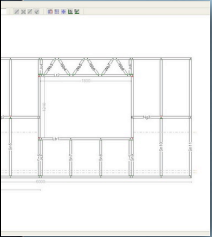
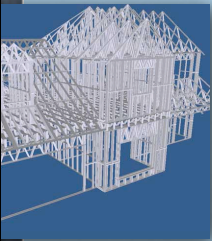


DATA TABLE		STAGE 2																				
		Probability (High)																				
		0.00	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00
STAGE 1 Probability (balanced)	0.00	699.0	715.8	732.7	749.5	766.3	783.1	800.0	816.8	833.6	850.5	867.3	884.1	901.0	917.8	934.6	951.5	968.3	985.1	1002.0	1018.8	1035.6
	0.05	682.2	699.0	715.8	732.7	749.5	766.3	783.1	800.0	816.8	833.6	850.5	867.3	884.1	901.5	919.2	936.8	954.5	972.2	989.9	1007.5	1025.2
	0.10	665.3	682.2	699.0	715.8	732.7	749.5	766.3	783.1	800.0	816.8	833.6	850.5	867.3	885.2	903.7	922.2	940.7	959.2	977.7	996.3	1014.8
	0.15	648.5	665.3	682.2	699.0	715.8	732.7	749.5	766.3	783.1	800.0	816.8	833.6	850.5	868.8	888.2	907.5	926.9	946.3	965.6	985.0	1004.3
	0.20	631.7	648.5	665.3	682.2	699.0	715.8	732.7	749.5	766.3	783.1	800.0	816.8	833.6	852.5	872.7	892.9	913.1	933.3	953.5	973.7	993.9
	0.25	614.8	631.7	648.5	665.3	682.2	699.0	715.8	732.7	749.5	766.3	783.1	800.0	816.8	836.2	857.2	878.3	899.3	920.3	941.4	962.4	983.5
	0.30	598.0	614.8	631.7	648.5	665.3	682.2	699.0	715.8	732.7	749.5	766.3	783.1	800.0	819.8	841.7	863.6	885.5	907.4	929.3	951.1	973.0
	0.35	581.2	598.0	614.8	631.7	648.5	665.3	682.2	699.0	715.8	732.7	749.5	766.3	783.1	803.5	826.2	849.0	871.7	894.4	917.1	939.9	962.6
	0.40	564.3	581.2	598.0	614.8	631.7	648.5	665.3	682.2	699.0	715.8	732.7	749.5	766.3	787.2	810.8	834.3	857.9	881.4	905.0	928.6	952.1
	0.45	547.5	564.3	581.2	598.0	614.8	631.7	648.5	665.3	682.2	699.0	715.8	732.7	749.5	770.9	795.3	819.7	844.1	868.5	892.9	917.3	941.7
	0.50	530.7	547.5	564.3	581.2	598.0	614.8	631.7	648.5	665.3	682.2	699.0	715.8	732.7	754.5	779.8	805.0	830.3	855.5	880.8	906.0	931.3
	0.55	513.8	530.7	547.5	564.3	581.2	598.0	614.8	631.7	648.5	665.3	682.2	699.0	715.8	738.2	764.3	790.4	816.5	842.6	868.7	894.7	920.8
	0.60	497.0	513.8	530.7	547.5	564.3	581.2	598.0	614.8	631.7	648.5	665.3	682.2	699.0	721.9	748.8	775.7	802.7	829.6	856.5	883.5	910.4
	0.65	480.2	497.0	513.8	530.7	547.5	564.3	581.2	598.0	614.8	631.7	648.5	665.3	682.2	705.5	733.3	761.1	788.9	816.6	844.4	872.2	900.0
	0.70	463.3	480.2	497.0	513.8	530.7	547.5	564.3	581.2	598.0	614.8	631.7	648.5	665.3	689.2	717.8	746.4	775.1	803.7	832.3	860.9	889.5
	0.75	446.5	463.3	480.2	497.0	513.8	530.7	547.5	564.3	581.2	598.0	614.8	631.7	648.5	672.9	702.3	731.8	761.3	790.7	820.2	849.6	879.1
	0.80	429.7	446.5	463.3	480.2	497.0	513.8	530.7	547.5	564.3	581.2	598.0	614.8	631.7	656.6	686.9	717.2	747.5	777.8	808.1	838.4	868.7
0.85	418.2	435.0	451.9	468.7	485.5	502.3	519.2	536.0	552.8	569.7	586.5	603.3	620.2	640.2	671.4	702.5	733.7	764.8	795.9	827.1	858.2	
0.90	418.2	435.0	451.9	468.7	485.5	502.3	519.2	536.0	552.8	569.7	586.5	603.3	620.2	637.0	655.9	687.9	719.9	751.8	783.8	815.8	847.8	
0.95	418.2	435.0	451.9	468.7	485.5	502.3	519.2	536.0	552.8	569.7	586.5	603.3	620.2	637.0	653.8	673.2	706.0	738.9	771.7	804.5	837.3	
1.00	418.2	435.0	451.9	468.7	485.5	502.3	519.2	536.0	552.8	569.7	586.5	603.3	620.2	637.0	653.8	670.7	692.2	725.9	759.6	793.2	826.9	

FLEXIBLE DESIGN
 FIXED DESIGN

Lattice Decision Analysis

- Value the option of running a regional office in the Northeast region, given the cost/benefit analysis previously introduced.
- Equivalent to a “call in” option, since the alternative evaluated would allow the firm to capture additional demand by augmenting their operational structure (i.e. changing their design).

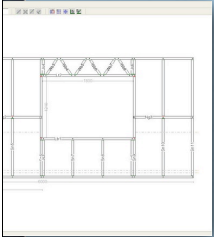
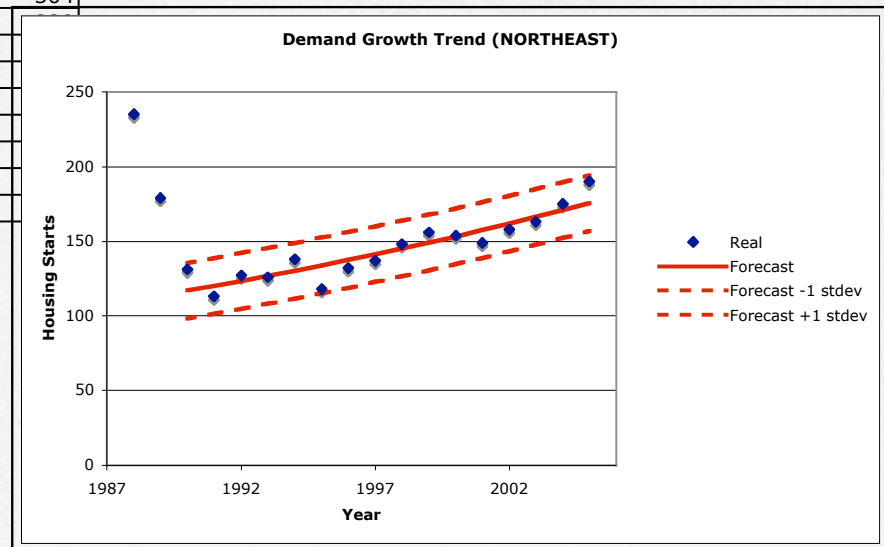


Lattice Demand Estimation

YEAR	U.S. TOTAL	NORTH EAST	MID WEST
1988	1,488	235	274
1989	1,376	179	266
1990	1,193	131	253
1991	1,014	113	233
1992	1,200	127	288
1993	1,288	126	298
1994	1,457	138	329
1995	1,354	118	290
1996	1,477	132	321
1997	1,474	137	304
1998	1,617	148	
1999	1,641	156	
2000	1,569	154	
2001	1,603	149	
2002	1,607	158	
2003	1,848	163	
2004	1,956	175	
2005	2,068	190	

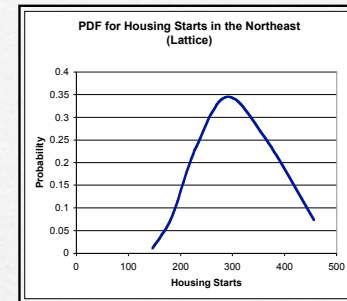
$$y(t) = y_0 \cdot a \cdot e^{rt}$$

$$y(t) = (131) \cdot (2.8E - 24) \cdot e^{(0.027)t}$$



Lattice Demand Estimation

S	144.4
v	0.027
σ	0.129
Δt	1
u	1.138
d	0.879
p	0.605
p Start Value Start	190

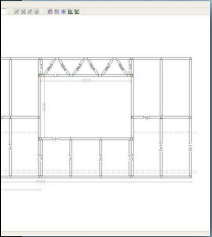
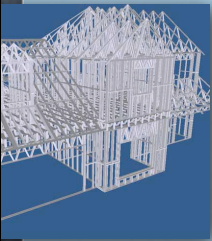


PROBABILITY LATTICE

0	1	2	3	4	5	Step
1.000	0.605	0.366	0.222	0.134	0.081	5
	0.395	0.478	0.434	0.350	0.265	4
		0.156	0.283	0.343	0.346	3
			0.062	0.149	0.225	2
				0.024	0.074	1
					0.010	0

HOUSING STARTS LATTICE

2005	2006	2007	2008	2009	2010	Step
190	216	246	280	319	363	5
	167	190	216	246	280	4
		147	167	190	216	3
			129	147	167	2
				113	129	1
					100	0



NPV Calculation Base Case

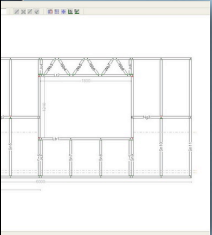
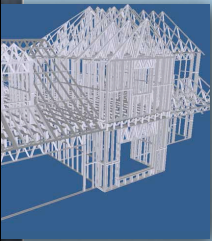
LGSF DEMAND LATTICE

2005	2006	2007	2008	2009	2010	Step
0	770	877	998	1135	1292	5
	595	677	770	877	998	4
		523	595	677	770	3
			459	523	595	2
				404	459	1
					355	0

EV (LGSF DEMAND) LATTICE

2005	2006	2007	2008	2009	2010	Step
0	466	321	221	152	105	5
	235	323	334	307	264	4
		81	168	232	266	3
			28	78	134	2
				10	34	1
					3	0

	2006	2007	2008	2009	2010
EV (Demand)	701.0	726.0	751.8	778.6	806.4
Discount Factor	1.12	1.25	1.40	1.57	1.76
Present Value	625.9	578.7	535.2	494.8	457.6
NPV (MU\$)	2692.2				
Discount Rate	12%				



Value of Option Using Lattice

VALUE OF REGIONAL OFFICE LATTICE

2005	2006	2007	2008	2009	2010
0	129	199	280	372	476
	12	66	129	199	280
		-37	12	66	129
			-79	-37	12
				-116	-79
					-149

5
4
3
2
1
0

DECISION ANALYSIS LATTICE

NPV w/OPTIONS

3108.0	3840.1	3707.0	3305.7	2540.9
	2721.8	2654.5	2404.4	1883.7
		1900.0	1716.0	1376.3
			1276.7	1006.0
				776.8

Step

4
3
2
1
0

VALUE OF REGIONAL OFFICE

25%	Increased demand
-385	Increased Fixed Cost
-25%	Decreased Variable Cost

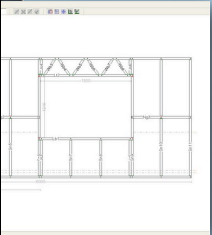
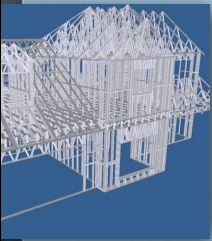
EXERCISE OF OPTION

TRUE	TRUE	TRUE	TRUE	TRUE
	TRUE	TRUE	TRUE	TRUE
		FALSE	TRUE	TRUE
			FALSE	FALSE
				FALSE

4
3
2
1
0

VALUE OF OPTION

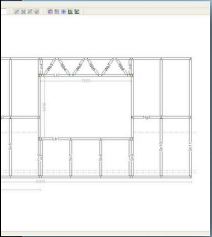
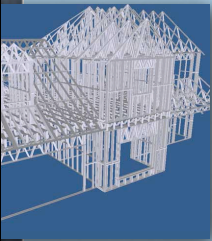
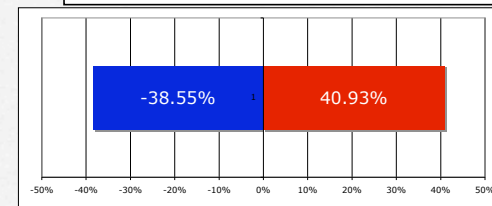
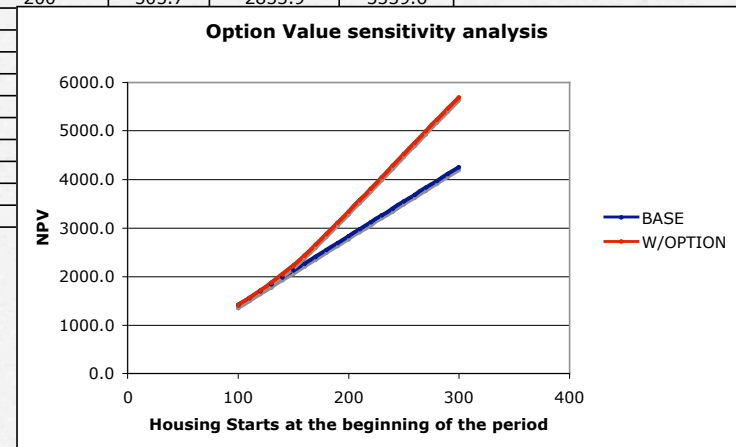
3108.0	NPV w/OPTIONS
-2692.2	NPV
415.8	OPTION (MU\$)



Sensitivity Analysis

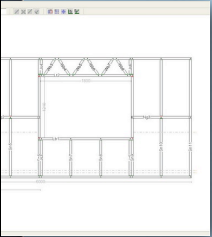
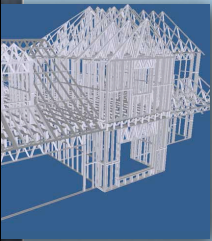
- The option starts to get valuable when the fixed cost increase is less than \$783,000.
- For a fixed cost increase of less than \$279,000 the option is always exercised.
- Range of costs to evaluate building a regional office (actual fixed cost increase was \$385,000)
- The plot lets us visualize the effect of the call option. It allows the company to increase their benefits, as the demand uncertainty gets favorable, thus creating an option with greater value.

DATA TABLE			
VALUE START	OPTION	BASE	W/OPTION
100	2.1	1416.9	1419.0
110	7.2	1558.6	1565.8
120	15.4	1700.3	1715.7
130	37.0	1842.0	1879.0
140	65.1	1983.7	2048.8
150	109.2	2125.4	2234.6
160	165.5	2267.1	2432.6
170	244.7	2408.8	2653.5
180	325.9	2550.5	2876.4
190	415.8	2692.2	3108.0
200	505.7	2833.9	3339.6



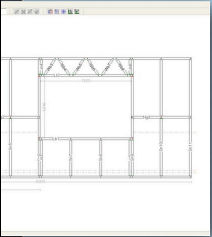
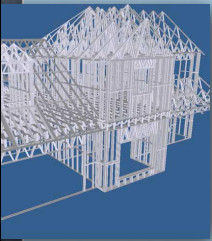
Conclusions

- This report presented two alternative approaches to analyze a project that had uncertain variables affecting its outcome.
- In both cases flexibility proved valuable, thus making the decision of implementing a regional office attractive to the company.



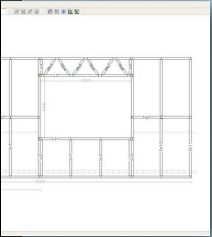
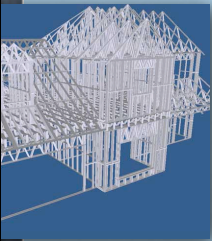
Conclusions Two-stage Decision Analysis

- It gives us a range of scenarios to compare two different designs. The first design presented the base case of running a centralized sales office, while the second one incorporated a grade of flexibility that allowed the firm to react under uncertain demand (regional office).
- One of the benefits of this dynamic plan is that it makes decisions responsive to chance outcomes.
- It is also a very simple way to explain the chosen strategy to different audiences.
- On the other hand, depending on the number alternative paths you decide to incorporate, the number of branches can grow very fast.



Conclusions Lattice Option Valuation

- ❑ Value the option of running a regional office in the Northeast region, given the cost/benefit analysis previously introduced.
- ❑ This method used a lattice to expand a range of values for one of our uncertainties.
- ❑ Broader range of possible outcomes, allowing for several consecutive evaluation periods (which would be very complex to implement in a decision analysis tree).
- ❑ Very difficult to use more than one uncertain variable at a time.
- ❑ The lattice demands path independence between each step, which in our case was not a restriction, but it may limit the use of a dynamic design that could adapt to changing scenarios.



Conclusions

- Both analyses gave us an idea of the value that flexibility brings into the evaluation of problems governed by unpredictable variables.
- Flexibility benefits from the ability to take advantage of excess demand and cut down losses. It makes projects with uncertainties more attractive as some of their risks can be either contained or converted into larger profits.
- By examining a range of results we can understand the real value of a project. We can look at the distribution of profitable results and:
 - Avoid erroneous assumptions (i.e. flaw of averages)
 - Avoid ranking alternative decisions with limited scope (i.e. shut down project too early).

