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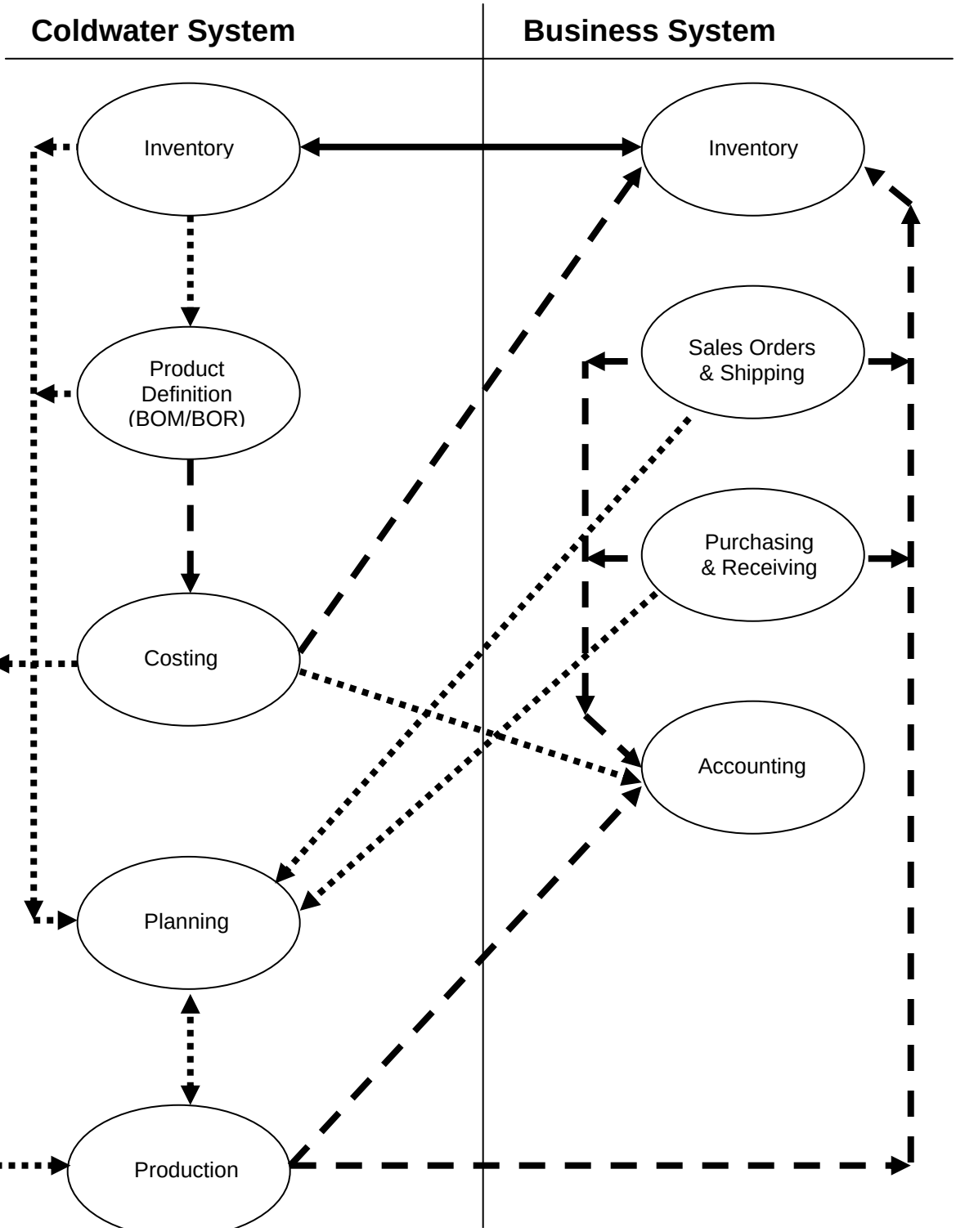
General Flow of Manufacturing Information



A ····▶ B **B** requires information from **A**

A ——▶ B **B** is updated with information from **A**

A ◀——▶ B Information is continuously synchronized between **A** & **B**

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Effects of Transactions

Inventory

- Purchase Order Entry
  - Increases 'On Order' quantity
- Purchasing Receipts
  - Decreases 'On Order' quantity
  - Increases 'On Hand' quantity

- Production Order Entry
  - Increases 'On Order' quantity for item being produced
  - Increases 'Committed' quantity for raw materials
- Production Order Postings
  - Decreases 'On Order' quantity for item being produced
  - Decreases 'Committed' quantity for raw materials
  - Increases 'On Hand' quantity for item being produced
  - Decreases 'On Hand' quantity for raw materials

- Sales Order Entry
  - Increases 'Committed' quantity for item being sold
- Sales Order Shipments
  - Decreases 'Committed' quantity for item being sold
  - Decreases 'On Hand' quantity for item being sold

- Cycle Counting
  - Could Increase or Decrease 'On Hand' quantity for any item
- Adjustments
  - Could Increase or Decrease 'On Hand' quantity for any item

Accounting

- Purchasing Receipts
  - Increases inventory value
- Production Order Postings
  - Increases inventory value for item being produced
  - Decreases inventory value for raw materials
- Sales Order Shipments
  - Decreases inventory value for item being sold
- Cycle Counting
  - Could Increase or Decrease inventory value for any item
- Adjustments
  - Could Increase or Decrease inventory value for any item

NOTE - Inventory value is changed by multiplying the inventory transaction quantity by the 'Standard Cost'. The 'Standard Cost' for produced items is determined by adding up all costs listed in the Bill Of Materials and Bill of Routings. The 'Standard Cost' for purchased items is manually maintained.

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The ABCs of Product Definition

The product definition of an inventory item describes what is required to change a collection of raw materials into a finished saleable product, or a sub-assembly that is required by the finished good. These requirements consist of materials and the labor required for assembly.

Types of Inventory

If someone were to say "I have 5 widgets in inventory.". Did they go out to the warehouse and manually count them? Or, did they use a inquiry screen in an application software system? The results of either option should be the same but, could vary greatly. If the person actually saw the widgets and counted them, that is considered **physical** inventory. If the person relied on the software inquiry, that is called the **perpetual** inventory. Perpetual inventory relies on 2 things to maintain accuracy: 1) correct starting balance, 2) correct/complete posting of transactions (receipts, usages, production, shipments, adjustments).

Inventory items are usually classified in one of 3 ways: Purchased, Produced or Phantoms. Each type is handled differently and has certain restrictions and features.

Purchased (or Buy) items are ordered and received from vendors on purchase orders. These items are normally called **raw materials** and don't have a product definition. Standard costs for bought items are manually maintained or may be updated by a utility program based on period averages. Depending on the market volatility of the item, the standard costs should be updated monthly, quarterly, semi-annually, or annually. The difference between the standard cost and the actual cost paid is known as the Purchase Price Variance.

Produced (or Make) items can range from the **finished good** (example: a refrigerator) to a **sub-assembly** to a finished good (example: a rack inside the refrigerator). Make item product definitions also range from very simple to extremely complex. Production Orders are created to produce these items and to capture the associated costs. Also, production orders can be reviewed at a later date to determine inefficiencies in material usage or actual labor applied. Should the need arise, Make items can be purchased. However, Buy items can't be produced.

Phantom (or Non-Stock) items are similar to Make items in that they have product definitions (BOMs & BORs), but are normally not produced and stocked for later use. They are usually sub-assemblies that are required in the production of another 'higher-level' item. Non-Stock items also differ from Make items in that they are not normally produced as repair or replacement parts that can be sold.

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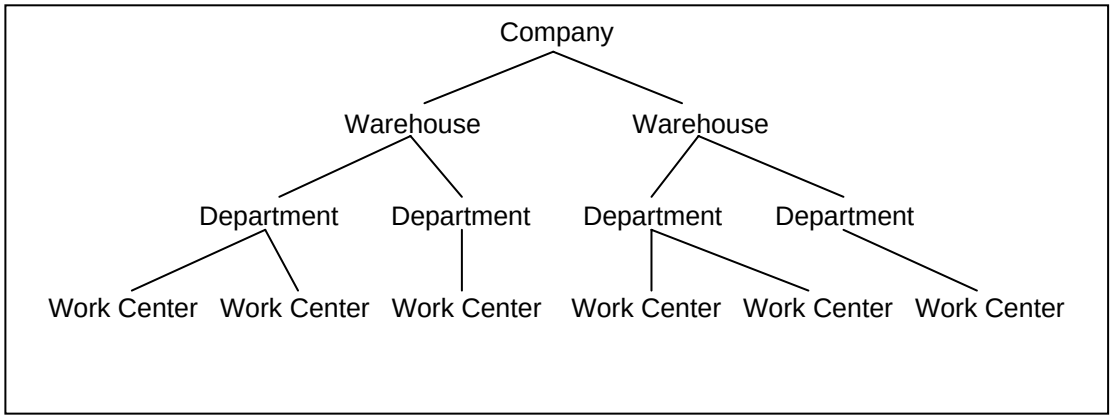
Manufacturing Facility Hierarchy

Most, if not all, organizations have a hierarchy. The same is true for application software systems designed for manufacturing tracking and planning.



At the top of the hierarchy is the **company**. The company level is normally where the accounting functions and tracking take place. Many application software systems can support multiple companies.

Each company can have one or more **warehouses**. Warehouses are generally physical locations where inventory (raw material & finished goods) is located. However, one physical location can contain multiple *logical* warehouses. For instance, one building can have designated areas for materials that have been received but not yet inspected. This is often referred to as the *quality assurance* (QA) warehouse. Once inspected, the materials are transferred (physically and within the software system) to a warehouse from which they can be issued to production. Using the application software system, someone could perform an inquiry that showed an item existing in both warehouses. In addition, product definitions can vary by warehouse. This may be due to the fact that certain raw materials are available in one physical location but, not in another.

Within each warehouse, there can be many **departments**. Departments are logical groupings of similar work tasks. The following are typical department designations: receiving, fabrication, assembly, painting, inspection, and shipping. Departments usually have an associated *hourly labor rate* that represents how much it costs the company for each employee to perform an hour of work. This hourly labor rate not only includes the employees pay rate, but also the departments share of the cost for utilities, rent/mortgage, taxes, insurance, and many other things. In addition, the amount of total employee output (or *capacity*) can be tracked at the department level. Capacity is calculated by multiplying the number of work shifts per day, times the number of hours per shift, times the number of employees per shift.

Beneath each department is one, or more, **work centers**. Work centers usually relate to a specific task, or even a single machine. When defining product definitions, each of the labor operations refers to a specific work center. Capacity calculations can also be done at the work center level. This possible capacity is compared to the actual *work load* in the manufacturing warehouse/department/work center. If the work load is greater than the capacity, then completion dates may be pushed back. Or, resources (personnel or machines) may be shifted to compensate for the capacity shortage.

Product Definition

Product definitions explain how to make something. They provide a list of what materials are required, how much of each material is required, and also what tasks need to be performed. The amounts (material or labor) listed in the product definition are considered to be *standards*. Standards describe what is 'normally required'.

Material standards are determined by reviewing documents created by the engineering department, such as CAD drawings. In cases were the materials required are not counted by the 'each', mathematical calculations or observations can be used. An example of this would be paint. This list of ingredients is called the **Bill of Materials (BOM)**. The BOM can consist of purchased items, non-stock items, or sub-assemblies. Besides listing what items are required, the BOM also contains a description, item unit of measure (UOM), and the warehouse the material is to be issued from.

Through observations, historical records, or calculations, the amount of time required to complete a task is determined. All of the tasks required to produce an item define the **Bill of Routings (BOR)**. Tasks listed on a BOR are also referred to as *Labor Operations*. The amount of time required is in total hours. If a task requires 3 people for 5 hours, then the labor operation has total requirement of 15 hours. Labor operations include two different types of time, **Set-up** and **Run**. *Set-up* time has to be performed prior to the actual start of the task and is independent of the quantity being produced. As an example, a drill press operator has to attach the proper bit and work jig which takes 15 minutes – regardless of whether the operator is performing the task 5 or 50 times. *Run* time is the amount of time required to perform the task on <u>each</u> item being produced.

> Labor operation example: A drill press operator must drill ¼" holes in 3 specific places on a piece of ½" plate steel. First, the bit and work jig must be attached (15 minutes or .25 hours). Next, the operator drills the holes. Each hole takes 5 minutes (3 holes X 5 minutes each = 15 minutes or .25 hours). Total labor operation time for one unit is 30 minutes or .5 hours (.25 set-up + .25 run time).

Normally, the BOR labor operations are listed in sequential order, has a brief description of the task that is to be performed, the department and work center the task is performed in, and may contain more specific notes.

Product definitions may also contain operations that are performed outside of the company. These are called **Outside Processes**. Examples of this are chrome plating, anodizing, or even specialized contract labor that is performed on-site. Usually, an outside process is initiated by a Purchase Order sent to a vendor.

After all of the required materials, labor and outside processes have been defined for an item, the application software system is used to total up the costs and store the **Standard Cost** of the item. This standard cost is used by the production processes to update the accounting files.

Flat vs. Indented Product Definitions

A BOM can be as simple as a straight list of basic materials like a shopping list or recipe. However, this can be very inefficient for more complex items, especially when many finished good items use the same assemblies or components. Sub-assemblies or Non-Stock items are used in product definitions to collect materials that are used in many different produced items and streamline the maintenance of the product definitions.

For example, if the same 10 raw materials are used in 10 different finished good BOMs, and one of the raw materials (paper gasket) was being replaced (with a rubber gasket). You would have to maintain 10 different finished good BOMs.

F/G Item 1	F/G Item 2	F/G Item 9	F/G Item 10
.	.	.	.
.	.	.	.
Nuts	Nuts	Nuts	Nuts
Bolts	Bolts	Bolts	Bolts
Flat Washers	Flat Washers	Flat Washers	Flat Washers
Lock Washers	Lock Washers	Lock Washers	Lock Washers
Paper Gasket	**Paper Gasket**	**Paper Gasket**	**Paper Gasket**
Cap	Cap	Cap	Cap
Sleeve	Sleeve	Sleeve	Sleeve
Retainer	Retainer	Retainer	Retainer
Filter	Filter	Filter	Filter
O-Ring	O-Ring	O-Ring	O-Ring
.	.	.	.
.		.	.

Now if we had gathered the 10 raw materials in a BOM for a Non-Stock item,

N/S Item 1(before)	N/S Item 1(after)
Nuts	Nuts
Bolts	Bolts
Flat Washers	Flat Washers
Lock Washers	Lock Washers
Paper Gasket	**Rubber Gasket**
Cap	Cap
Sleeve	Sleeve
Retainer	Retainer
Filter	Filter
O-Ring	O-Ring

then placed the Non-Stock item in the finished good BOMs, then we would only have to change the Non-Stock item BOM to affect the other 10 finished good items.

F/G Item 1	F/G Item 2	F/G Item 9	F/G Item 10
.			
.			
N/S Item 1	N/S Item 1	N/S Item 1	N/S Item 1
.			
.			

The example above introduces the concept of **'indention'**. Indention breaks down a product definition into **levels**. The finished good item is at the top level and is referred to as a 'level 0' item. Sub-assemblies and raw materials in the product definition exist below the finished good at levels 1, 2, 3, or lower. Using the data above the *Indented BOM* for 'F/G ITEM 1' would appear as:

Level	Item/Component
0	F/G Item 1
1	Sub-assembly 1
1	N/S Item 1
2	Nuts
2	Bolts
2	Flat Washers
2	Lock Washers
2	Paper Gasket
2	Cap
2	Sleeve
2	Retainer
2	Filter
2	O-Ring
1	Raw Material 1

In addition to simplifying BOM maintenance, using indented BOMs with sub-assemblies (or Non-Stock) items also makes creating new product definitions easier by providing the ability to copy existing definitions to a new item and then making minor changes to the new BOM. Costing of WIP (work in process) is also facilitated with indentions. The same ideas presented above apply to BORs.

0	1	2	3	4	LEVELS
RED 12 SPEED					
BIKE26-RED-12					
	FRAME26				
		ALLOY6061X1.0			
		SEATCLAMP			
		STEERSLEEVE			
			ALLOY6061X1.5		
		PEDALSLEEVE			
			ALLOY6061X2.0		
	WHEEL26FR --				
	WHEEL26RR12				
		TIRE26			
		TUBE26			
		RIM26			
		SPOKE26			
		BRAKEHUB12			
			BEARINGKIT		
				INNERBEARING	
				OUTERBEARING	
				SEAL	
			SPROCKET12X24 --		
			AXLE		
			HUB		
			BRAKEPADS		
	DRIVE26X12 --				
	SEAT26 --				
	STEER26 --				
	CABLEKIT --				
	PAINT-RED				
ALTERNATES FOR BLUE 10 SPEED					
BIKE26-BLUE-10					
	…				
	WHEEL26RR10				
		TIRE26			
		TUBE26			
		RIM26			
		SPOKE26			
		BRAKEHUB10			
			BEARINGKIT		
				INNERBEARING	
				OUTERBEARING	
				SEAL	
			SPROCKET12X20 --		
			AXLE		
			HUB		
			BRAKEPADS		
	PAINT-BLUE…				