THE USE OF SPREADSHEETS TO TEACH MASTER PRODUCTION SCHEDULE (MPS) AND MATERIALS REQUIREMENTS PLANNING (MRP)

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Abstract: Master Production Scheduling (MPS) and Materials Requirements Planning (MRP) are difficult techniques to explain, even with detailed explanations in the textbook. Using spreadsheets with "what-if" and graphical capabilities helps students to grasp some of the more elusive concepts, such as Available-to-Promise, Lot-for-Lot vs. fixed order quantity, and infinite vs. finite capacity. This paper describes some of the spreadsheets designed for this purpose.

PRODUCTION PLANNING HIERARCHY

This is a paper about using spreadsheets to show how master production schedules (MPS) and materials requirements planning (MRP) schedules are prepared. Beginning with a production planning hierarchy, we show how production planning leads into MPS and, subsequently, MRP scheduling. We also show the effects of lumpy demand and level demand on the MRP schedule.

Figure 1 shows the production planning hierarchy. In this paper, we will describe only the MPS and MRP scheduling. We described production planning in an earlier conference (Crandall and Main 2006).

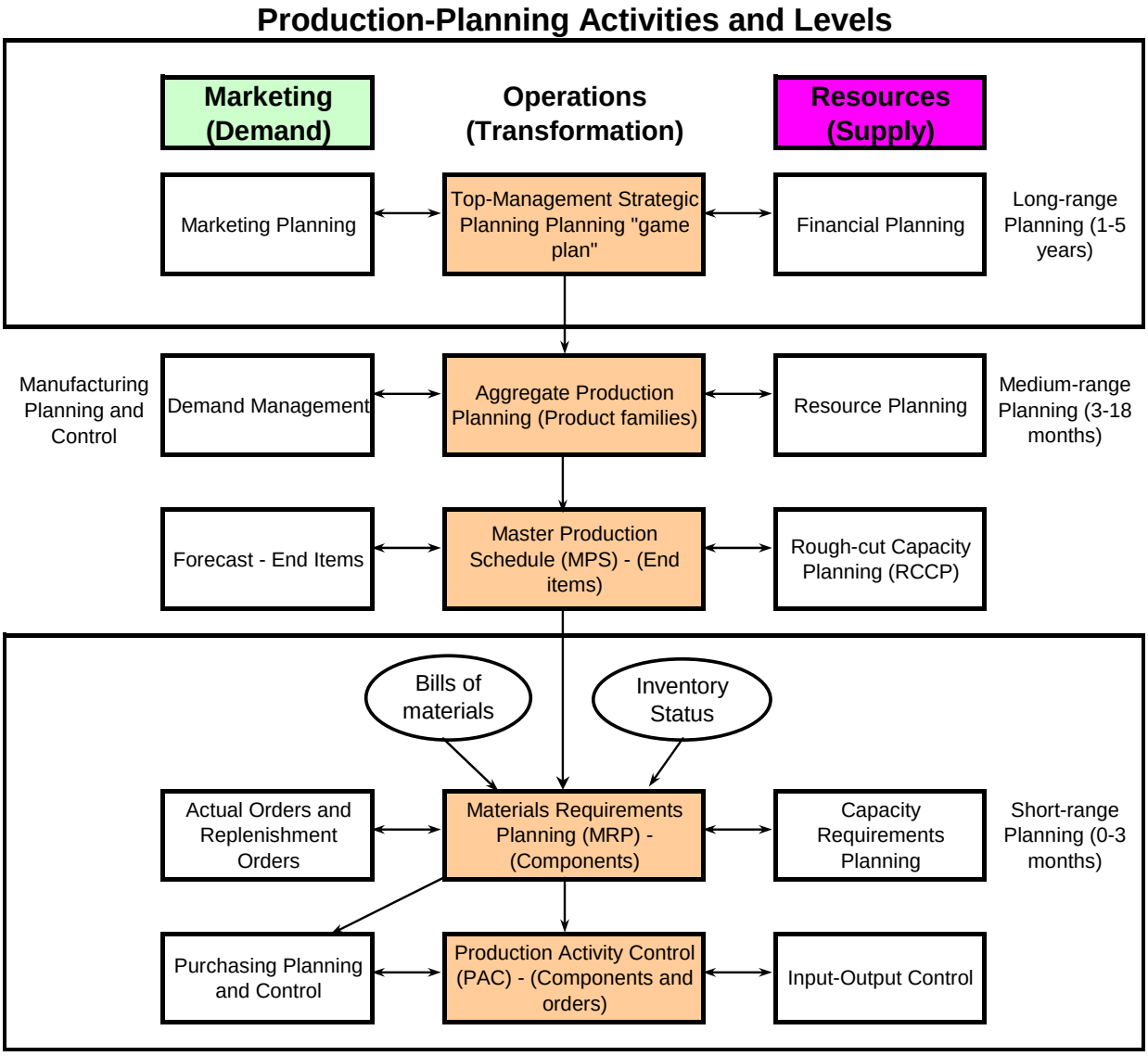
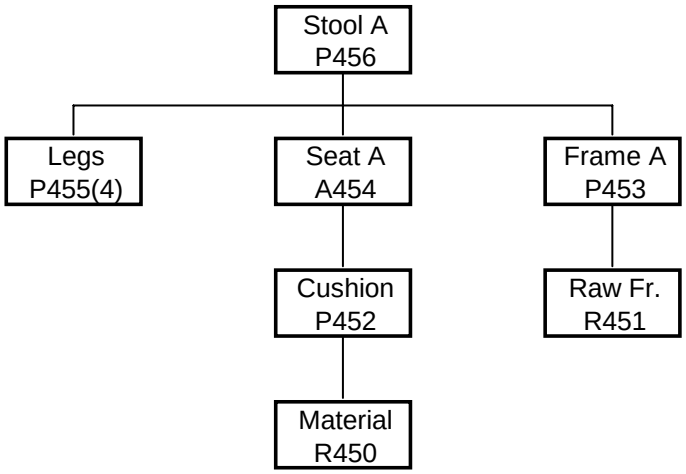


Figure 1. Production Planning Hierarchy

PRODUCT EXAMPLE

To keep the explanation of MPS and MRP simple, we used a stool as the product being planned. Figure 2 shows graphical bills of material for the stool. In addition to being simple, it is a product to which all students can relate.

GRAPHIC BILL OF MATERIALS - STOOL



TIME-PHASED BILL OF MATERIALS

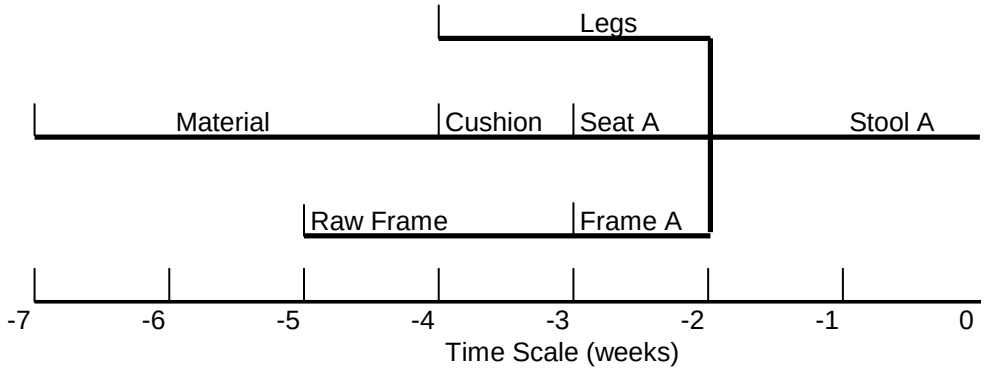


Figure 2. Bills of Material for Stool

MASTER PRODUCTION SCHEDULE (MPS)

The production plan usually covers a 6 to 18 month period but the MPS is usually limited to a shorter period. Our example will be for a 12-week period. Figure 3 shows the format of the MPS and sample schedule for two different end items. In the conference presentation, we will be able to show how each part of the schedule is developed. The spreadsheet design makes it possible to change some of the variables to show their effect on the overall schedule. This is especially helpful in trying to explain such variables as lot size, lead times and the available-to-promise concept.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1							MASTER PRODUCTION SCHEDULE									
2				Periods												
3				1	2	3	4	5	6	7	8	9	10	11	12	TOT
4	ITEM:	A					LOT SIZE-UNITS			500		LEAD TIME-WKS			1	
5	DESC:						LOT SIZE-WEEKS					QTY ON HAND			600	
6	Forecast			550	300	400	450	300	350	200	300	450	400			3700
7	Orders booked			300	350	250	250	200	150	100	100	100	100			1900
8	Projected on hand		600	50	200	300	350	50	200		200	250	350	350	350	
9	MPS receipt				500	500	500		500		500	500	500			3500
10	MPS start			500	500	500		500		500	500	500				3500
11	Avail. To promise			300	150	250	50		250		400	400	400			2200
12																
13										WEEKS						
14				1	2	3	4	5	6	7	8	9	10	11	12	TOT
15	ITEM:	B					LOT SIZE-UNITS			125		LEAD TIME-WKS			1	
16	DESC:						LOT SIZE-WEEKS					QTY ON HAND			50	
17	Forecast			10	15	20	30	40	60	80	120	120	120			615
18	Orders booked			12	9	11	5	2		4						43
19	Projected on hand		50	38	23	3	98	58	123	43	48	53	58	58	58	55
20	MPS receipt						125		125		125	125	125			625
21	MPS start					125		125		125	125	125				625
22	Avail. To promise			18			118		121		125	125	125			632
23																
24	Summary of Orders to be Received															
25		A			500	500	500		500		500	500	500			3500
26		B					125		125		125	125	125			625
27																
28	Note:		These cells contain formulas. Other cells require data to be entered.													
29			The tables above have room for two different products.													
30			You can change the lot size, lead time and beginning quantity to see the effects.													
31			ATP formula only works if there is an order at least once every four weeks. It can be extended.													

Figure 3. MPS Schedule

MATERIALS REQUIREMENTS PLANNING (MRP)

Once the MPS has been developed, the next step is to prepare an MRP schedule. Figure 4 shows the format of this schedule for all levels of the stool. When used in an oral presentation, it is possible to show dynamically the effect of changing requirements, lead times, lot size rules, safety stock requirements, and dependent demand relationships.

File: **MRPExample** **(Lumpy Demand)** Topic: MRP
Name: Problem: Chapter: 14
Section: Date:

		PERIOD NUMBER										
		1	2	3	4	5	6	7	8	9	10	TOTAL
Item No.	**Stool**				On Hand				Size Rule:		L4L	
Parents:					Lead time		2		Lot Size:			
					Safety Stock				Action:			
Gross Requirements								80			120	200
Scheduled Receipts												
On hand - No action								-80	-80	-80	-200	
Net Requirements								80			120	
Plan Order Receipt								80			120	200
Plan Order Release						80			120			200
Projected on Hand												
Item No.	**Frame**				On Hand				Size Rule:		L4L	
Parents:	Stool	1			Lead time		1		Lot Size:			
					Safety Stock				Action:			
Gross Requirements						80			120			200
Scheduled Receipts												
On hand - No action						-80	-80	-80	-200	-200	-200	
Net Requirements						80			120			
Plan Order Receipt						80			120			200
Plan Order Release					80			120				200
Projected on Hand												
Item No.	**Seat**				On Hand				Size Rule:		L4L	
Parents:	Stool	1			Lead time		1		Lot Size:			
					Safety Stock				Action:			
Gross Requirements						80			120			200
Scheduled Receipts												
On hand - No action						-80	-80	-80	-200	-200	-200	
Net Requirements						80			120			
Plan Order Receipt						80			120			200
Plan Order Release					80			120				200
Projected on Hand												
Item No.	**Legs**				On Hand				Size Rule:		FOQ	
Parents:	Stool	4			Lead time		2		Lot Size:		600	
					Safety Stock				Action:			
Gross Requirements						320			480			800
Scheduled Receipts												
On hand - No action						-320	-320	-320	-800	-800	-800	
Net Requirements						320			480			
Plan Order Receipt						600			600			1200
Plan Order Release				600			600					1200
Projected on Hand						280	280	280	400	400	400	204
Item No.	**Cushion**				On Hand				Size Rule:		FOQ	
Parents:	Seat	1			Lead time		1		Lot Size:		400	
					Safety Stock				Action:			
Gross Requirements					80			120				200
Scheduled Receipts												
On hand - No action					-80	-80	-80	-200	-200	-200	-200	

Net Requirements					80			120				
Plan Order Receipt					400							400
Plan Order Release				400								400
Projected on Hand					320	320	320	200	200	200	200	176
Item No.	Raw Frame				On Hand				Size Rule:		L4L	
Parents:	Frame	1			Lead time		2		Lot Size:			
					Safety Stock				Action:			
Gross Requirements					80			120				
Scheduled Receipts												
On hand - No action					-80	-80	-80	-200	-200	-200	-200	
Net Requirements					80			120				
Plan Order Receipt					80			120				200
Plan Order Release			80			120						200
Projected on Hand												
Item No.	Material				On Hand				Size Rule:		FOQ	
Parents:	Cushion	1			Lead time		2		Lot Size:		1000	
					Safety Stock				Action:			
Gross Requirements				400								400
Scheduled Receipts		100										100
On hand - No action		100	100	-300	-300	-300	-300	-300	-300	-300	-300	
Net Requirements				300								
Plan Order Receipt				1000								1000
Plan Order Release		1000										1000
Projected on Hand		100	100	700	700	700	700	700	700	700	700	580
Demand												
Planned Order Rel. (units)		1	2	3	4	5	6	7	8	9	10	Total
L4L	Stool					80			120			200
L4L	Frame				80			120				200
L4L	Seat				80			120				200
FOQ	Legs			600			600					1200
FOQ	Cushion			400								400
L4L	Raw Frame		80			120						200
FOQ	Material	1000										1000
	Total	1000	80	1000	160	200	600	240	120			1800
Total Hours Required												
Hours/unit	Item	1	2	3	4	5	6	7	8	9	10	Total
10	Stool					800			1200			2000
7	Frame				560			840				1400
5	Seat				400			600				1000
1	Legs			600			600					1200
2	Cushion			800								800
2	Raw Frame		160			240						400
1	Material	1000										1000
	Total	1000	160	1400	960	1040	600	1440	1200			5600

Figure 4. MRP Schedule with Lumpy Demand

COMPARISON OF LUMPY AND LEVEL DEMAND

Figure 4 shows the effect of a lumpy demand pattern. It is also useful to show how level demand makes the production manager's job much easier. We show a graphical comparison of the orders released to production and the corresponding hours required for both lumpy demand (Figure 5) and level or JIT demand (Figure 6).

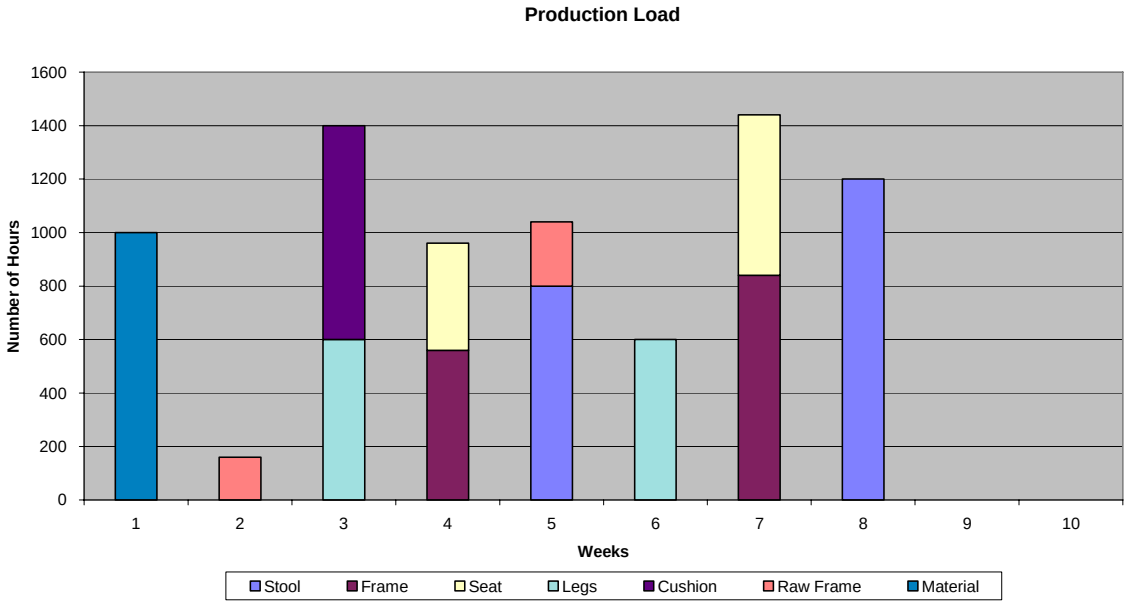


Figure 5. Production Load with Lumpy Demand

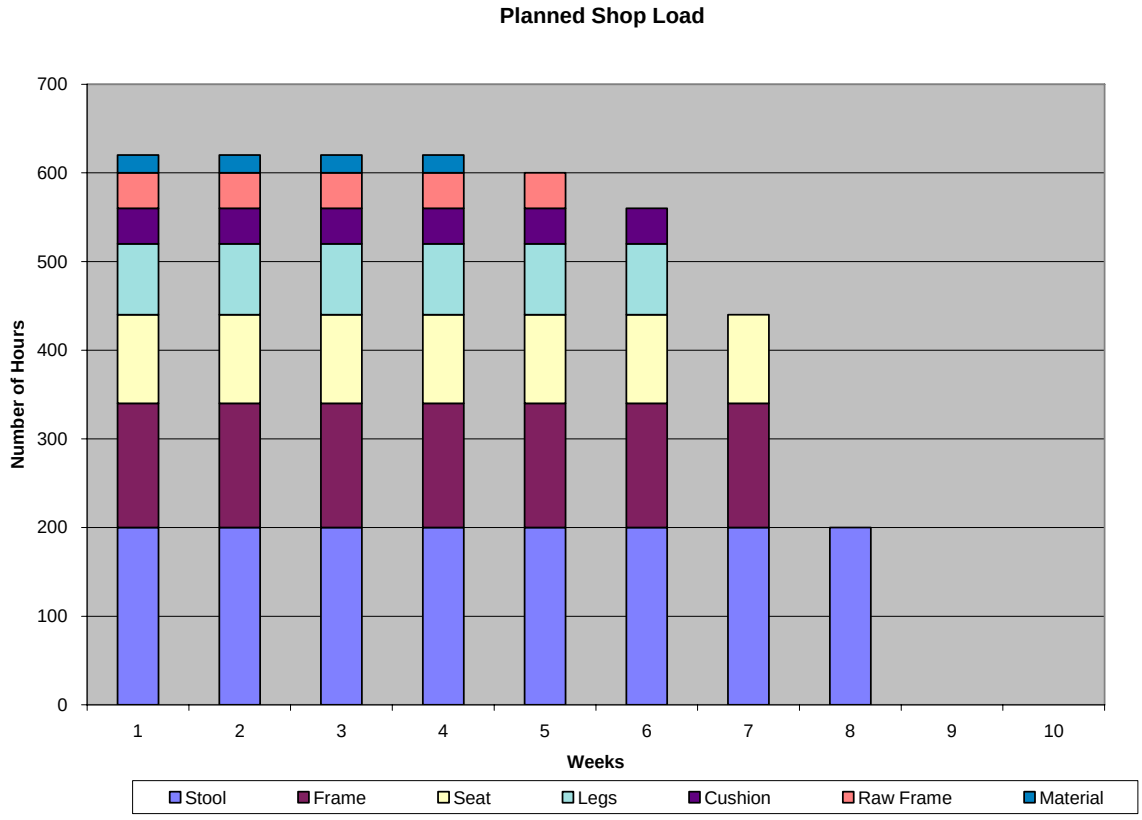


Figure 6. Production Load with Level Demand

SUMMARY

MPS and MRP are difficult to explain even with step-to-step explanations in the textbook. Using spreadsheets with “what-if” and graphical capabilities helps the students to grasp the concepts. They also respond positively to presentations that are not static, such as in a textbook, but include movement and change.

References

1. Crandall, Richard E. and Karen T. Main, Why Production Planning is for Everyone, *Proceedings of the SEDSI Meeting*, February 2007.