

Production Planning Case Study

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Constraint Based Production Scheduling

Acknowledgments

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Key Points

- Case study from industry
- Production planning and detailed scheduling
- Based on project with medical devices company in Cork
 - Real problem
 - Realistic data
- Solved in two stages
 - Production planning based on run-out days and safety stock levels
 - Scheduling using our generic scheduling tool

Problem

This is a case study from industry, combining production planning and detailed scheduling. It is based on a project that some of my colleagues were working on for a local medical devices company. The overall problem is to decide which products to make in which quantities over the planning horizon, so that we have enough stock to satisfy any customer demand, and make sure that we have some safety margin if the demand suddenly increases. At the same time we do not want to create inventory in products that we will not sell in the near future, as this increases our inventory carrying cost.

The company uses two main concepts for production planning: The run-out days for each product state how long the current stock will last, given a projected customer demand profile. We try to achieve the same run-out days value for all products, this works well for fast and slow moving products.

The safety stock values says how much stock we should have for each product. This gives us more control over the stock levels, this works better if the demand cannot be predicted as accurately as we would like, but it is more difficult to compare the stock levels for different products.

The production planning part of the application decides how much to produce for which product, but this is based on an estimate of the production capacity for the planning period. We use the detailed scheduling part of the application to validate the plan generated, and make sure that we can really produce the required capacities in the given planning period.

Product List

| Name | ShortName | Nr | DailySales | InventoryAtStart | CalcDaysCover | LotSize | CycleTime | LotDuration | Machine | ProductType | SafetyStock | SafetyAlert |
|------|-----------|----|------------|------------------|---------------|---------|-----------|-------------|-------------------|-------------|-------------|-------------|
| P1 | P1 | 1 | 3.20 | 877 | 274.06 | 163 | 1.33 | 217 | 8 | pt1 | 66 | 253.44 |
| P2 | P2 | 2 | 11.40 | 1,011 | 88.68 | 240 | 1.20 | 288 | 8 | pt2 | 774 | 20.79 |
| P3 | P3 | 3 | 796.20 | 26,204 | 32.91 | 420 | 2.10 | 882 | 5,7,9,10,13,14,16 | pt3 | 12,108 | 17.70 |
| P4 | P4 | 4 | 233.80 | 7,877 | 33.69 | 420 | 2.00 | 840 | 5,7,9,10,13,14,16 | pt4 | 3,358 | 19.33 |
| P5 | P5 | 5 | 267.30 | 7,152 | 26.76 | 350 | 2.30 | 805 | 5,7,9,10,13,14,16 | pt5 | 3,906 | 12.14 |
| P6 | P6 | 6 | 606.20 | 18,654 | 30.77 | 350 | 2.30 | 805 | 5,7,9,10,13,14,16 | pt6 | 9,293 | 15.44 |
| P7 | P7 | 7 | 137.30 | 4,939 | 35.97 | 420 | 2.00 | 840 | 5,7,9,10,13,14,16 | pt7 | 1,979 | 21.56 |
| P8 | P8 | 8 | 88.30 | 3,152 | 35.70 | 350 | 2.30 | 805 | 5,7,9,10,13,14,16 | pt8 | 1,342 | 20.50 |
| P9 | P9 | 9 | 77.20 | 2,688 | 34.82 | 420 | 2.10 | 882 | 5,7,9,10,13,14,16 | pt9 | 1,082 | 20.80 |
| P10 | P10 | 10 | 165.60 | 5,971 | 36.06 | 420 | 2.10 | 882 | 5,7,9,10,13,14,16 | pt10 | 2,649 | 20.06 |
| P11 | P11 | 11 | 60.70 | 2,310 | 38.06 | 420 | 2.10 | 882 | 5,7,9,10,13,14,16 | pt11 | 877 | 23.61 |
| P12 | P12 | 12 | 51.80 | 1,928 | 37.22 | 350 | 2.30 | 805 | 5,7,9,10,13,14,16 | pt12 | 883 | 20.17 |
| P13 | P13 | 13 | 79.00 | 2,231 | 28.24 | 320 | 2.30 | 736 | 5,7,9,10,13,14,16 | pt13 | 1,193 | 13.14 |
| P14 | P14 | 14 | 271.20 | 8,951 | 33.01 | 432 | 2.10 | 908 | 5,7,9,10,13,14,16 | pt14 | 3,732 | 19.24 |
| P15 | P15 | 15 | 86.60 | 3,244 | 37.46 | 336 | 2.00 | 672 | 5,7,9,10,13,14,16 | pt15 | 1,454 | 20.67 |
| P16 | P16 | 16 | 42.40 | 2,110 | 49.76 | 420 | 2.10 | 882 | 5,7,9,10,13,14,16 | pt16 | 875 | 29.13 |
| P17 | P17 | 17 | 17.60 | 681 | 38.69 | 420 | 2.00 | 840 | 5,7,9,10,13,14,16 | pt17 | 290 | 22.22 |
| P18 | P18 | 18 | 217.50 | 5,710 | 26.25 | 336 | 2.00 | 672 | 5,7,9,10,13,14,16 | pt18 | 2,814 | 13.31 |
| P19 | P19 | 19 | 56.30 | 2,450 | 43.52 | 420 | 2.00 | 840 | 5,7,9,10,13,14,16 | pt19 | 804 | 29.24 |
| P20 | P20 | 20 | 13.60 | 506 | 37.21 | 480 | 2.00 | 960 | 5,7,9,10,13,14,16 | pt20 | 272 | 17.21 |
| P21 | P21 | 21 | 10.80 | 977 | 90.46 | 360 | 2.10 | 756 | 5,7,9,10,13,14,16 | pt21 | 293 | 63.33 |
| P22 | P22 | 22 | 21.80 | 1,538 | 70.55 | 420 | 2.00 | 840 | 5,7,9,10,13,14,16 | pt22 | 349 | 54.54 |
| P23 | P23 | 23 | 189.10 | 5,195 | 27.47 | 360 | 2.30 | 828 | 5,7,9,10,13,14,16 | pt23 | 2,941 | 11.92 |
| P24 | P24 | 24 | 9.50 | 886 | 93.26 | 350 | 2.30 | 805 | 5,7,9,10,13,14,16 | pt24 | 191 | 73.16 |
| P25 | P25 | 25 | 7.50 | 326 | 43.47 | 120 | 2.30 | 276 | 5,7,9,10,13,14,16 | pt25 | 210 | 15.47 |
| P26 | P26 | 26 | 11.60 | 418 | 36.03 | 360 | 2.10 | 756 | 5,7,9,10,13,14,16 | pt26 | 187 | 19.91 |
| P27 | P27 | 27 | 16.50 | 1,388 | 84.12 | 480 | 2.10 | 1,008 | 5,7,9,10,13,14,16 | pt27 | 218 | 70.91 |

Product List (Sorted by Daily Sales)

| Product X | | | | | | | | | | | | | | |
|-----------|-----------|-----|-------------|------------------|---------------|---------|-----------|-------------|-------------------|-------------|-------------|-------------|--|--|
| Name | ShortName | Nr | DailySales▼ | InventoryAtStart | CalcDaysCover | LotSize | CycleTime | LotDuration | Machine | ProductType | SafetyStock | SafetyAlert | | |
| P3 | P3 | 3 | 796.20 | 26,204 | 32.91 | 420 | 2.10 | 882 | 5,7,9,10,13,14,16 | pt3 | 12,108 | 17.70 | | |
| P6 | P6 | 6 | 606.20 | 18,654 | 30.77 | 350 | 2.30 | 805 | 5,7,9,10,13,14,16 | pt6 | 9,293 | 15.44 | | |
| P14 | P14 | 14 | 271.20 | 8,951 | 33.01 | 432 | 2.10 | 908 | 5,7,9,10,13,14,16 | pt14 | 3,732 | 19.24 | | |
| P53 | P53 | 53 | 267.70 | 8,264 | 30.87 | 504 | 1.20 | 605 | 1,2,3,8 | pt2 | 3,734 | 16.92 | | |
| P5 | P5 | 5 | 267.30 | 7,152 | 26.76 | 350 | 2.30 | 805 | 5,7,9,10,13,14,16 | pt5 | 3,906 | 12.14 | | |
| P124 | P124 | 124 | 242.70 | 16,503 | 68.00 | 240 | 5.00 | 1,200 | 15,18,19 | pt65 | 3,595 | 53.19 | | |
| P4 | P4 | 4 | 233.80 | 7,877 | 33.69 | 420 | 2.00 | 840 | 5,7,9,10,13,14,16 | pt4 | 3,358 | 19.33 | | |
| P123 | P123 | 123 | 223.40 | 7,600 | 34.02 | 490 | 2.33 | 1,142 | 1,2,3,8 | pt51 | 3,738 | 17.29 | | |
| P18 | P18 | 18 | 217.50 | 5,710 | 26.25 | 336 | 2.00 | 672 | 5,7,9,10,13,14,16 | pt18 | 2,814 | 13.31 | | |
| P23 | P23 | 23 | 189.10 | 5,195 | 27.47 | 360 | 2.30 | 828 | 5,7,9,10,13,14,16 | pt23 | 2,941 | 11.92 | | |
| P56 | P56 | 56 | 168.20 | 4,824 | 28.68 | 504 | 1.20 | 605 | 1,2,3,8 | pt2 | 2,660 | 12.87 | | |
| P10 | P10 | 10 | 165.60 | 5,971 | 36.06 | 420 | 2.10 | 882 | 5,7,9,10,13,14,16 | pt10 | 2,649 | 20.06 | | |
| P59 | P59 | 59 | 152.80 | 5,666 | 37.08 | 420 | 1.33 | 559 | 1,2,3,8 | pt51 | 3,095 | 16.83 | | |
| P7 | P7 | 7 | 137.30 | 4,939 | 35.97 | 420 | 2.00 | 840 | 5,7,9,10,13,14,16 | pt7 | 1,979 | 21.56 | | |
| P57 | P57 | 57 | 134.80 | 5,358 | 39.75 | 588 | 1.10 | 647 | 1,2,3,8 | pt53 | 2,294 | 22.73 | | |
| P36 | P36 | 36 | 133.50 | 3,895 | 29.18 | 336 | 2.00 | 672 | 5,7,9,10,13,14,16 | pt36 | 2,057 | 13.77 | | |
| P54 | P54 | 54 | 122.40 | 5,059 | 41.33 | 480 | 1.33 | 639 | 1,2,3,8 | pt51 | 1,965 | 25.28 | | |
| P121 | P121 | 121 | 98.10 | 4,334 | 44.18 | 588 | 1.10 | 647 | 1,2,3,8 | pt53 | 1,524 | 28.64 | | |
| P8 | P8 | 8 | 88.30 | 3,152 | 35.70 | 350 | 2.30 | 805 | 5,7,9,10,13,14,16 | pt8 | 1,342 | 20.50 | | |
| P125 | P125 | 125 | 86.90 | 8,593 | 98.88 | 240 | 5.00 | 1,200 | 15,18,19 | pt65 | 1,022 | 87.12 | | |
| P15 | P15 | 15 | 86.60 | 3,244 | 37.46 | 336 | 2.00 | 672 | 5,7,9,10,13,14,16 | pt15 | 1,454 | 20.67 | | |
| P100 | P100 | 100 | 85.20 | 2,665 | 31.28 | 420 | 1.33 | 559 | 1,2,3,8 | pt56 | 1,115 | 18.19 | | |
| P55 | P55 | 55 | 79.50 | 2,876 | 36.18 | 441 | 2.33 | 1,028 | 1,2,3,8 | pt52 | 1,367 | 18.98 | | |
| P13 | P13 | 13 | 79.00 | 2,231 | 28.24 | 320 | 2.30 | 736 | 5,7,9,10,13,14,16 | pt13 | 1,193 | 13.14 | | |
| P9 | P9 | 9 | 77.20 | 2,688 | 34.82 | 420 | 2.10 | 882 | 5,7,9,10,13,14,16 | pt9 | 1,082 | 20.80 | | |
| P47 | P47 | 47 | 74.60 | 5,391 | 72.27 | 160 | 6.84 | 1,095 | 2,11 | pt47 | 1,132 | 57.09 | | |
| P11 | P11 | 11 | 60.70 | 2,310 | 38.06 | 420 | 2.10 | 882 | 5,7,9,10,13,14,16 | pt11 | 877 | 23.61 | | |
| P61 | P61 | 61 | 60.30 | 2,758 | 45.74 | 490 | 1.33 | 652 | 1,2,3,8 | pt56 | 1,073 | 27.94 | | |
| P78 | P78 | 78 | 57.60 | 2,234 | 38.78 | 588 | 1.10 | 647 | 1,2,3,8 | pt59 | 824 | 24.48 | | |
| P19 | P19 | 19 | 56.30 | 2,450 | 43.52 | 420 | 2.00 | 840 | 5,7,9,10,13,14,16 | pt19 | 804 | 29.24 | | |

Product List (Sorted by Days Cover)

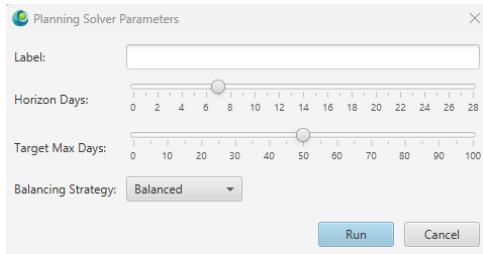
| Product X | | | | | | | | | | | | | | |
|-----------|-----------|-----|------------|------------------|---------------|---------|-----------|-------------|-------------------|-------------|-------------|-------------|--|--|
| Name | ShortName | Nr | DailySales | InventoryAtStart | CalcDaysCover | LotSize | CycleTime | LotDuration | Machine | ProductType | SafetyStock | SafetyAlert | | |
| P35 | P35 | 35 | 1.30 | 26 | 20.00 | 120 | 2.30 | 276 | 5,7,9,10,13,14,16 | pt35 | 33 | 0.00 | | |
| P18 | P18 | 18 | 217.50 | 5,710 | 26.25 | 336 | 2.00 | 672 | 5,7,9,10,13,14,16 | pt18 | 2,814 | 13.31 | | |
| P5 | P5 | 5 | 267.30 | 7,152 | 26.76 | 350 | 2.30 | 805 | 5,7,9,10,13,14,16 | pt5 | 3,906 | 12.14 | | |
| P23 | P23 | 23 | 189.10 | 5,195 | 27.47 | 360 | 2.30 | 828 | 5,7,9,10,13,14,16 | pt23 | 2,941 | 11.92 | | |
| P13 | P13 | 13 | 79.00 | 2,231 | 28.24 | 320 | 2.30 | 736 | 5,7,9,10,13,14,16 | pt13 | 1,193 | 13.14 | | |
| P56 | P56 | 56 | 168.20 | 4,824 | 28.68 | 504 | 1.20 | 605 | 1,2,3,8 | pt2 | 2,660 | 12.87 | | |
| P58 | P58 | 58 | 55.00 | 1,590 | 28.91 | 420 | 2.33 | 979 | 1,2,3,8 | pt54 | 1,208 | 6.95 | | |
| P36 | P36 | 36 | 133.50 | 3,895 | 29.18 | 336 | 2.00 | 672 | 5,7,9,10,13,14,16 | pt36 | 2,057 | 13.77 | | |
| P6 | P6 | 6 | 606.20 | 18,654 | 30.77 | 350 | 2.30 | 805 | 5,7,9,10,13,14,16 | pt6 | 9,293 | 15.44 | | |
| P53 | P53 | 53 | 267.70 | 8,264 | 30.87 | 504 | 1.20 | 605 | 1,2,3,8 | pt2 | 3,734 | 16.92 | | |
| P100 | P100 | 100 | 85.20 | 2,665 | 31.28 | 420 | 1.33 | 559 | 1,2,3,8 | pt56 | 1,115 | 18.19 | | |
| P122 | P122 | 122 | 45.40 | 1,421 | 31.30 | 490 | 1.33 | 652 | 1,2,3,8 | pt56 | 725 | 15.33 | | |
| P3 | P3 | 3 | 796.20 | 26,204 | 32.91 | 420 | 2.10 | 882 | 5,7,9,10,13,14,16 | pt3 | 12,108 | 17.70 | | |
| P14 | P14 | 14 | 271.20 | 8,951 | 33.01 | 432 | 2.10 | 908 | 5,7,9,10,13,14,16 | pt14 | 3,732 | 19.24 | | |
| P4 | P4 | 4 | 233.80 | 7,877 | 33.69 | 420 | 2.00 | 840 | 5,7,9,10,13,14,16 | pt4 | 3,358 | 19.33 | | |
| P123 | P123 | 123 | 223.40 | 7,600 | 34.02 | 490 | 2.33 | 1,142 | 1,2,3,8 | pt51 | 3,738 | 17.29 | | |
| P77 | P77 | 77 | 33.00 | 1,146 | 34.73 | 336 | 1.20 | 404 | 1,2,3,8 | pt61 | 565 | 17.61 | | |
| P9 | P9 | 9 | 77.20 | 2,688 | 34.82 | 420 | 2.10 | 882 | 5,7,9,10,13,14,16 | pt9 | 1,082 | 20.80 | | |
| P8 | P8 | 8 | 88.30 | 3,152 | 35.70 | 350 | 2.30 | 805 | 5,7,9,10,13,14,16 | pt8 | 1,342 | 20.50 | | |
| P7 | P7 | 7 | 137.30 | 4,939 | 35.97 | 420 | 2.00 | 840 | 5,7,9,10,13,14,16 | pt7 | 1,979 | 21.56 | | |
| P26 | P26 | 26 | 11.60 | 418 | 36.03 | 360 | 2.10 | 756 | 5,7,9,10,13,14,16 | pt26 | 187 | 19.91 | | |
| P10 | P10 | 10 | 165.60 | 5,971 | 36.06 | 420 | 2.10 | 882 | 5,7,9,10,13,14,16 | pt10 | 2,649 | 20.06 | | |
| P55 | P55 | 55 | 79.50 | 2,876 | 36.18 | 441 | 2.33 | 1,028 | 1,2,3,8 | pt52 | 1,367 | 18.98 | | |
| P63 | P63 | 63 | 42.40 | 1,565 | 36.91 | 490 | 1.33 | 652 | 1,2,3,8 | pt51 | 689 | 20.66 | | |
| P59 | P59 | 59 | 152.80 | 5,666 | 37.08 | 420 | 1.33 | 559 | 1,2,3,8 | pt51 | 3,095 | 16.83 | | |
| P20 | P20 | 20 | 13.60 | 506 | 37.21 | 480 | 2.00 | 960 | 5,7,9,10,13,14,16 | pt20 | 272 | 17.21 | | |
| P12 | P12 | 12 | 51.80 | 1,928 | 37.22 | 350 | 2.30 | 805 | 5,7,9,10,13,14,16 | pt12 | 883 | 20.17 | | |
| P44 | P44 | 44 | 5.50 | 205 | 37.27 | 360 | 2.10 | 756 | 5,7,9,10,13,14,16 | pt44 | 126 | 14.36 | | |
| P15 | P15 | 15 | 86.60 | 3,244 | 37.46 | 336 | 2.00 | 672 | 5,7,9,10,13,14,16 | pt15 | 1,454 | 20.67 | | |

Product List (Sorted by Safety Alert)

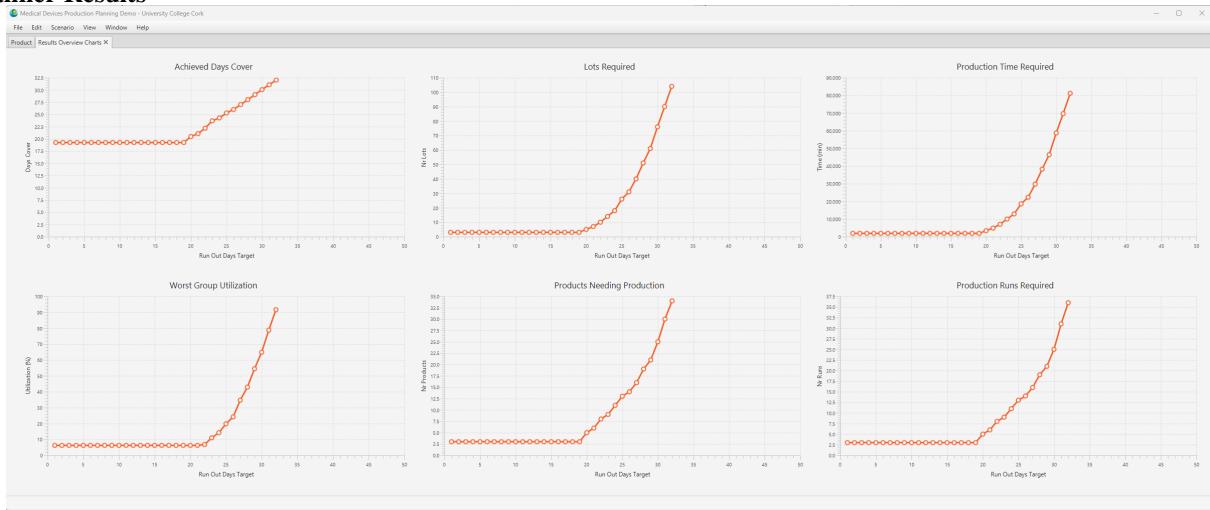
| Product X | | | | | | | | | | | | | | | | |
|-----------|-----------|-----|------------|------------------|---------------|---------|-----------|-------------|-------------------|-------------|-------------|--------------|--|--|--|--|
| Name | ShortName | Nr | DailySales | InventoryAtStart | CalcDaysCover | LotSize | CycleTime | LotDuration | Machine | ProductType | SafetyStock | SafetyAl...▲ | | | | |
| P35 | P35 | 35 | 1.30 | 26 | 20.00 | 120 | 2.30 | 276 | 5,7,9,10,13,14,16 | pt35 | 33 | 0.00 | | | | |
| P51 | P51 | 51 | 5.70 | 405 | 71.05 | 140 | 4.50 | 630 | 2 | pt50 | 381 | 4.21 | | | | |
| P58 | P58 | 58 | 55.00 | 1,590 | 28.91 | 420 | 2.33 | 979 | 1,2,3,8 | pt54 | 1,208 | 6.95 | | | | |
| P82 | P82 | 82 | 6.10 | 259 | 42.46 | 441 | 1.33 | 587 | 1,2,3,8 | pt51 | 189 | 11.48 | | | | |
| P23 | P23 | 23 | 189.10 | 5,195 | 27.47 | 360 | 2.30 | 828 | 5,7,9,10,13,14,16 | pt23 | 2,941 | 11.92 | | | | |
| P5 | P5 | 5 | 267.30 | 7,152 | 26.76 | 350 | 2.30 | 805 | 5,7,9,10,13,14,16 | pt5 | 3,906 | 12.14 | | | | |
| P56 | P56 | 56 | 168.20 | 4,824 | 28.68 | 504 | 1.20 | 605 | 1,2,3,8 | pt2 | 2,660 | 12.87 | | | | |
| P13 | P13 | 13 | 79.00 | 2,231 | 28.24 | 320 | 2.30 | 736 | 5,7,9,10,13,14,16 | pt13 | 1,193 | 13.14 | | | | |
| P18 | P18 | 18 | 217.50 | 5,710 | 26.25 | 336 | 2.00 | 672 | 5,7,9,10,13,14,16 | pt18 | 2,814 | 13.31 | | | | |
| P36 | P36 | 36 | 133.50 | 3,895 | 29.18 | 336 | 2.00 | 672 | 5,7,9,10,13,14,16 | pt36 | 2,057 | 13.77 | | | | |
| P44 | P44 | 44 | 5.50 | 205 | 37.27 | 360 | 2.10 | 756 | 5,7,9,10,13,14,16 | pt44 | 126 | 14.36 | | | | |
| P122 | P122 | 122 | 45.40 | 1,421 | 31.30 | 490 | 1.33 | 652 | 1,2,3,8 | pt56 | 725 | 15.33 | | | | |
| P6 | P6 | 6 | 606.20 | 18,654 | 30.77 | 350 | 2.30 | 805 | 5,7,9,10,13,14,16 | pt6 | 9,293 | 15.44 | | | | |
| P25 | P25 | 25 | 7.50 | 326 | 43.47 | 120 | 2.30 | 276 | 5,7,9,10,13,14,16 | pt25 | 210 | 15.47 | | | | |
| P59 | P59 | 59 | 152.80 | 5,666 | 37.08 | 420 | 1.33 | 559 | 1,2,3,8 | pt51 | 3,095 | 16.83 | | | | |
| P53 | P53 | 53 | 267.70 | 8,264 | 30.87 | 504 | 1.20 | 605 | 1,2,3,8 | pt2 | 3,734 | 16.92 | | | | |
| P112 | P112 | 112 | 3.40 | 134 | 39.41 | 588 | 1.20 | 706 | 1,2,3,8 | pt2 | 76 | 17.06 | | | | |
| P20 | P20 | 20 | 13.60 | 506 | 37.21 | 480 | 2.00 | 960 | 5,7,9,10,13,14,16 | pt20 | 272 | 17.21 | | | | |
| P32 | P32 | 32 | 5.40 | 222 | 41.11 | 480 | 2.00 | 960 | 5,7,9,10,13,14,16 | pt32 | 129 | 17.22 | | | | |
| P123 | P123 | 123 | 223.40 | 7,600 | 34.02 | 490 | 2.33 | 1,142 | 1,2,3,8 | pt51 | 3,738 | 17.29 | | | | |
| P99 | P99 | 99 | 5.70 | 247 | 43.33 | 96 | 2.00 | 192 | 1,2,3,8 | pt60 | 148 | 17.37 | | | | |
| P77 | P77 | 77 | 33.00 | 1,146 | 34.73 | 336 | 1.20 | 404 | 1,2,3,8 | pt61 | 565 | 17.61 | | | | |
| P3 | P3 | 3 | 796.20 | 26,204 | 32.91 | 420 | 2.10 | 882 | 5,7,9,10,13,14,16 | pt3 | 12,108 | 17.70 | | | | |
| P100 | P100 | 100 | 85.20 | 2,665 | 31.28 | 420 | 1.33 | 559 | 1,2,3,8 | pt56 | 1,115 | 18.19 | | | | |
| P55 | P55 | 55 | 79.50 | 2,876 | 36.18 | 441 | 2.33 | 1,028 | 1,2,3,8 | pt52 | 1,367 | 18.98 | | | | |
| P14 | P14 | 14 | 271.20 | 8,951 | 33.01 | 432 | 2.10 | 908 | 5,7,9,10,13,14,16 | pt14 | 3,732 | 19.24 | | | | |
| P80 | P80 | 80 | 7.20 | 293 | 40.69 | 420 | 1.33 | 559 | 1,2,3,8 | pt51 | 154 | 19.31 | | | | |
| P4 | P4 | 4 | 233.80 | 7,877 | 33.69 | 420 | 2.00 | 840 | 5,7,9,10,13,14,16 | pt4 | 3,358 | 19.33 | | | | |
| P49 | P49 | 49 | 50.90 | 2,273 | 44.66 | 378 | 1.00 | 378 | 2 | pt48 | 1,260 | 19.90 | | | | |

Setup Matrix

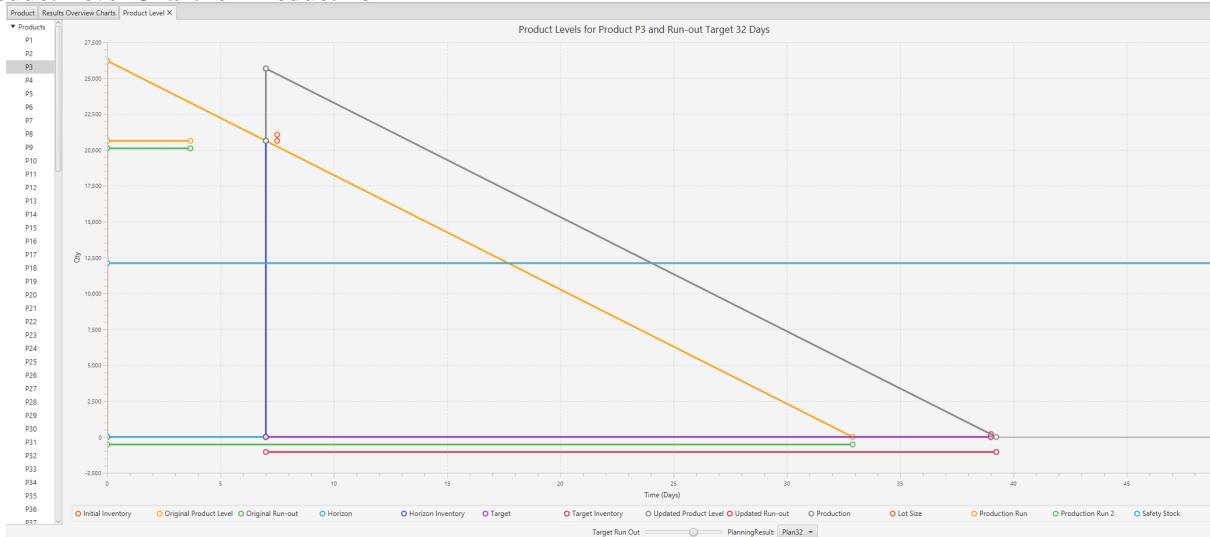
| Row | | Setup Matrix X | p1t1 | p1t2 | p1t3 | p1t4 | p1t5 | p1t6 | p1t7 | p1t8 | p1t9 | p1t10 | p1t11 | p1t12 | p1t13 | p1t14 | p1t15 | p1t16 | p1t17 | p1t18 | p1t19 | p1t20 | p1t21 | p1t22 | p1t23 | p1t24 | p1t25 | p1t26 | p1t27 | p1t28 | p1t29 | p1t30 | p1t31 | p1t32 | p1t33 | p1t34 | p1t35 | p1t36 | p1t37 | p1t38 | p1t39 | p1t40 | p1t41 | p1t42 | p1t43 | p1t44 | p1t45 | p1t46 | p1t47 | p1t48 | p1t49 | p1t50 | p1t51 | p1t52 | p1t53 | p1t54 | p1t55 | p1t56 | p1t57 | p1t58 | p1t59 | p1t60 | p1t61 | p1t62 | p1t63 | p1t64 | p1t65 | p1t66 | p1t67 | p1t68 | p1t69 | p1t70 | p1t71 | p1t72 | p1t73 | p1t74 | p1t75 | p1t76 | p1t77 | p1t78 | p1t79 | p1t80 | p1t81 | p1t82 | p1t83 | p1t84 | p1t85 | p1t86 | p1t87 | p1t88 | p1t89 | p1t90 | p1t91 | p1t92 | p1t93 | p1t94 | p1t95 | p1t96 | p1t97 | p1t98 | p1t99 | p1t100 | p1t101 | p1t102 | p1t103 | p1t104 | p1t105 | p1t106 | p1t107 | p1t108 | p1t109 | p1t110 | p1t111 | p1t112 | p1t113 | p1t114 | p1t115 | p1t116 | p1t117 | p1t118 | p1t119 | p1t120 | p1t121 | p1t122 | p1t123 | p1t124 | p1t125 | p1t126 | p1t127 | p1t128 | p1t129 | p1t130 | p1t131 | p1t132 | p1t133 | p1t134 | p1t135 | p1t136 | p1t137 | p1t138 | p1t139 | p1t140 | p1t141 | p1t142 | p1t143 | p1t144 | p1t145 | p1t146 | p1t147 | p1t148 | p1t149 | p1t150 | p1t151 | p1t152 | p1t153 | p1t154 | p1t155 | p1t156 | p1t157 | p1t158 | p1t159 | p1t160 | p1t161 | p1t162 | p1t163 | p1t164 | p1t165 | p1t166 | p1t167 | p1t168 | p1t169 | p1t170 | p1t171 | p1t172 | p1t173 | p1t174 | p1t175 | p1t176 | p1t177 | p1t178 | p1t179 | p1t180 | p1t181 | p1t182 | p1t183 | p1t184 | p1t185 | p1t186 | p1t187 | p1t188 | p1t189 | p1t190 | p1t191 | p1t192 | p1t193 | p1t194 | p1t195 | p1t196 | p1t197 | p1t198 | p1t199 | p1t200 | p1t201 | p1t202 | p1t203 | p1t204 | p1t205 | p1t206 | p1t207 | p1t208 | p1t209 | p1t210 | p1t211 | p1t212 | p1t213 | p1t214 | p1t215 | p1t216 | p1t217 | p1t218 | p1t219 | p1t220 | p1t221 | p1t222 | p1t223 | p1t224 | p1t225 | p1t226 | p1t227 | p1t228 | p1t229 | p1t230 | p1t231 | p1t232 | p1t233 | p1t234 | p1t235 | p1t236 | p1t237 | p1t238 | p1t239 | p1t240 | p1t241 | p1t242 | p1t243 | p1t244 | p1t245 | p1t246 | p1t247 | p1t248 | p1t249 | p1t250 | p1t251 | p1t252 | p1t253 | p1t254 | p1t255 | p1t256 | p1t257 | p1t258 | p1t259 | p1t260 | p1t261 | p1t262 | p1t263 | p1t264 | p1t265 | p1t266 | p1t267 | p1t268 | p1t269 | p1t270 | p1t271 | p1t272 | p1t273 | p1t274 | p1t275 | p1t276 | p1t277 | p1t278 | p1t279 | p1t280 | p1t281 | p1t282 | p1t283 | p1t284 | p1t285 | p1t286 | p1t287 | p1t288 | p1t289 | p1t290 | p1t291 | p1t292 | p1t293 | p1t294 | p1t295 | p1t296 | p1t297 | p1t298 | p1t299 | p1t300 | p1t301 | p1t302 | p1t303 | p1t304 | p1t305 | p1t306 | p1t307 | p1t308 | p1t309 | p1t310 | p1t311 | p1t312 | p1t313 | p1t314 | p1t315 | p1t316 | p1t317 | p1t318 | p1t319 | p1t320 | p1t321 | p1t322 | p1t323 | p1t324 | p1t325 | p1t326 | p1t327 | p1t328 | p1t329 | p1t330 | p1t331 | p1t332 | p1t333 | p1t334 | p1t335 | p1t336 | p1t337 | p1t338 | p1t339 | p1t340 | p1t341 | p1t342 | p1t343 | p1t344 | p1t345 | p1t346 | p1t347 | p1t348 | p1t349 | p1t350 | p1t351 | p1t352 | p1t353 | p1t354 | p1t355 | p1t356 | p1t357 | p1t358 | p1t359 | p1t360 | p1t361 | p1t362 | p1t363 | p1t364 | p1t365 | p1t366 | p1t367 | p1t368 | p1t369 | p1t370 | p1t371 | p1t372 | p1t373 | p1t374 | p1t375 | p1t376 | p1t377 | p1t378 | p1t379 | p1t380 | p1t381 | p1t382 | p1t383 | p1t384 | p1t385 | p1t386 | p1t387 | p1t388 | p1t389 | p1t390 | p1t391 | p1t392 | p1t393 | p1t394 | p1t395 | p1t396 | p1t397 | p1t398 | p1t399 | p1t400 | p1t401 | p1t402 | p1t403 | p1t404 | p1t405 | p1t406 | p1t407 | p1t408 | p1t409 | p1t410 | p1t411 | p1t412 | p1t413 | p1t414 | p1t415 | p1t416 | p1t417 | p1t418 | p1t419 | p1t420 | p1t421 | p1t422 | p1t423 | p1t424 | p1t425 | p1t426 | p1t427 | p1t428 | p1t429 | p1t430 | p1t431 | p1t432 | p1t433 | p1t434 | p1t435 | p1t436 | p1t437 | p1t438 | p1t439 | p1t440 | p1t441 | p1t442 | p1t443 | p1t444 | p1t445 | p1t446 | p1t447 | p1t448 | p1t449 | p1t450 | p1t451 | p1t452 | p1t453 | p1t454 | p1t455 | p1t456 | p1t457 | p1t458 | p1t459 | p1t460 | p1t461 | p1t462 | p1t463 | p1t464 | p1t465 | p1t466 | p1t467 | p1t468 | p1t469 | p1t470 | p1t471 | p1t472 | p1t473 | p1t474 | p1t475 | p1t476 | p1t477 | p1t478 | p1t479 | p1t480 | p1t481 | p1t482 | p1t483 | p1t484 | p1t485 | p1t486 | p1t487 | p1t488 | p1t489 | p1t490 | p1t491 | p1t492 | p1t493 | p1t494 | p1t495 | p1t496 | p1t497 | p1t498 | p1t499 | p1t500 | p1t501 | p1t502 | p1t503 | p1t504 | p1t505 | p1t506 | p1t507 | p1t508 | p1t509 | p1t510 | p1t511 | p1t512 | p1t513 | p1t514 | p1t515 | p1t516 | p1t517 | p1t518 | p1t519 | p1t520 | p1t521 | p1t522 | p1t523 | p1t524 | p1t525 | p1t526 | p1t527 | p1t528 | p1t529 | p1t530 | p1t531 | p1t532 | p1t533 | p1t534 | p1t535 | p1t536 | p1t537 | p1t538 | p1t539 | p1t540 | p1t541 | p1t542 | p1t543 | p1t544 | p1t545 | p1t546 | p1t547 | p1t548 | p1t549 | p1t550 | p1t551 | p1t552 | p1t553 | p1t554 | p1t555 | p1t556 | p1t557 | p1t558 | p1t559 | p1t560 | p1t561 | p1t562 | p1t563 | p1t564 | p1t565 | p1t566 | p1t567 | p1t568 | p1t569 | p1t570 | p1t571 | p1t572 | p1t573 | p1t574 | p1t575 | p1t576 | p1t577 | p1t578 | p1t579 | p1t580 | p1t581 | p1t582 | p1t583 | p1t584 | p1t585 | p1t586 | p1t587 | p1t588 | p1t589 | p1t590 | p1t591 | p1t592 | p1t593 | p1t594 | p1t595 | p1t596 | p1t597 | p1t598 | p1t599 | p1t600 | p1t601 | p1t602 | p1t603 | p1t604 | p1t605 | p1t606 | p1t607 | p1t608 | p1t609 | p1t610 | p1t611 | p1t612 | p1t613 | p1t614 | p1t615 | p1t616 | p1t617 | p1t618 | p1t619 | p1t620 | p1t621 | p1t622 | p1t623 | p1t624 | p1t625 | p1t626 | p1t627 | p1t628 | p1t629 | p1t630 | p1t631 | p1t632 | p1t633 | p1t634 | p1t635 | p1t636 | p1t637 | p1t638 | p1t639 | p1t640 | p1t641 | p1t642 | p1t643 | p1t644 | p1t645 | p1t646 | p1t647 | p1t648 | p1t649 | p1t650 | p1t651 | p1t652 | p1t653 | p1t654 | p1t65 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |



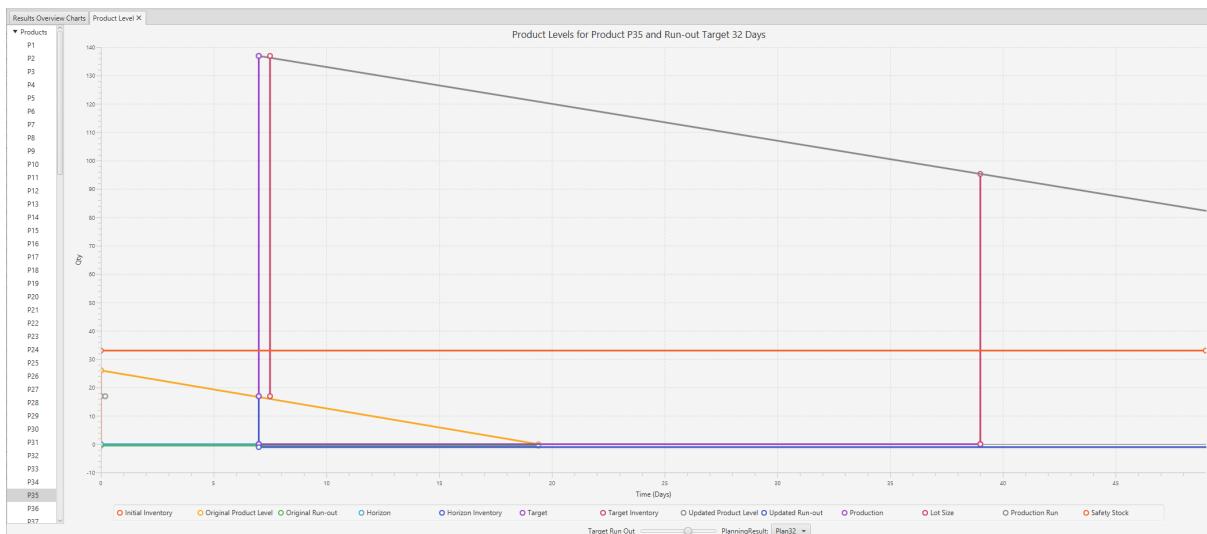
Planner Results



Product Level Chart for Product P3



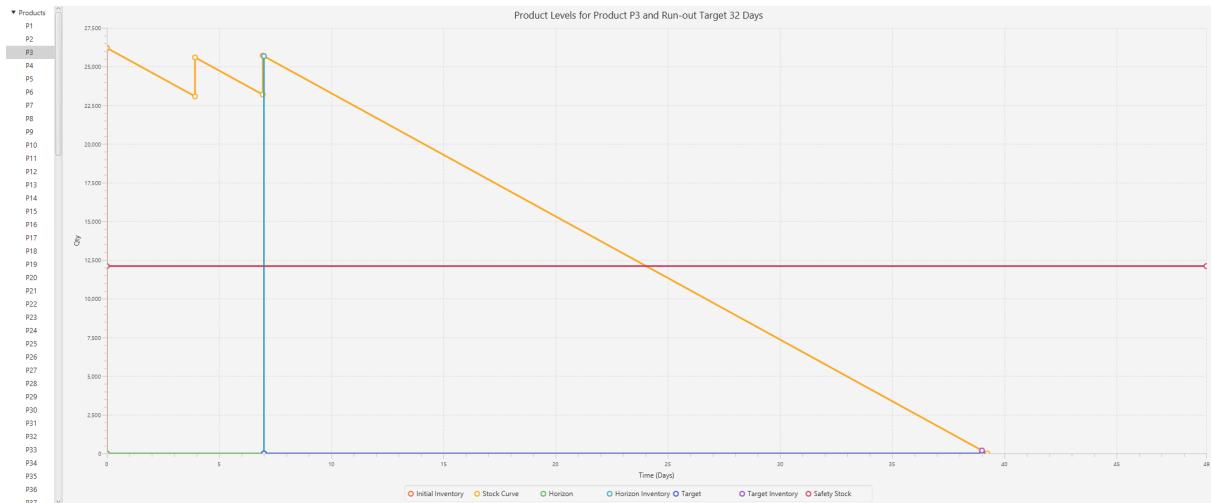
Product Level Chart for Product P35



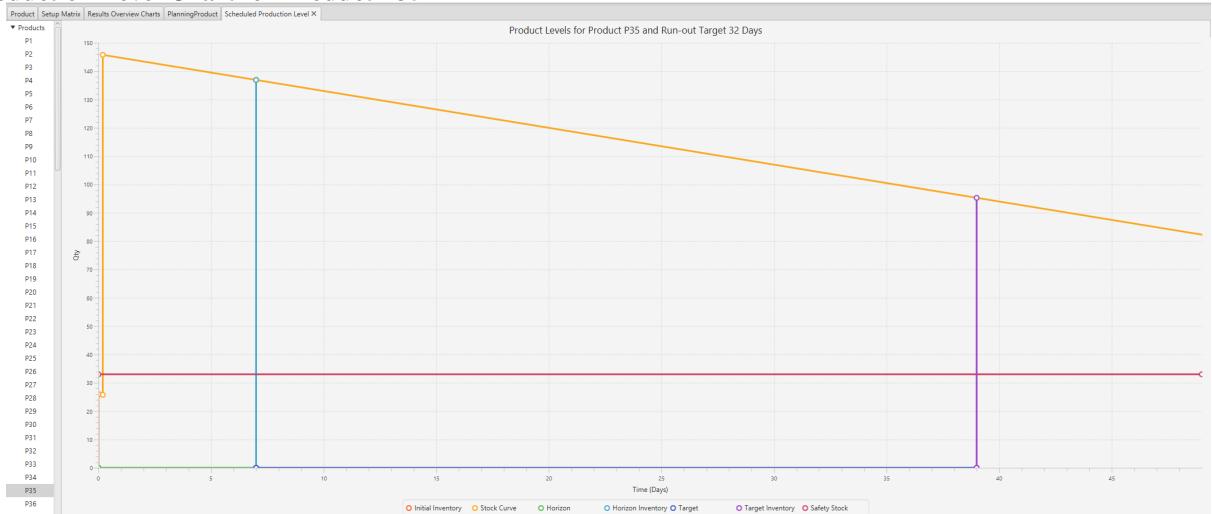
Scheduled Production Runs

| Product | Results Overview Charts | | Product Level | | Scheduled Production Level | | ProductionRun X | | |
|---------|-------------------------|--------|---------------|--------|----------------------------|--------|-----------------|----------|--------|
| Name | Product | NrLots | Qty | Due | Start | End | Duration | StartDay | EndDay |
| job3_0 | P3 | 6 | 2,520 | 10,080 | 366 | 5,658 | 5,292 | 0.25 | 3.93 |
| job3_1 | P3 | 6 | 2,520 | 10,080 | 4,712 | 10,004 | 5,292 | 3.27 | 6.95 |
| job4_0 | P4 | 3 | 1,260 | 10,080 | 0 | 2,520 | 2,520 | 0.00 | 1.75 |
| job5_0 | P5 | 10 | 3,500 | 10,080 | 1,794 | 9,844 | 8,050 | 1.25 | 6.84 |
| job6_0 | P6 | 7 | 2,450 | 10,080 | 4,224 | 9,859 | 5,635 | 2.93 | 6.85 |
| job6_1 | P6 | 8 | 2,800 | 10,080 | 0 | 6,440 | 6,440 | 0.00 | 4.47 |
| job7_0 | P7 | 1 | 420 | 10,080 | 7,442 | 8,282 | 840 | 5.17 | 5.75 |
| job8_0 | P8 | 1 | 350 | 10,080 | 816 | 1,621 | 805 | 0.57 | 1.13 |
| job9_0 | P9 | 1 | 420 | 10,080 | 3,282 | 4,164 | 882 | 2.28 | 2.89 |
| job10_0 | P10 | 2 | 840 | 10,080 | 0 | 1,764 | 1,764 | 0.00 | 1.23 |
| job11_0 | P11 | 1 | 420 | 10,080 | 6,500 | 7,382 | 882 | 4.51 | 5.13 |
| job12_0 | P12 | 1 | 350 | 10,080 | 1,651 | 2,456 | 805 | 1.15 | 1.71 |
| job13_0 | P13 | 3 | 960 | 10,080 | 0 | 2,208 | 2,208 | 0.00 | 1.53 |
| job14_0 | P14 | 4 | 1,728 | 10,080 | 0 | 3,632 | 3,632 | 0.00 | 2.52 |
| job15_0 | P15 | 1 | 336 | 10,080 | 2,580 | 3,252 | 672 | 1.79 | 2.26 |
| job17_0 | P17 | 1 | 420 | 10,080 | 5,718 | 6,558 | 840 | 3.97 | 4.55 |
| job18_0 | P18 | 9 | 3,024 | 10,080 | 3,144 | 9,192 | 6,048 | 2.18 | 6.38 |
| job20_0 | P20 | 1 | 480 | 10,080 | 3,692 | 4,652 | 960 | 2.56 | 3.23 |
| job23_0 | P23 | 7 | 2,520 | 10,080 | 2,516 | 8,312 | 5,796 | 1.75 | 5.77 |
| job26_0 | P26 | 1 | 360 | 10,080 | 0 | 756 | 756 | 0.00 | 0.53 |
| job35_0 | P35 | 1 | 120 | 0 | 0 | 276 | 276 | 0.00 | 0.19 |
| job36_0 | P36 | 4 | 1,344 | 10,080 | 6,618 | 9,306 | 2,688 | 4.60 | 6.46 |
| job44_0 | P44 | 1 | 360 | 10,080 | 2,298 | 3,054 | 756 | 1.60 | 2.12 |
| job46_0 | P46 | 1 | 350 | 10,080 | 8,372 | 9,177 | 805 | 5.81 | 6.37 |
| job51_0 | P51 | 1 | 140 | 6,064 | 0 | 630 | 630 | 0.00 | 0.44 |
| job53_0 | P53 | 5 | 2,520 | 10,080 | 707 | 3,732 | 3,025 | 0.49 | 2.59 |
| job55_0 | P55 | 1 | 441 | 10,080 | 2,580 | 3,608 | 1,028 | 1.79 | 2.51 |
| job56_0 | P56 | 4 | 2,016 | 10,080 | 7,218 | 9,638 | 2,420 | 5.01 | 6.69 |
| job58_0 | P58 | 2 | 840 | 10,002 | 3,668 | 5,626 | 1,958 | 2.55 | 3.91 |
| job59_0 | P59 | 1 | 420 | 10,080 | 464 | 1,023 | 559 | 0.32 | 0.71 |
| job63_0 | P63 | 1 | 490 | 10,080 | 0 | 652 | 652 | 0.00 | 0.45 |
| job77_0 | P77 | 1 | 336 | 10,080 | 0 | 404 | 404 | 0.00 | 0.28 |
| job78_0 | P78 | 1 | 588 | 10,080 | 0 | 647 | 647 | 0.00 | 0.45 |

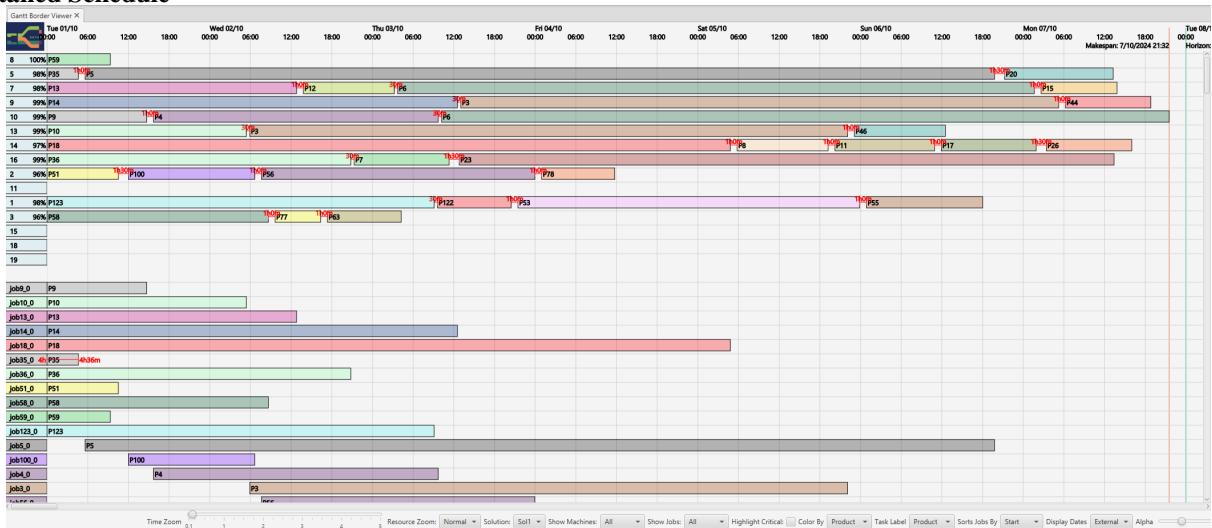
Production Level Chart for Product P3



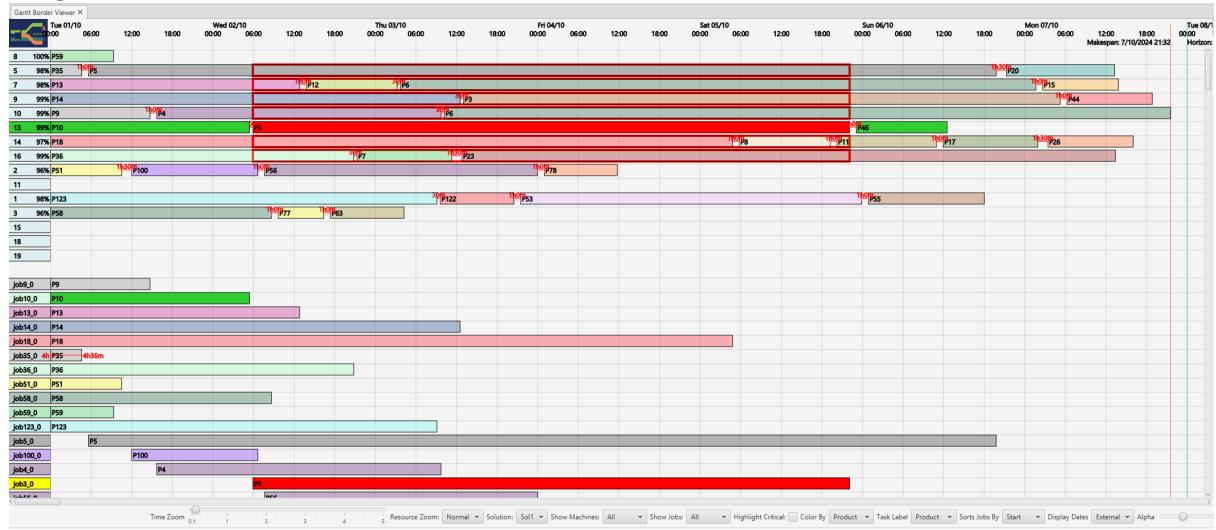
Production Level Chart for Product P35



Detailed Schedule



Showing Alternative Machines in Gantt Chart



Summary

- We demonstrated the use of our scheduling tool inside a production planning problem from industry
- Production planning decides which products to make in which quantity
 - Balance stock levels against projected demand
 - Allow for product specific safety stock levels
- Uses estimate of production capacity over planning horizon
- Use detailed scheduling to validate plan