PUSH & PULL

< Experiment result & analysis >

1. Report on simulation result for each model.

	Order waiting time	product CT	product WIP
PUSH	0.036	1.807	21.654
PULL	0.366	3.014	4.692

2. A total of 4 Hold modules are used to implement the Pull system. Explain **in detail** what the operating mechanic is.

1. **Generating an Order:** A Create module is used to time intervals between order releases and rates of raw material creation

2. **Actual Production:** Raw material are created and moved into a buffer (Raw 1). The Raw 1 buffer can hold a maximum of 30 raw materials, and if queue is smaller than 30, a raw material entity is assigned an attribute value.

3. **Hold Module Configuration:** The Hold modules act as buffers, ensuring that entities only proceed when the following process is ready. So, the system uses signals to control the flow of item which can ensure efficiency in production and minimization of excess inventory.

1) Hold Module 1 (Raw 1 Buffer): Raw materials are held in this module if the queue has less than 30 entities. Only when Process 1 is idle and there is space in Raw 2 buffer, raw materials proceed to the next stage.
2) Hold Module 2 (Raw 2 buffer): After raw materials are processed in Process 1, they wait in the Raw 2 buffer until Process 2 is idle and the Raw 3 buffer is empty at the same time.
3) Hold Module 3 (Raw 3 Buffer): After raw materials are processed in Process 2, they wait in the Raw 3 buffer. They are proceeded to Process 3 when Process 3 is idle and the inventory of finished products is equal or less than 5.
4) Hold Module 4 (Finished Goods Buffer): This module represents the buffer for completed products waiting to be matched with an order. Completed products would wait in this buffer until an order entity arrives at the Batch module. When an order arrives, the finished product is batched with the order and proceeds to the next step.

4. **Order Fulfillment:** When an order arrives at the Batch module, it is paired with a finished product. If finished products are not yet available, the order waits in the Batch module's queue. Matched orders and products are then moved for further processing.

< Discussion & conclusion >

(1) List as many the ways as possible that a company can set the WIP upper bound.

1. Using simulation models to predict the impact of different WIP limits on production performance.
2. Applying the queuing theory to figure out optimal WIP limits based on arrival rates and service rates.
3. Using Kanban pull-based approach where the downstream determines the WIP limits for the upstream.
4. Applying lean principles to set WIP limits which maximize value and minimize waste.
5. Setting a fixed specific number of tasks that can be in progress at any given time for each stage of the production system.
6. Defining the WIP limit as a percentage of the total tasks needed.
7. Setting WIP limits based on the availability of resources such as tools, labor, or workspace.
8. Regularly reviewing and dynamically adjusting WIP limits based on actual performance metrics.
9. Conducting cost-benefit analyses to determine the most cost-effective WIP limits.

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(2) Why is a Pull system more robust than a Push system? What practical results does this have on the manufacturing floor?

Pull System is More Robust than a push system for multiple reasons.
1. Production Mechanism: In the case of the push system, production is based on forecasts which leads to the risk of overproduction or underproduction. Whereas, since in the pull system, production is based on actual customer demand, production only happens when there are requests.
2. Flexibility: The pull system is flexible in manufacturing, as it quickly adapts to changes in demand or market conditions. However, the push system is less flexible, thus less robust, in a sense that it produces based on pre-scheduled agenda, and this makes it hard for the system to adapt to sudden changes.
3. Reduced Inventory: The pull system minimizes inventory level, as it produces the needed only. This reduces inventory cost and the risk of inventory obsolescence. Yet, the push system often has high inventory levels due to incorrect forecasts, which can lead to excess stock and less robustness.

Utilizing the pull system can have the following results on the manufacturing floor.

1. Reduced Lead Times: Production lead times are reduced as WIP is minimized and production is conducted based on actual demand.
2. Increased Flexibility: The manufacturing floor becomes more dynamic and responsive as, it can more easily adapt to changes in customer orders.
3. Lower Costs: Holding costs, defect costs, and waste costs are significantly reduced, resulting in overall cost savings.

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