Heijunka scheduling may use a type of kanban called a heijunka box to signal when to shift between unit types. It does this by breaking the "box" into time slots equal to takt time. The result is that lean often will have much smaller batch sizes, with an ideal being a batch size of one. As fits with this one-piece flow, often master schedules will use daily time buckets rather than weekly to better schedule an uninterrupted flow to each workstation.

For the portion of production in which lean uses demand pull signals, it will operate on orders rather than forecasts and so will not use time fences. It will be purely reactive to demand. For elements with longer lead times than the required customer lead time, lean will still use master schedules and capacity planning on this push side of operations. For these push elements, lean can benefit from using time fences, because schedule stability in turn promotes production stability. However, lean will work to reduce time horizons and thus the space between time fences by working with suppliers to deliver in shorter lead times. If possible, lead times are reduced to the point where all production is based on actual orders, and forecasts are used only for longer-term planning and perhaps for certain material purchases.

Note that similar results can be accomplished using a variation of conventional manufacturing planning and control. The *Dictionary* defines two terms related to this method:

> **Mixed-model scheduling:** The process of developing one or more schedules to enable mixed-model production. The goal is to achieve a day's production each day.
>
> **Mixed-model production:** Making several different parts or products in varying lot sizes so that a factory produces close to the same mix of products that will be sold that day. The mixed-model schedule governs the making and the delivery of component parts, including those provided by outside suppliers. The goal is to build every model every day, according to daily demand.

Topic 3: Master Scheduling and Sales

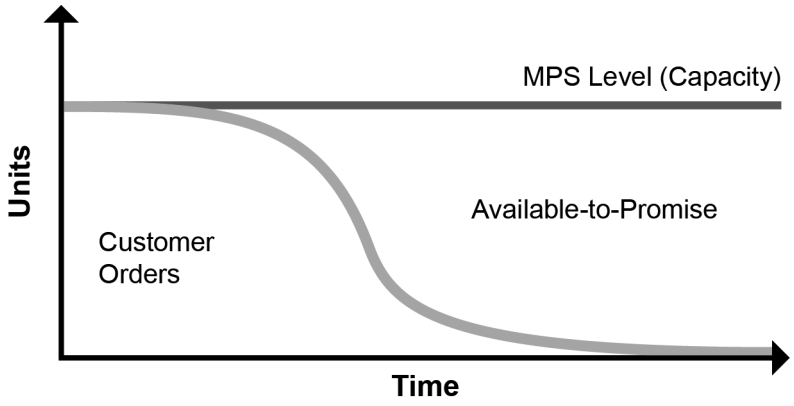
This topic relates to enabling order entry using order promising. The *APICS Dictionary,* 15th edition, defines these terms as follows:

> **Order entry:** The process of accepting and translating what a customer wants into terms used by the manufacturer or distributor. The commitment should be based on the available-to-promise (ATP) line in the master schedule. This can be as simple as creating shipping documents for finished goods in a make-to-stock environment, or it might be a more complicated series of activities, including design efforts for make-to-order products.
>
> **Order promising:** The process of making a delivery commitment (i.e., answering the question, "When can you ship?"). For make-to-order products, this usually involves a check of uncommitted material and availability of capacity, often as represented by the master schedule available-to-promise.

While make-to-stock fulfills customer orders using inventory, make-to-order and assemble-to-order create production capacity and then satisfy demand using this available capacity. Even make-to-stock environments will do this to some extent, since orders that exceed available inventory will next look to the master production schedule to determine what is available to be promised to customers. The distinction is that the master production schedule is just an anticipated build schedule based on demand in the form of forecasts and/or actual customer orders, adjusted by available inventories and safety stocks as well as desired inventories and/or backlog levels. Because the master schedules for the various items must match the production plan totals, there is some assurance that these priority plans are realistic and achievable. Since the production plan was agreed to by sales and marketing and others, this consensus helps ensure that the MPS reflects what sales and marketing believe they can actually sell, subject to the availability of resources. If the MPS is realistic and achievable, sales can provide reliable delivery lead time quotes. If not, manufacturing and sales will be reacting to a series of emergencies and customer complaints.

Exhibit 1-79 shows conceptually how the committed portion of the MPS, in the form of actual orders, leaves the uncommitted portion to be promised to customers who have not yet ordered, which is called available-to-promise (ATP).

Exhibit 1-79: How ATP Is Uncommitted Portion of MPS



The closer one gets to the present, the more the cumulative actual orders displace forecasts or available capacity. This leads us to a few definitions related to inventory availability from the *Dictionary.*

Available inventory: The on-hand inventory balance minus allocations, reservations, backorders, and (usually) quantities held for quality problems. Often called beginning available balance.

On-hand balance: The quantity shown in the inventory records as being physically in stock.

In addition to checking inventory levels (if any), sales professionals will be able to view available-to-promise information in the organization's master schedule. The *Dictionary* defines **available-to-promise (ATP)** in part as follows:

> In operations, the uncommitted portion of a company's inventory and planned production maintained in the master schedule to support customer-order promising. The ATP quantity is the uncommitted inventory balance in the first period and is normally calculated for each period in which an MPS receipt is scheduled. In the first period, ATP includes on-hand inventory less customer orders that are due and overdue.

Next we will see how to calculate available-to-promise in the master schedule. Note that the method discussed here is called the discrete available-to-promise method because two other methods exist (cumulative with look-ahead and cumulative without look-ahead, but those methods are not presented here). The topic concludes with a brief mention of a related concept, capable-to-promise.

Calculating Available-to-Promise

ATP is calculated for the first period of a master schedule and, after that, for each period that has an MPS. The ATP between those periods will be the same as the last ATP and so does not need to be calculated. The first period will draw from available inventory, so there are two slightly different ATP calculations:

First Period ATP = Beginning Inventory −
Sum of Customer Orders Before Period Containing FirstScheduledMPS Receipt

First Period ATP = 70 units − 48 units = 22 units

ATP for Periods Containing MPS = Scheduled MPS Receipt −
Sum of Customer Orders Before Next Period ContainingScheduled MPS Receipt

ATP for Period 2 = 100 units − 66 units = 34 units

Note that this type of ATP makes an assumption that available to promise from prior periods will be consumed by orders that have not come in yet and so does not treat the ATP from prior periods as an available balance (there is an exception to this that we will show shortly). Exhibit 1-80 revisits our simple master schedule from the last topic. Note that the negative value in week 3 means that another rule needs to be added to our calculations.

Exhibit 1-80: Incomplete ATP Calculations on Master Schedule

Master Schedule: Make-to-stock Chase Production Example
Beginning inventory = 70 units Lot size = 100 units

Week	0	1	2	3	4	5	6	...	12	13	14	15	16
Forecast		50	60	70	90	70	20		20	20	20	20	20
Customer Orders		48	66	57	62	30	0		0	0	0	0	0
Projected Available Balance	70	22	56	99	9	39	19		99	79	59	39	19
Master Production Schedule			100	100		100			100				
Available-to-Promise		22	34	-19		70			100				

Demand Time Fence Planning Time Fence

The ATP was calculated using the calculation rules for each period as follows:

- Week 1: 70 units beginning inventory – 48 units of orders = 22 units ATP
- Week 2: 100 units MPS – 66 units of orders = 34 units ATP
- Week 3: 100 units MPS – (57 + 62 units of orders) = –19 units ATP
- Week 5: 100 units MPS – (30 + 0 units of orders) = 70 units ATP

In week 3, actual orders exceed the MPS. Whenever this occurs, we need to apply an additional rule: **Reduce the prior ATP by the amount by which the next ATP would be negative, and then add this amount to the negative ATP field so it is no longer negative.**

This rule is the only time you access ATP from prior periods when using this method. Therefore, 19 units are subtracted from the week 2 ATP and added to the week 3 ATP. Exhibit 1-81 shows the results of this rule. The scheduling software would automatically calculate this for the master scheduler.

Exhibit 1-81: Completed ATP Calculations on Master Schedule

Master Schedule: Make-to-stock Chase Production Example
Beginning inventory = 70 units Lot size = 100 units

Week	0	1	2	3	4	5	6	...	12	13	14	15	16
Forecast		50	60	70	90	70	20		20	20	20	20	20
Customer Orders		48	66	57	62	30	0		0	0	0	0	0
Projected Available Balance	70	22	56	99	9	39	19		99	79	59	39	19
Master Production Schedule			100	100		100			100				
Available-to-Promise		22	15	0		70			100				

Demand Time Fence Planning Time Fence

Now the week 2 and 3 calculations are as follows:

- Week 2: 100 units MPS – 66 units of orders – 19 units = 15 units ATP
- Week 3: 100 units MPS – (57 + 62 units of orders) + 19 units = 0 units ATP

The prior period ATP is reduced because these actual orders are already committed, and the adjustment shows what is actually left over to be promised.

A salesperson wanting to make an order promise to a customer would use ATP as follows: If the customer wants immediate shipping, the salesperson can promise up to 22 units of this inventory. Even though the beginning inventory is 70 units, 48 of these are committed to customers who already placed their orders. As soon as an order is entered into the system, the system automatically adjusts the customer orders higher and reduces the ATP. If the customer can wait a week, the salesperson can promise up to 15 additional units to be delivered with this longer lead time. If even more are wanted, the customer would need to accept a lead time of five weeks. Alternately, the order could be entered for week 4 since the forecast is higher than the current customer orders. However, this will reduce the available-to-promise levels in prior periods, so this might be one way those 22 + 15 units are promised. If the order was higher than this sum, it would require a new MPS entry and thus would be subject to master scheduler approval, since it is in the slushy zone and changing the schedule could impact production efficiency. If a new MPS order was placed in week 4, the projected available balance and ATP would also be recalculated.

Capable-to-Promise

The *APICS Dictionary,* 15th edition, defines **capable-to-promise (CTP)** as follows:

> The process of committing orders against available capacity as well as inventory. This process may involve multiple manufacturing or distribution sites. Used to determine when a new or unscheduled customer order can be delivered. Employs a finite-scheduling model of the manufacturing system to determine when an item can be delivered. Includes any constraints that might restrict the production, such as availability of resources, lead times for raw materials or purchased parts, and requirements for lower-level components or subassemblies. The resulting delivery date takes into consideration production capacity, the current manufacturing environment, and future order commitments. The objective is to reduce the time spent by production planners in expediting orders and adjusting plans because of inaccurate delivery-date promises.

Further discussion of CTP is beyond the scope of this module.

Progress Check

The following questions are included as study aids and may not follow the format used for questions in the APICS CPIM examination. Read each question and respond in the space provided. Answers and page references follow the progress check questions.

1. What is the available-to-promise amount for week 3 of the master schedule shown in the figure below?

Master Schedule: Make-to-stock Chase Production Example
Beginning inventory = 60 units Lot size = 100 units

Week	0	1	2	3	4	5	6
Forecast		60	70	50	80	60	40
Customer Orders		58	65	46	63	30	0
Projected Available Balance	60	0	30	80	0	40	0
Master Production Schedule			100	100		100	
Available-to-Promise		2	35	?		70	

a) –9 units
b) 0 units
c) 26 units
d) 54 units

2. What is the portion of inventory or production that has yet to be assigned to specific customer orders?

a) Anticipation inventory
b) Available-to-promise
c) Excess production
d) Capable-to-promise

Progress check answers

1. b. To calculate the (discrete method) available-to-promise (ATP), use the following calculation: ATP for Periods Containing MPS = Scheduled MPS Receipt – Sum of Customer Orders Before Next Period Containing Scheduled MPS Receipt. For week 3: 100 units – (46 units + 63 units) = – 9 units. However, because this would result in a negative value, an additional rule needs to be applied, which is to reduce the prior period's ATP level by the shortfall and add it to this period. So 9 units are removed from the week 2 ATP and added to the week 3 ATP, resulting in an answer of 0 units ATP for week 3. Note also in the figure below that the ATP for week 2 is now reduced by 9 units (p. 1-158)

Master Schedule: Make-to-stock Chase Production Example
Beginning inventory = 60 units Lot size = 100 units

Week	0	1	2	3	4	5	6
Forecast		60	70	50	80	60	40
Customer Orders		58	65	46	63	30	0
Projected Available Balance	60	0	30	80	0	40	0
Master Production Schedule			100	100		100	
Available-to-Promise		2	26	0		70	

2. b. Available-to-promise (ATP) inventory has not yet been committed to customer orders. Answers c and d are not appropriate descriptions for inventory that might still have a chance of being sold. Answer a is not a term commonly used to describe ATP inventory. (p. 1-157)