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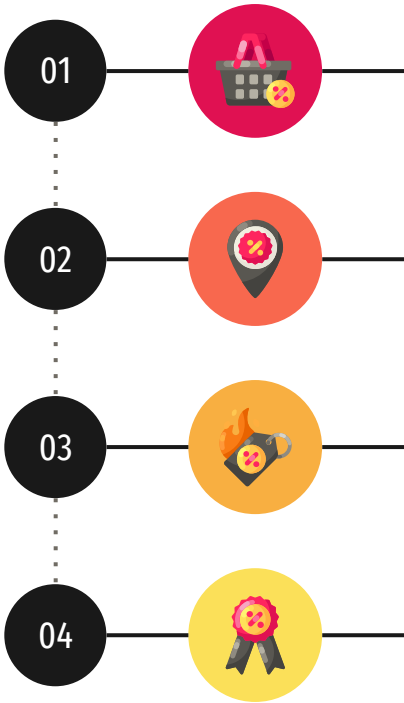
MacPherson Refrigeration Limited

S&OP Planning & Workforce Management Optimization



Pros and Cons of Each Policy

Level Strategy

PROS
- More control of the production (stability)
- Lower Marginal Cost

CONS
- Any changes/fluctuations in the estimated demand might not be met
- Inventory holding costs

Chase Strategy

PROS
- Reduced inventory costs
- Higher level of worker utilization

CONS
- Needs to control the fluctuating workforce
- Exposure to labor union issues

Optimization-Based

PROS
- Optimization of inventory costs
- Accounts for multiple constraints (current, and future)

CONS
- Exposure to labor union issues
- Hiring many workers in a short time period can prove to be difficult

Optimization Model

Objective

MIN: Total Cost = SUM(Labor Costs, Holding Costs)

Decision Variables

- Hirings per Month
- Layoffs per Month
- Overtime

Constraints

- Plant capacity exceeds the production in each month.
- Sum of production and inventory in each month exceeds the demand for that month.
- Hiring, Layoffs and Overtime are integers.
- CDOL limits for overtime - 10% in base scenario

Model Recommendation

Optimization-Based Model w/ CDOL Initiative

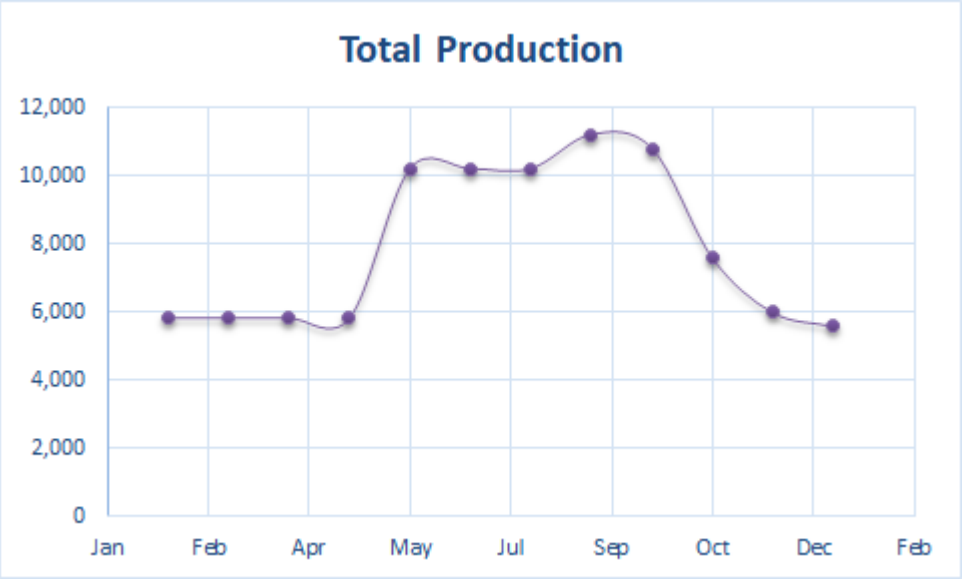
IMPLEMENTATION

- Starting in January, change production schedule to reflect production for each month in model
- Note the hiring of 109 employees in May, and begin the search in January - if we expect it, we can prepare for it
- Assuming CDOL Initiative is inevitable, MacPherson should prepare for the policy change by implementing the initiative now - starting at 19% overtime and reducing to 10% if policy is enacted
- Prepare to lay off workers in given months, and account for Labor Union backlash
- End of Horizon Effect: since forecasts are revised monthly, end of horizon effect is effectively nullified as production plans will get updated with updated forecasts. If needed we can change constraints in our model and add a desired non zero inventory level for end of the year to avoid loss of sales at a minimal additional investment

Capacity Expansion

Question 2

- Capacity Expansion is ***not*** needed for production in the factory.
- Current peak total production does ***not*** reach current capacity of 13,000 (it is 11,200), thus increasing capacity will not change the optimal solution apart from increasing costs associated with increasing capacity. There is a buffer in place for peak demand periods

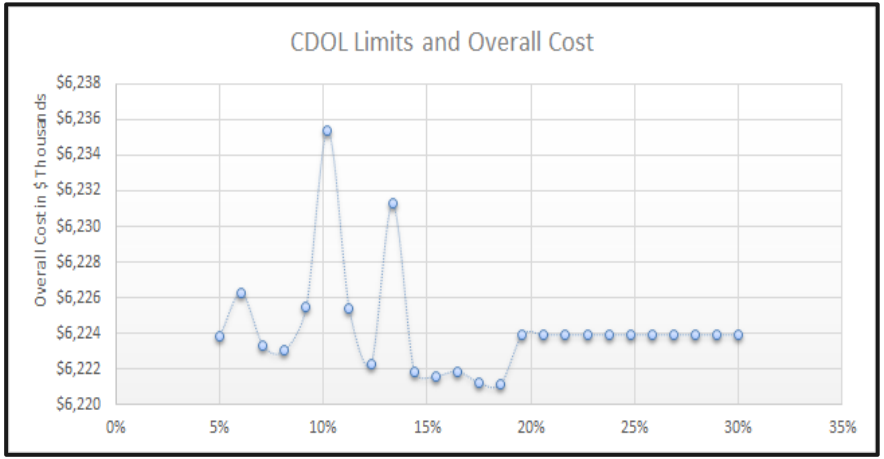


CDOL Initiative

Question 3

- CDOL Initiative is a valid concern and should be accounted for
- The current model implements the CDOL Initiative in preparation for the policy implementation
- Additionally, the model accounts for numerous values of overtime production (10-30%) and showcases an optimal solution (19%).
- In this case, MacPherson can first implement an 19% policy and promptly change to 10% when the policy is enacted

- On trying Sensitivity analysis with ASP within 5% to 30% limits for overtime we find that 19% overtime yields least total cost



Switching to Make-to-Order & End of Horizon Effect

Question 4

- Make-to-Order will ***increase*** operating costs (+3%) and should not be immediately implemented
- Make-to-Order optimal solution does not account for CDOL Initiative either
    - If CDOL is accounted for, then hirings and layoffs will drastically ***increase*** in frequency resulting in numerous logistical difficulties (e.g. 130 hires in June, 80 layoffs in October)
- Appendix G shows the revised values with CDOL limits

Question 5

- To accommodate demand on the first few days of the next year an End of Horizon inventory level greater than zero does make sense. And since the forecasts are getting revised monthly we can determine the approximate demand for the first month of next year. To cater to first few days a mix of the existing inventory at end of year and newly produced inventory would be utilized. We know the production capacity per day at the end of the year. We used 300 units as end of year inventory and costs increased by $12,180. This is a minimal investment to avoid loss of sales

APPENDIX

Appendix A: Screenshot of Optimization Model (no CDOL Limits)

Production

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Demand		4,400	4,400	6,000	8,000	6,600	11,800	13,000	11,200	10,800	7,600	6,000	5,600
Regular Production		6,400	6,400	6,400	6,400	9,480	9,480	9,480	9,480	9,480	7,600	6,000	5,600
Overtime Production		0	0	0	0	0	0	0	1,640	1,320	0	0	0
Production In the month		6,400	6,400	6,400	6,400	9,480	9,480	9,480	11,120	10,800	7,600	6,000	5,600
Cum. Demand		4,400	8,800	14,800	22,800	29,400	41,200	54,200	65,400	76,200	83,800	89,800	95,400
Cum. Production		6,400	12,800	19,200	25,600	35,080	44,560	54,040	65,160	75,960	83,560	89,560	95,160
Inventory	240	2,240	4,240	4,640	3,040	5,920	3,600	80	0	0	0	0	0

Labor

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
#Workers	160	160	160	160	160	237	237	237	237	237	190	150	140
Hirings		0	0	0	0	77	0	0	0	0	0	0	0
Layoffs		0	0	0	0	0	0	0	0	0	47	40	10
Overtime		0	0	0	0	0	0	0	41	33	0	0	0

Accounting

		30	60	90	120	150	180	210	240	270	300	330	360	Total
Hiring Cost		0	0	0	0	138,600	0	0	0	0	0	0	0	$138,600
Layoff Costs		0	0	0	0	0	0	0	0	0	56,400	48,000	12,000	$116,400
Inventory holding costs		17,920	33,920	37,120	24,320	47,360	28,800	640	0	0	0	0	0	$190,080
Labour -Regular		384,000	384,000	384,000	384,000	568,800	568,800	568,800	568,800	568,800	456,000	360,000	336,000	$5,532,000
Labour -Overtime		0	0	0	0	0	0	0	135,300	108,900	0	0	0	$244,200
													Total Cost	$6,221,280

Appendix B: Screenshot of Optimization Model with CDOL Limits

Production

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Demand		4,400	4,400	6,000	8,000	6,600	11,800	13,000	11,200	10,800	7,600	6,000	5,600
Regular Production		5,840	5,840	5,840	5,840	10,200	10,200	10,200	10,200	10,200	7,600	6,000	5,600
Overtime Production		0	0	0	0	0	0	0	1,000	600	0	0	0
Production In the month		5,840	5,840	5,840	5,840	10,200	10,200	10,200	11,200	10,800	7,600	6,000	5,600
Cum. Demand		4,400	8,800	14,800	22,800	29,400	41,200	54,200	65,400	76,200	83,800	89,800	95,400
Cum. Production		5,840	11,680	17,520	23,360	33,560	43,760	53,960	65,160	75,960	83,560	89,560	95,160
Inventory	240	1,680	3,120	2,960	800	4,400	2,800	0	0	0	0	0	0

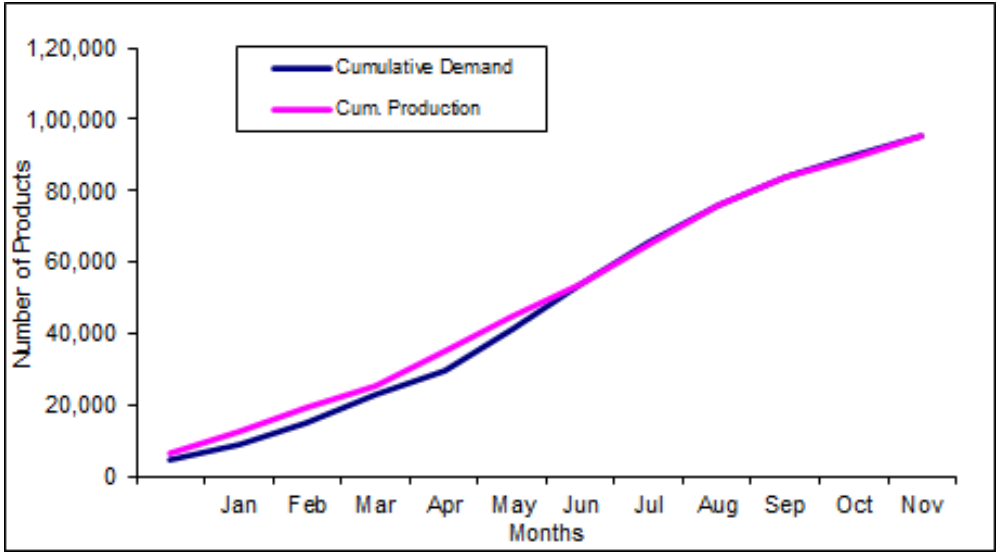
Labor

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
#Workers	160	146	146	146	146	255	255	255	255	255	190	150	140
Hirings		0	0	0	0	109	0	0	0	0	0	0	0
Layoffs		14	0	0	0	0	0	0	0	0	65	40	10
Overtime		0	0	0	0	0	0	0	25	15	0	0	0
CDOL Limit	10%	15	15	15	15	26	26	26	26	26	19	15	14

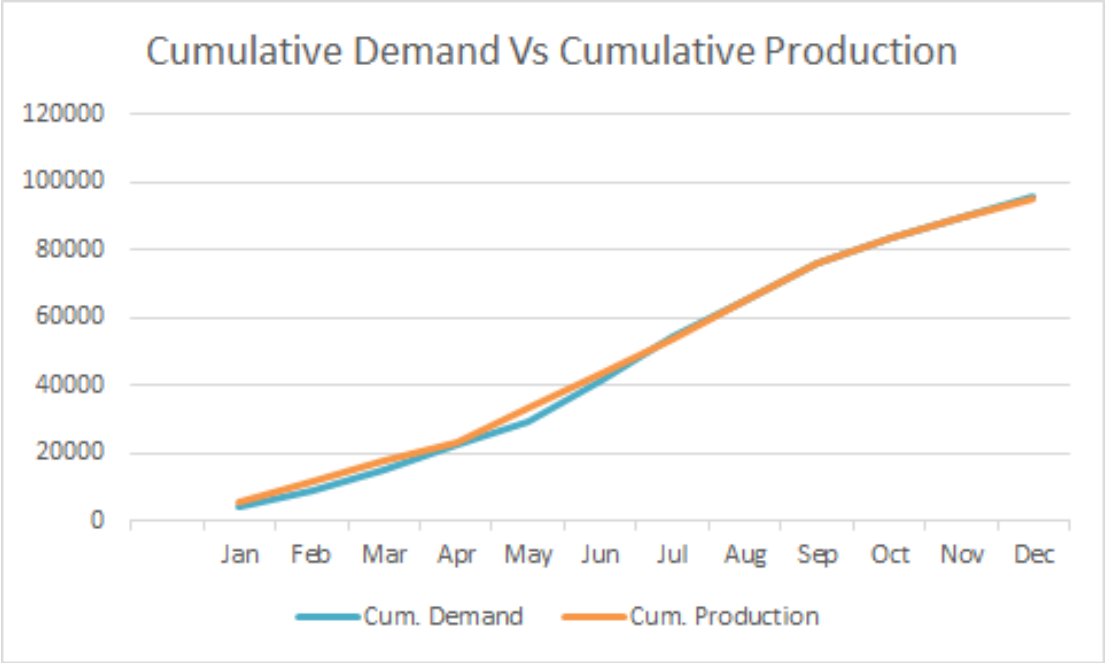
Accounting

	30	60	90	120	150	180	210	240	270	300	330	360	Total
Hiring Cost	0	0	0	0	196,200	0	0	0	0	0	0	0	$196,200
Layoff Costs	16,800	0	0	0	0	0	0	0	0	78,000	48,000	12,000	$154,800
Inventory holding costs	13,440	24,960	23,680	6,400	35,200	22,400	0	0	0	0	0	0	$126,080
Labour -Regular	350,400	350,400	350,400	350,400	612,000	612,000	612,000	612,000	612,000	456,000	360,000	336,000	$5,613,600
Labour -Overtime	0	0	0	0	0	0	0	82,500	49,500	0	0	0	$132,000
												Total Cost	$6,222,680

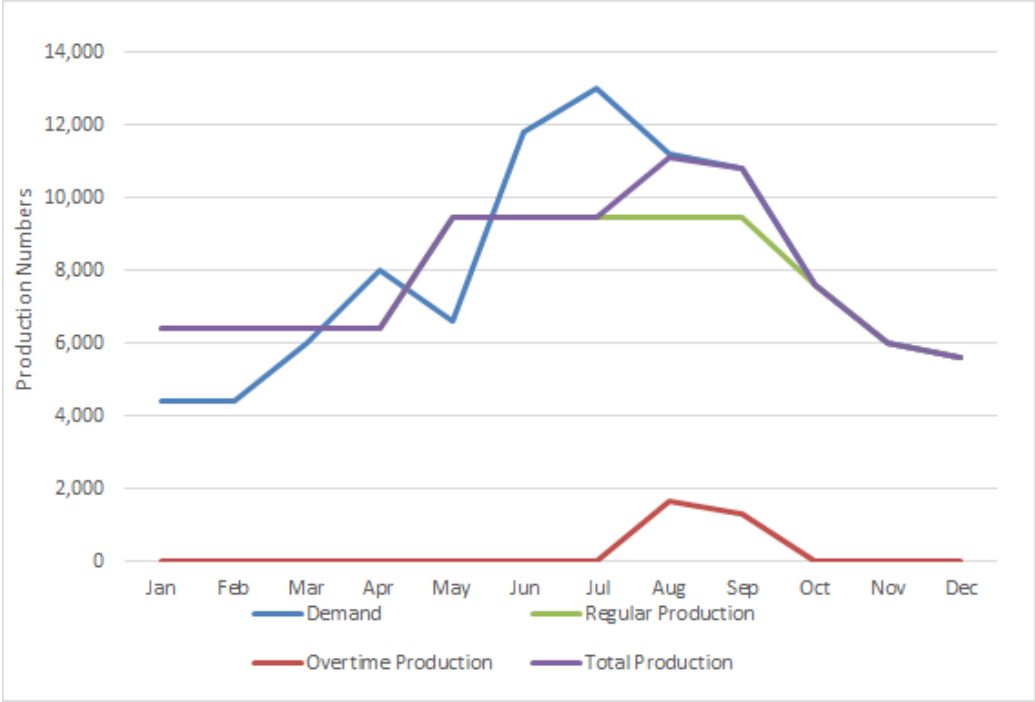
Appendix C: Cumulative Demand & Production (no CDOL)



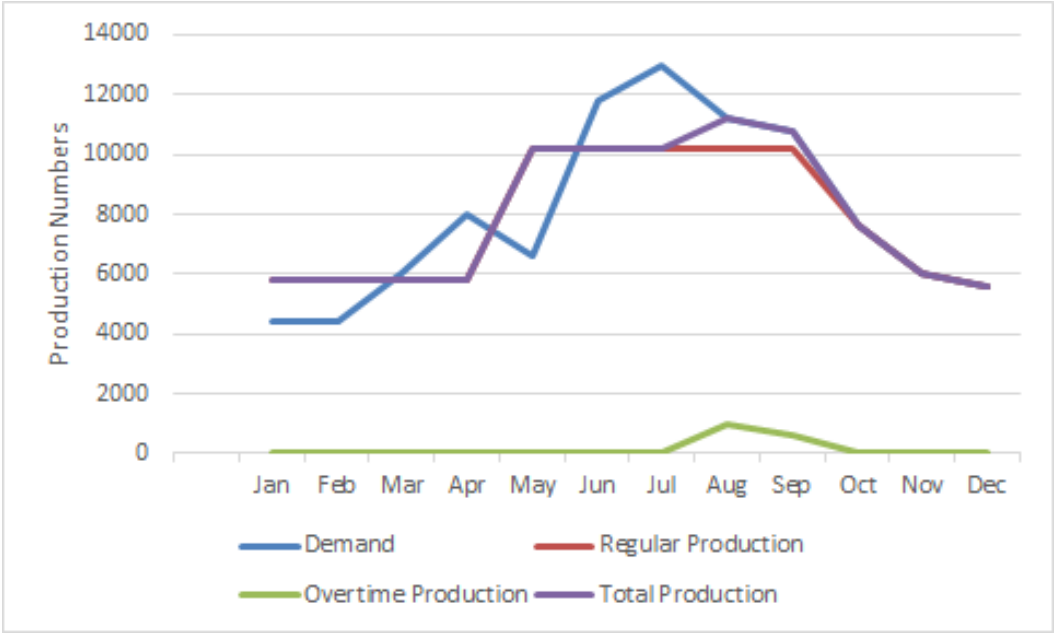
Appendix D: Cumulative Demand & Production (with CDOL)



Appendix E: Production Levels (Optimization Model no CDOL)



Appendix F: Production Levels (Optimization Model with CDOL)



Appendix G: Make to Order with CDOL Overtime Limits

Production													
		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Demand		4,400	4,400	6,000	8,000	6,600	11,800	13,000	11,200	10,800	7,600	6,000	5,600
Regular Production		4,160	4,400	6,000	7,280	6,600	11,800	11,840	11,200	10,800	7,600	6,000	5,600
Overtime Production		0	0	0	720	0	0	1,160	0	0	0	0	0
Production In the month		4,160	4,400	6,000	8,000	6,600	11,800	13,000	11,200	10,800	7,600	6,000	5,600
Cum. Demand		4,400	8,800	14,800	22,800	29,400	41,200	54,200	65,400	76,200	83,800	89,800	95,400
Cum. Production		4,160	8,560	14,560	22,560	29,160	40,960	53,960	65,160	75,960	83,560	89,560	95,160
Inventory	240	0	0	0	0	0	0	0	0	0	0	0	0

Labor													
		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
#Workers	160	104	110	150	182	165	295	296	280	270	190	150	140
Hirings		0	6	40	32	0	130	1	0	0	0	0	0
Layoffs		56	0	0	0	17	0	0	16	10	80	40	10
Overtime		0	0	0	18	0	0	29	0	0	0	0	0
CDOL Limit	10%	10	11	15	18	17	30	30	28	27	19	15	14

Accounting														
		30	*60*	*90*	*120*	*150*	*180*	*210*	*240*	*270*	*300*	*330*	*360*	Total
Hiring Cost		0	10,800	72,000	57,600	0	234,000	1,800	0	0	0	0	0	$376,200
Layoff Costs		67,200	0	0	0	20,400	0	0	19,200	12,000	96,000	48,000	12,000	$274,800
Inventory holding costs		0	0	0	0	0	0	0	0	0	0	0	0	$0
Labour -Regular		249,600	264,000	360,000	436,800	396,000	708,000	710,400	672,000	648,000	456,000	360,000	336,000	$5,596,800
Labour -Overtime		0	0	0	59,400	0	0	95,700	0	0	0	0	0	$155,100
													Total Cost	$6,402,900

Appendix H: End Of Horizon Effect

Production

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Demand		4,400	4,400	6,000	8,000	6,600	11,800	13,000	11,200	10,800	7,600	6,000	5,600
Regular Production		5,880	5,880	5,880	5,880	10,160	10,160	10,160	10,160	10,160	7,600	6,000	5,920
Overtime Production		0	0	0	0	0	0	0	1,000	640	0	0	0
Total Production		5,880	5,880	5,880	5,880	10,160	10,160	10,160	11,160	10,800	7,600	6,000	5,920
Cum. Demand		4,400	8,800	14,800	22,800	29,400	41,200	54,200	65,400	76,200	83,800	89,800	95,400
Cum. Production		5,880	11,760	17,640	23,520	33,680	43,840	54,000	65,160	75,960	83,560	89,560	95,480
Inventory	240	1,720	3,200	3,080	960	4,520	2,880	40	0	0	0	0	320

Labor

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
#Workers	160	147	147	147	147	254	254	254	254	254	190	150	148
Hirings		0	0	0	0	107	0	0	0	0	0	0	0
Layoffs		13	0	0	0	0	0	0	0	0	64	40	2
Overtime		0	0	0	0	0	0	0	25	16	0	0	0
CDOL Limits	10%	15	15	15	15	25	25	25	25	25	19	15	15

Accounting

		30	60	90	120	150	180	210	240	270	300	330	360	Total
Hiring Cost		0	0	0	0	192,600	0	0	0	0	0	0	0	$192,600
Layoff Costs		15,600	0	0	0	0	0	0	0	0	76,800	48,000	2,400	$142,800
Inventory holding costs		13,760	25,600	24,640	7,680	36,160	23,040	320	0	0	0	0	2,560	$133,760
Labour -Regular		352,800	352,800	352,800	352,800	609,600	609,600	609,600	609,600	609,600	456,000	360,000	355,200	$5,630,400
Labour -Overtime		0	0	0	0	0	0	0	82,500	52,800	0	0	0	$135,300
													Total Cost	$ 6,234,860.00