

# Production Planning Case Study

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## Constraint Based Production Scheduling



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# 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.

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Production Scheduling

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## 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

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# 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	

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# 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	

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Production Scheduling

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# Product List (Sorted by Safety Alert)

Product X													NTIRE	
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	4.21	
P51	P51	51	5.70	405	71.05	140	4.50	630	2	pt50	381	6.95		
P58	P58	58	55.00	1,590	28.91	420	2.33	979	1,2,3,8	pt54	1,208	11.48		
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		

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Production Scheduling

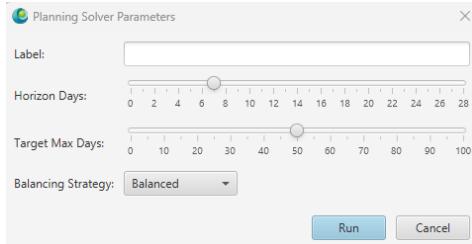
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## Setup Matrix



Row		pt1	pt2	pt3	pt4	pt5	pt6	pt7	pt8	pt9	pt10	pt11	pt12	pt13	pt14	pt15	pt16	pt17	pt18	pt19	pt20	pt21	pt22	pt23	pt24	pt25	pt26	pt27	pt28	pt29	pt30	pt31	pt32	pt33	pt34	pt35	pt36	pt37	pt38	pt39	pt40	pt41	pt42	pt43	pt44	pt45	pt46	pt47	pt48	pt49	pt50	pt51	pt52	pt53	pt54	pt55	pt56	pt57	pt58	pt59	pt60	pt61	pt62	pt63	pt64	pt65	pt66	pt67	pt68	pt69	pt70	pt71	pt72	pt73	pt74	pt75	pt76	pt77	pt78	pt79	pt80	pt81	pt82	pt83	pt84	pt85	pt86	pt87	pt88	pt89	pt90	pt91	pt92	pt93	pt94	pt95	pt96	pt97	pt98	pt99	pt100	pt101	pt102	pt103	pt104	pt105	pt106	pt107	pt108	pt109	pt110	pt111	pt112	pt113	pt114	pt115	pt116	pt117	pt118	pt119	pt120	pt121	pt122	pt123	pt124	pt125	pt126	pt127	pt128	pt129	pt130	pt131	pt132	pt133	pt134	pt135	pt136	pt137	pt138	pt139	pt140	pt141	pt142	pt143	pt144	pt145	pt146	pt147	pt148	pt149	pt150	pt151	pt152	pt153	pt154	pt155	pt156	pt157	pt158	pt159	pt160	pt161	pt162	pt163	pt164	pt165	pt166	pt167	pt168	pt169	pt170	pt171	pt172	pt173	pt174	pt175	pt176	pt177	pt178	pt179	pt180	pt181	pt182	pt183	pt184	pt185	pt186	pt187	pt188	pt189	pt190	pt191	pt192	pt193	pt194	pt195	pt196	pt197	pt198	pt199	pt200	pt201	pt202	pt203	pt204	pt205	pt206	pt207	pt208	pt209	pt210	pt211	pt212	pt213	pt214	pt215	pt216	pt217	pt218	pt219	pt220	pt221	pt222	pt223	pt224	pt225	pt226	pt227	pt228	pt229	pt230	pt231	pt232	pt233	pt234	pt235	pt236	pt237	pt238	pt239	pt240	pt241	pt242	pt243	pt244	pt245	pt246	pt247	pt248	pt249	pt250	pt251	pt252	pt253	pt254	pt255	pt256	pt257	pt258	pt259	pt260	pt261	pt262	pt263	pt264	pt265	pt266	pt267	pt268	pt269	pt270	pt271	pt272	pt273	pt274	pt275	pt276	pt277	pt278	pt279	pt280	pt281	pt282	pt283	pt284	pt285	pt286	pt287	pt288	pt289	pt290	pt291	pt292	pt293	pt294	pt295	pt296	pt297	pt298	pt299	pt300	pt301	pt302	pt303	pt304	pt305	pt306	pt307	pt308	pt309	pt310	pt311	pt312	pt313	pt314	pt315	pt316	pt317	pt318	pt319	pt320	pt321	pt322	pt323	pt324	pt325	pt326	pt327	pt328	pt329	pt330	pt331	pt332	pt333	pt334	pt335	pt336	pt337	pt338	pt339	pt340	pt341	pt342	pt343	pt344	pt345	pt346	pt347	pt348	pt349	pt350	pt351	pt352	pt353	pt354	pt355	pt356	pt357	pt358	pt359	pt360	pt361	pt362	pt363	pt364	pt365	pt366	pt367	pt368	pt369	pt370	pt371	pt372	pt373	pt374	pt375	pt376	pt377	pt378	pt379	pt380	pt381	pt382	pt383	pt384	pt385	pt386	pt387	pt388	pt389	pt390	pt391	pt392	pt393	pt394	pt395	pt396	pt397	pt398	pt399	pt400	pt401	pt402	pt403	pt404	pt405	pt406	pt407	pt408	pt409	pt410	pt411	pt412	pt413	pt414	pt415	pt416	pt417	pt418	pt419	pt420	pt421	pt422	pt423	pt424	pt425	pt426	pt427	pt428	pt429	pt430	pt431	pt432	pt433	pt434	pt435	pt436	pt437	pt438	pt439	pt440	pt441	pt442	pt443	pt444	pt445	pt446	pt447	pt448	pt449	pt450	pt451	pt452	pt453	pt454	pt455	pt456	pt457	pt458	pt459	pt460	pt461	pt462	pt463	pt464	pt465	pt466	pt467	pt468	pt469	pt470	pt471	pt472	pt473	pt474	pt475	pt476	pt477	pt478	pt479	pt480	pt481	pt482	pt483	pt484	pt485	pt486	pt487	pt488	pt489	pt490	pt491	pt492	pt493	pt494	pt495	pt496	pt497	pt498	pt499	pt500	pt501	pt502	pt503	pt504	pt505	pt506	pt507	pt508	pt509	pt510	pt511	pt512	pt513	pt514	pt515	pt516	pt517	pt518	pt519	pt520	pt521	pt522	pt523	pt524	pt525	pt526	pt527	pt528	pt529	pt530	pt531	pt532	pt533	pt534	pt535	pt536	pt537	pt538	pt539	pt540	pt541	pt542	pt543	pt544	pt545	pt546	pt547	pt548	pt549	pt550	pt551	pt552	pt553	pt554	pt555	pt556	pt557	pt558	pt559	pt560	pt561	pt562	pt563	pt564	pt565	pt566	pt567	pt568	pt569	pt570	pt571	pt572	pt573	pt574	pt575	pt576	pt577	pt578	pt579	pt580	pt581	pt582	pt583	pt584	pt585	pt586	pt587	pt588	pt589	pt590	pt591	pt592	pt593	pt594	pt595	pt596	pt597	pt598	pt599	pt600	pt601	pt602	pt603	pt604	pt605	pt606	pt607	pt608	pt609	pt610	pt611	pt612	pt613	pt614	pt615	pt616	pt617	pt618	pt619	pt620	pt621	pt622	pt623	pt624	pt625	pt626	pt627	pt628	pt629	pt630	pt631	pt632	pt633	pt634	pt635	pt636	pt637	pt638	pt639	pt640	pt641	pt642	pt643	pt644	pt645	pt646	pt647	pt648	pt649	pt650	pt651	pt652	pt653	pt654	pt655	pt656	pt657	pt658	pt659	pt660	pt661	pt662	pt663	pt664	pt665	pt666	pt667	pt668	pt669	pt670	pt671	pt672	pt673	pt674	pt675	pt676	pt677	pt678	pt679	pt680	pt681	pt682	pt683	pt684	pt685	pt686	pt687	pt688	pt689	pt690	pt691	pt692	pt693	pt694	pt695	pt696	pt697	pt698	pt699	pt700	pt701	pt702	pt703	pt704	pt705	pt706	pt707	pt708	pt709	pt710	pt711	pt712	pt713	pt714	pt715	pt716	pt717	pt718	pt719	pt720	pt721	pt722	pt723	pt724	pt725	pt726	pt727	pt728	pt729	pt730	pt731	pt732	pt733	pt

# Running the Planning Solver

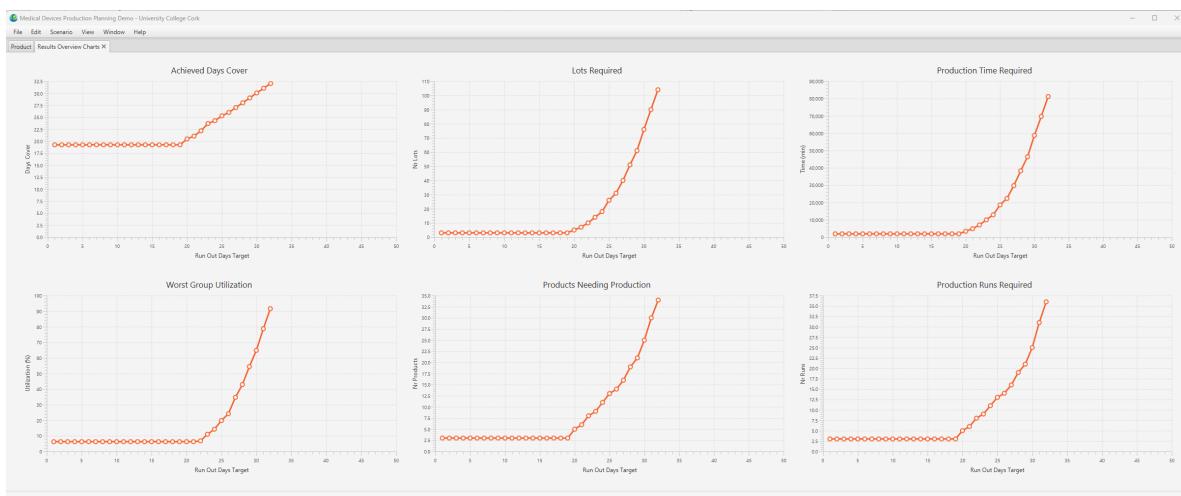


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## Planner Results

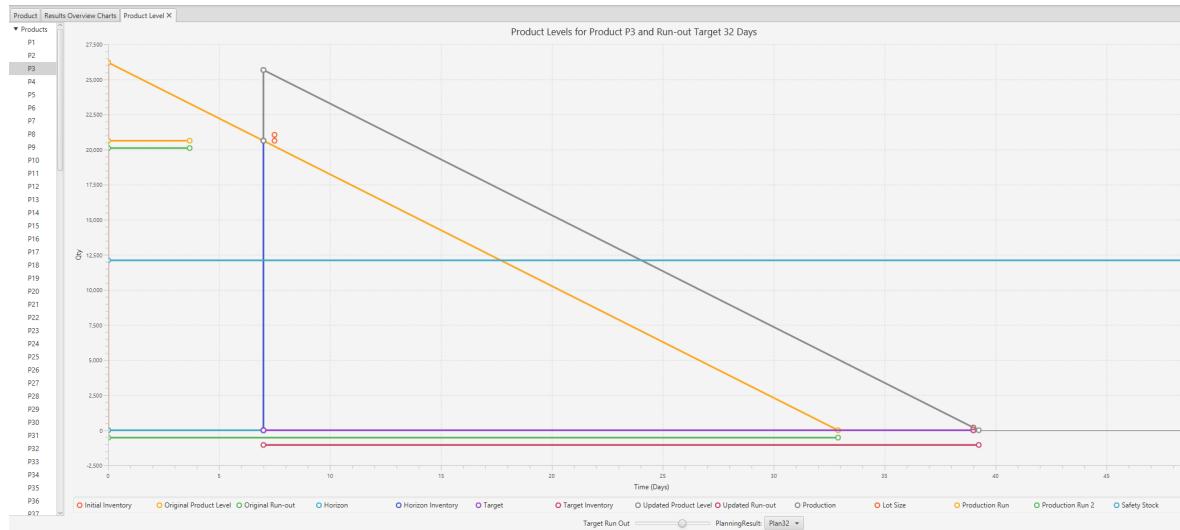


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# Product Level Chart for Product P3

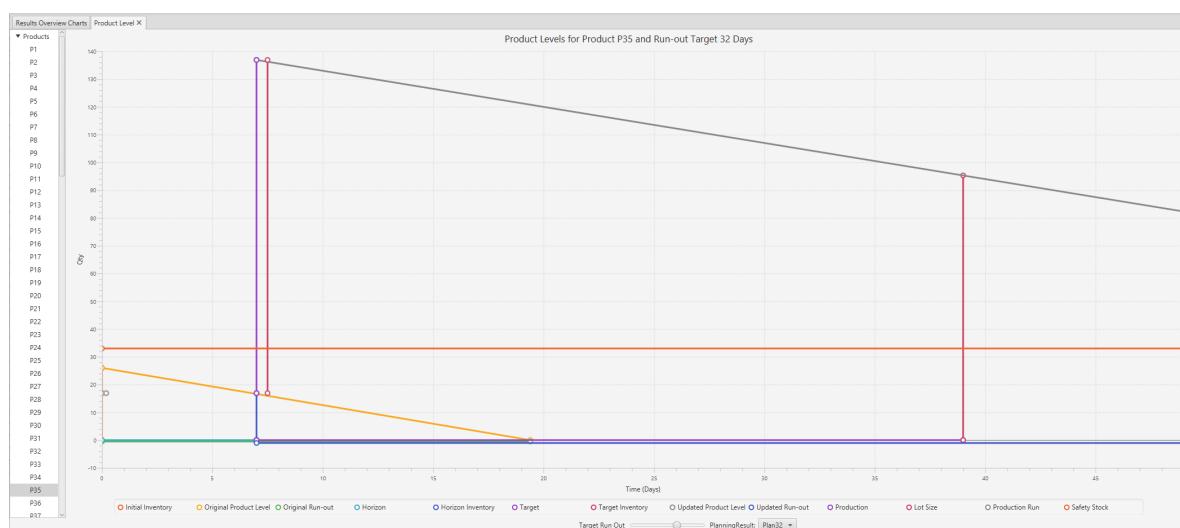


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# Product Level Chart for Product P35



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# Scheduled Production Runs



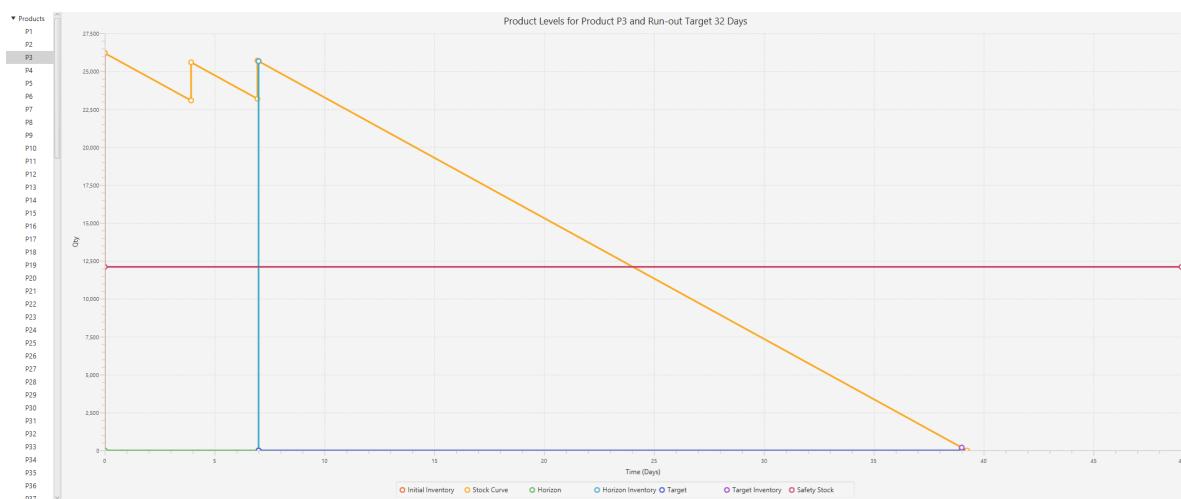
Product	Results Overview Charts	Product Level	Scheduled Production Level	ProductionRun X					
Name	Product	NrLots	Qty	Due	Start	End	Duration	StartDay	EndDay
job3_0	P3	6	2,520	10,080	366	5,658	5,292	0.25	3.93
job3_1	P3	6	2,520	10,080	4,712	10,004	5,292	3.27	6.95
job4_0	P4	3	1,260	10,080	0	2,520	2,520	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

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## Production Level Chart for Product P3

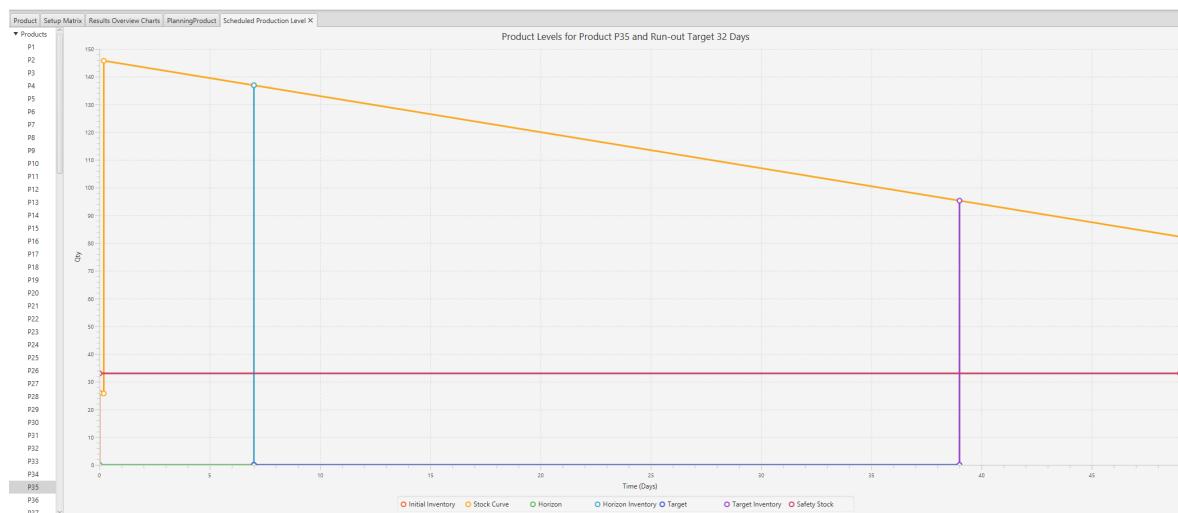


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# Production Level Chart for Product P35



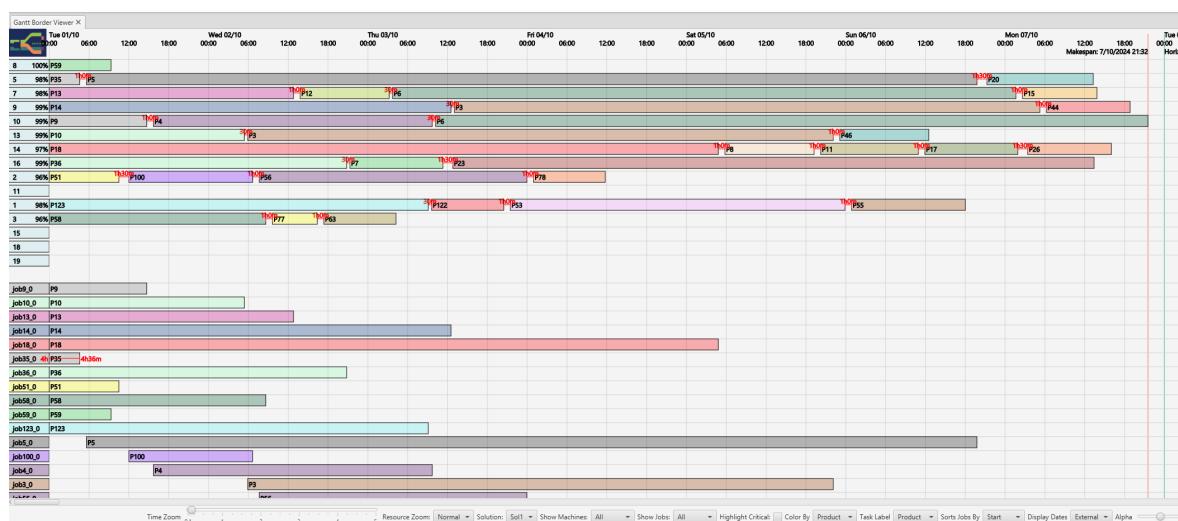
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## Production Scheduling

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## Detailed Schedule

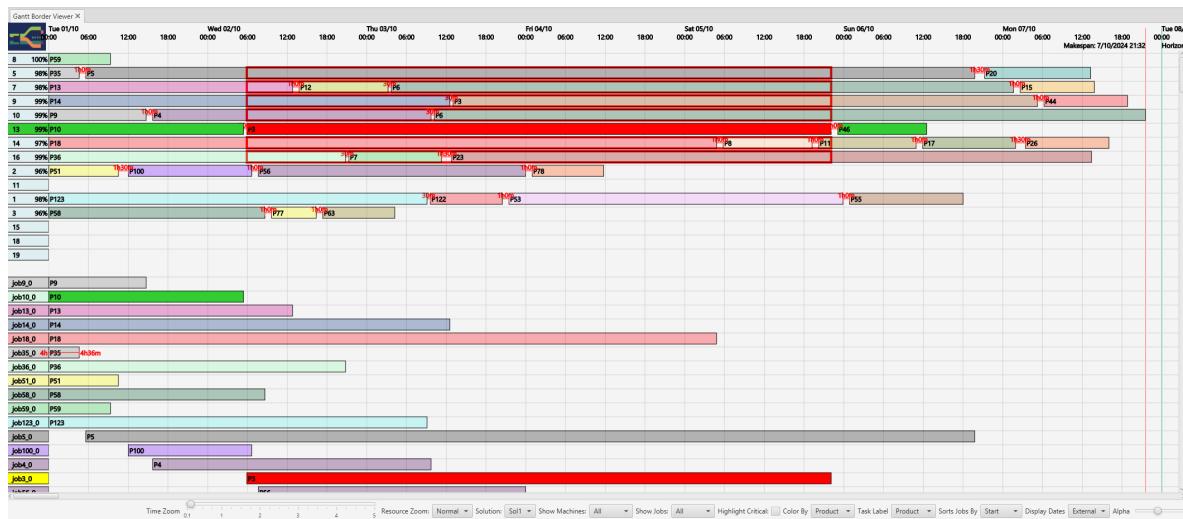


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# Showing Alternative Machines in Gantt Chart



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## 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

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