

CASE STUDY
NO. 20

OPTIMIZING MATERIAL HANDLING
SYSTEM COSTS

ABSTRACT: This case involves three competing warehouse designs requiring time study analysis, economic analysis, layout analysis and sensitivity analysis of business changes to evaluate trade-offs between automated and conventional equipment and between capital and operating expenses.

by

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MATERIAL HANDLING CASE STUDY
OPTIMIZING MATERIAL HANDLING SYSTEM COSTS

Directions - Part 1

You are a material handling engineer with a large consumer products company. Your boss has just given you three alternatives that are being considered for a new product distribution center. They are:

- Automated System: In this alternative, product will be automatically transferred to the storage area with an automated guided vehicle system (AGVS). Put-away and retrieval from storage will occur with an automated storage and retrieval system (AS/RS) and the products will be transferred to the dock area by the AGVS.
- Conventional System: In this alternative, product will be manually handled with forklifts, stored in three-high eight-deep roller track storage, and transferred to the dock area with forklifts. The warehouse will be built and owned by the company.
- Conventional System in a Leased Facility: In this alternative, product will be transferred with forklifts and stored one pallet high in marked areas on the floor. Forklifts will also be used to transfer product to the dock area. The warehouse will be leased by the company.

The accounting department has determined that \$1,000,000 can be saved annually by the proposed distribution center since its location is ideal to support current needs and future growth. The present system will adequately support the needs of the company for two years while one of the proposals is being implemented.

Your boss has demanded an immediate answer as to which alternative maximizes the project's net present value. The Vice President of Finance has mandated that the cash flows for this project be discounted at an annual rate of 25%. In other words, all cash flows should be considered to occur at the end of the year and should be discounted on

an annual basis utilizing a 25% discount rate to arrive at a net present value for each alternative. Business growth in the area has been determined to be fairly certain, so the project's investment life should be 10 years. Assume zero salvage for all equipment at the end of the ten year life. Also, ignore the impact of taxes.

You have been supplied with the following data:

- A partially complete from/to chart with layout distances and product velocity information
- data on labor, equipment, building and overhead costs
- data on equipment throughput, storage utilization and layout guidelines
- time study data for pertinent material handling activities

Your analysis should include your recommendation and a summary of key points that support your conclusions. Please report your findings to Part 1 before continuing.

Forklift Time Study Data:

Pickup and deposit load	0.00300 hrs./occurrence	(1)
Travel time	0.00013 hrs./ft./round trip	(2)

AS/RS Storage and Retrieval Machine Throughput Data:

<u>S/R Machine Aisle Length</u>	<u>Throughput</u>
up to 150 ft.	22 pallets/hr./machine (3)
151 - 300 ft.	19 pallets/hr./machine
301 - 450 ft.	15 pallets/hr./machine

Assume 10% total downtime and idle time for forklifts, automated storage and retrieval machines and guided vehicles. Also, assume that the AS/RS and the associated computer systems have been designed to allow for a three-shift operation if necessary.

(1) The listed time is the combined time to pick up and deposit a load. In reality, the distances and times would change with the design of the layout. However, assume that

they are fixed for the purpose of this analysis. Also, assume that the forklifts handle only one pallet at a time.

(2) The listed time is the time to travel from the pickup point to the deposit point and then return to the pickup point. This is a round trip time. Do NOT use it as a one way time. To calculate the total time, simply multiply the distance between the pickup and deposit points by this rate. Additionally, this rate incorporates all other periodic activities required to support each forklift such as the time required to change the forklift's batteries.

(3) The throughput was estimated by computer simulation. The throughput is based on a put-away and a retrieval. For example: a single storage and retrieval machine of length up to 150 feet can store 22 pallets/hour while retrieving 22 pallets/hour. Additionally, the AS/RS design does not incorporate transfer cars, is single deep (one pallet to each side of the crane) and there is only one crane allowed per aisle.

AGVS Throughput Data:

Throughput 5 pallets/hr./AGV (1)

Storage Requirements:

A 20% partial lane factor should be added to the conventional storage requirements to compensate for the eight-deep storage lanes. A 15% utilization factor should be added to the AS/RS storage requirements to provide allocation flexibility.

(1) The throughput was estimated by computer simulation and is based on delivering a pallet to and from storage. For example: a single AGV can deliver 5 pallets/hour to storage while retrieving 5 pallets/hour from storage and delivering them to a dock.

Expenses:

The warehouse lease expense is estimated to increase by 7% per year. Average warehouse operator wages are \$9.00/hour including benefits.

Equipment/Building Costs:

AS/RS building space	\$25/ft. ²
New warehouse space	\$35/ft. ²
Leased warehouse space	\$4/ft. ²
Lease hold improvements	\$300,000
Forklift	\$22,000 each
Automated Guided Vehicle	\$40,000 each
S/R Machine (max length: 450 ft.)	\$100,000 each
AS/RS and AGVS computer	\$600,000
Flowtrack storage (8 deep lanes)	\$300/pallet area
AS/RS storage (8 levels high)	\$350/pallet area

The AS/RS warehouse is rack supported. Therefore, the "AS/RS building space" cost only includes the site work, floor and building "skin" costs. The hi-rise racking is in addition to these costs. The clear height of the owned conventional building supports three high storage while the clear height of the leased facility will only allow floor storage single high. Assume that you can secure a warehouse lease in 5,000 ft.² increments.

Layout:

Standard forklift aisle widths are 11 feet. Perimeter aisles are 15 feet wide. The maximum distance between adjacent aisles for access purposes should be no greater than 60 feet. All conventional storage is on flowtrack that is eight pallets deep or less due to needs for product selectivity. The AS/RS system requires a 5-foot storage and retrieval machine aisle width and 30 feet of clear space at the back end of the AS/RS system for access and maintenance. The AS/RS system can support storage 8 pallets high. Product is stored on 40' by 48' four-way entry GMA type pallets. Assume that

pallets will be stored on 5-foot centers in all storage modes (automated and conventional). Assume that all other space requirements (docks, AGV access at front of AS/RS, staging area for conventional warehouse, offices, break areas, etc.) are similar and will not affect the economic (net present value) of the alternatives.

On-going overhead and support costs:

	<u>Automated System</u>	<u>Conv. System Owned Whse.</u>	<u>Conv. System Leased Whse.</u>
Maintenance	\$6,240/mo.	\$2,080/mo.	\$2,080/mo.
Clerical	\$1,387/mo.	\$2,773/mo.	\$2,773/mo.
Engineering Support	\$3,467/mo.	\$1,733/mo.	\$417/mo.
Inventory Losses	<u>\$250/mo.</u>	<u>\$1,500/mo.</u>	<u>\$1,667/mo.</u>
Total	\$11,344/mo.	\$8,086/mo.	\$6,937/mo.

Assume that all other costs such as administration, support and energy usage are the same for each alternative.

Timing:

The lead time to build and start-up an automated hi-rise storage and retrieval facility is two years. The lead time for a conventional flowtrack storage facility is one year. The lead time to occupy a leased facility is two months. Assume that the investment is incurred in the year that the facility starts up.

Material Handling Activity Analysis

Product Description	Inventory Level (weeks)	Average Pallets/week	Leased <u>Alternative</u> Average one- way travel distance (ft.)	Conv. Owned <u>Alternative</u> Average one- way travel distance (ft.)
Beach Towels-reg	0.80	200		
Beach Towels-blue	1.40	120		
Beach Towels-red	0.80	155		
Beach Towels-haww	0.50	200		
Beach Towels-flag	2.00	12		
Beach Towels-str	1.70	77		
Beach Towels-large	0.50	200		
Beach Towels-sungl	1.50	72		
Beach Towels-D_pile	1.50	66		
Sunglasses-reg	1.00	100		
Sunglasses-mirr	1.60	88		
Sunglasses-blk	1.60	65		
Sunglasses-red	1.60	93		
Sunglasses-ski	1.60	45		
Sunglasses-pol	1.50	110		
Sunglasses-poltint	1.20	130		
Sunglasses-kid	2.00	35		
Sunglasses-xlarge	1.70	12		
Ice Buckets-reg	0.50	217		
Ice Buckets-large	0.50	336		
Ice Buckets-flagg	2.00	19		
Ice Buckets-therm	2.00	47		
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Material Handling Activity Analysis

Product Description	Inventory Level (weeks)	Average Pallets/week	Leased <u>Alternative</u> Average one- way travel distance (ft.)	Conv. Owned <u>Alternative</u> Average one- way travel distance (ft.)
Beach Towels-reg	0.80	200	400	200
Beach Towels-blue	1.40	120	500	200
Beach Towels-red	0.80	155	500	200
Beach Towels-haww	0.50	200	500	200
Beach Towels-flag	2.00	12	500	200
Beach Towels-str	1.70	77	540	200
Beach Towels-large	0.50	200	400	150
Beach Towels-sungl	1.50	72	540	200
Beach Towels-D_pile	1.50	66	540	200
Sunglasses-reg	1.00	100	600	250
Sunglasses-mirr	1.60	88	600	225
Sunglasses-blk	1.60	65	600	225
Sunglasses-red	1.60	93	600	225
Sunglasses-ski	1.60	45	600	225
Sunglasses-pol	1.50	110	550	180
Sunglasses-poltint	1.20	130	550	180
Sunglasses-kid	2.00	35	600	225
Sunglasses-xlarge	1.70	12	600	225
Ice Buckets-reg	0.50	217	800	170
Ice Buckets-large	0.50	336	800	200
Ice Buckets-flagg	2.00	19	900	150
Ice Buckets-therm	2.00	47	900	150
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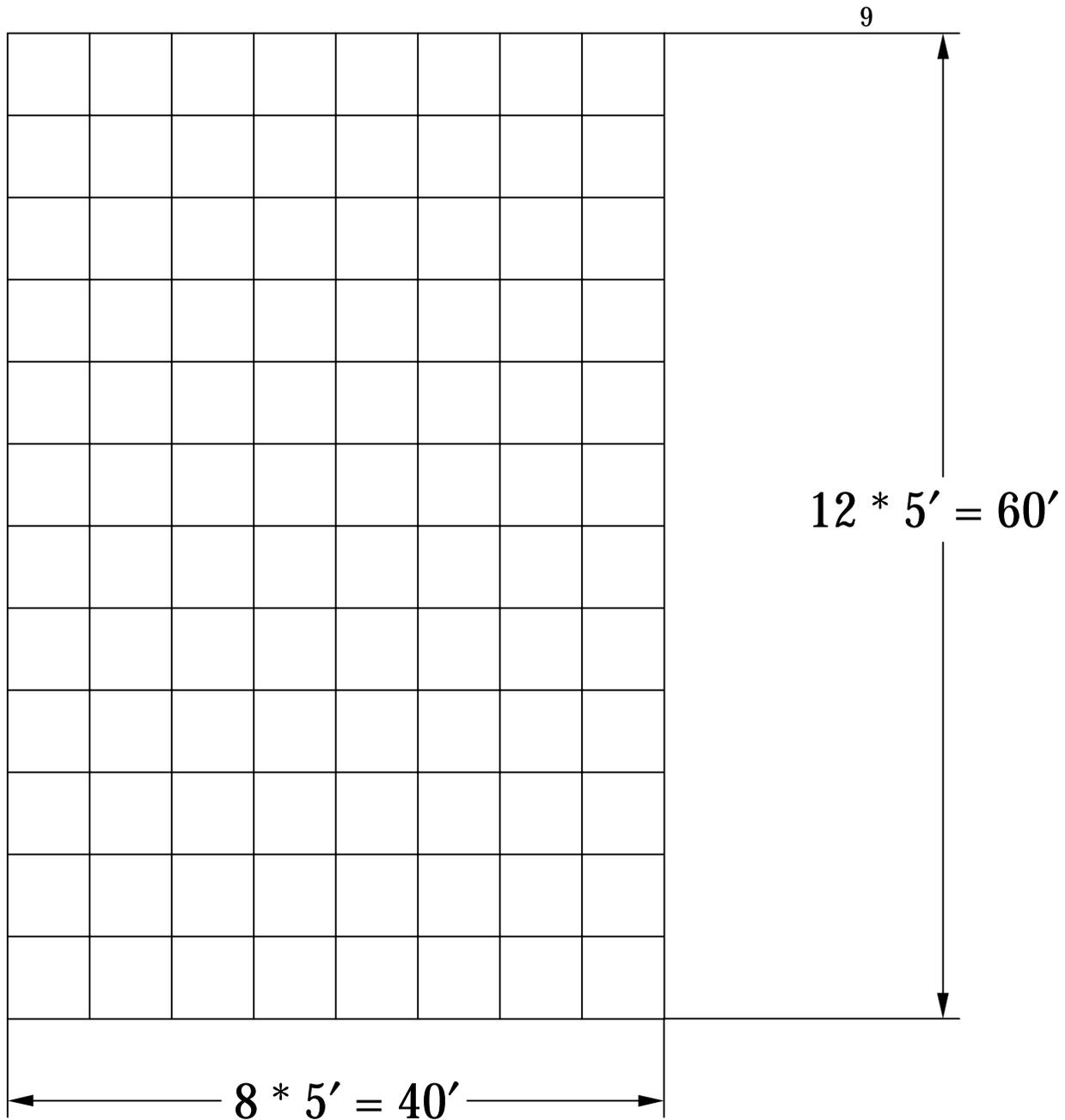


Figure 1. Sample of Conventional Storage Layout

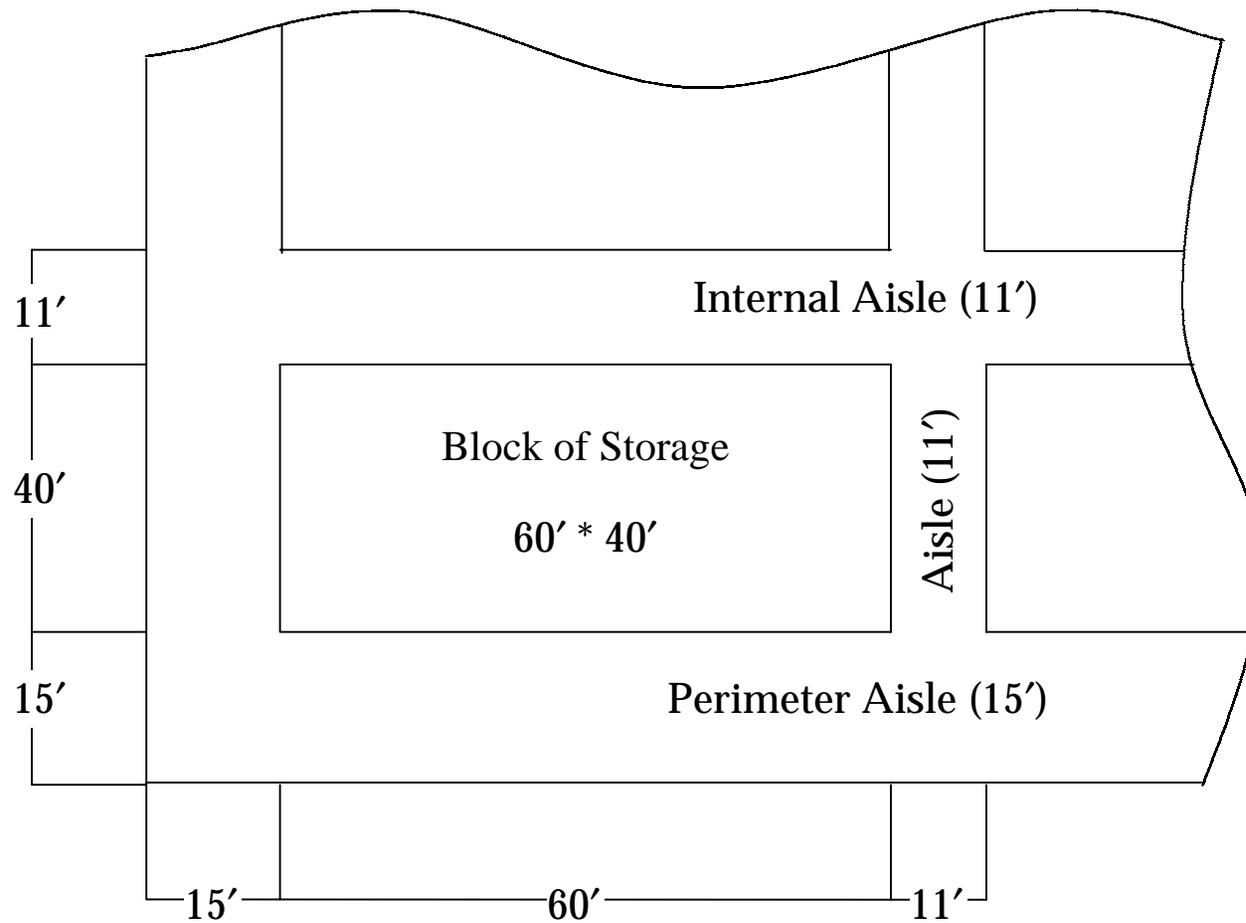


Figure 2. Block Layout for Conventional Warehouse

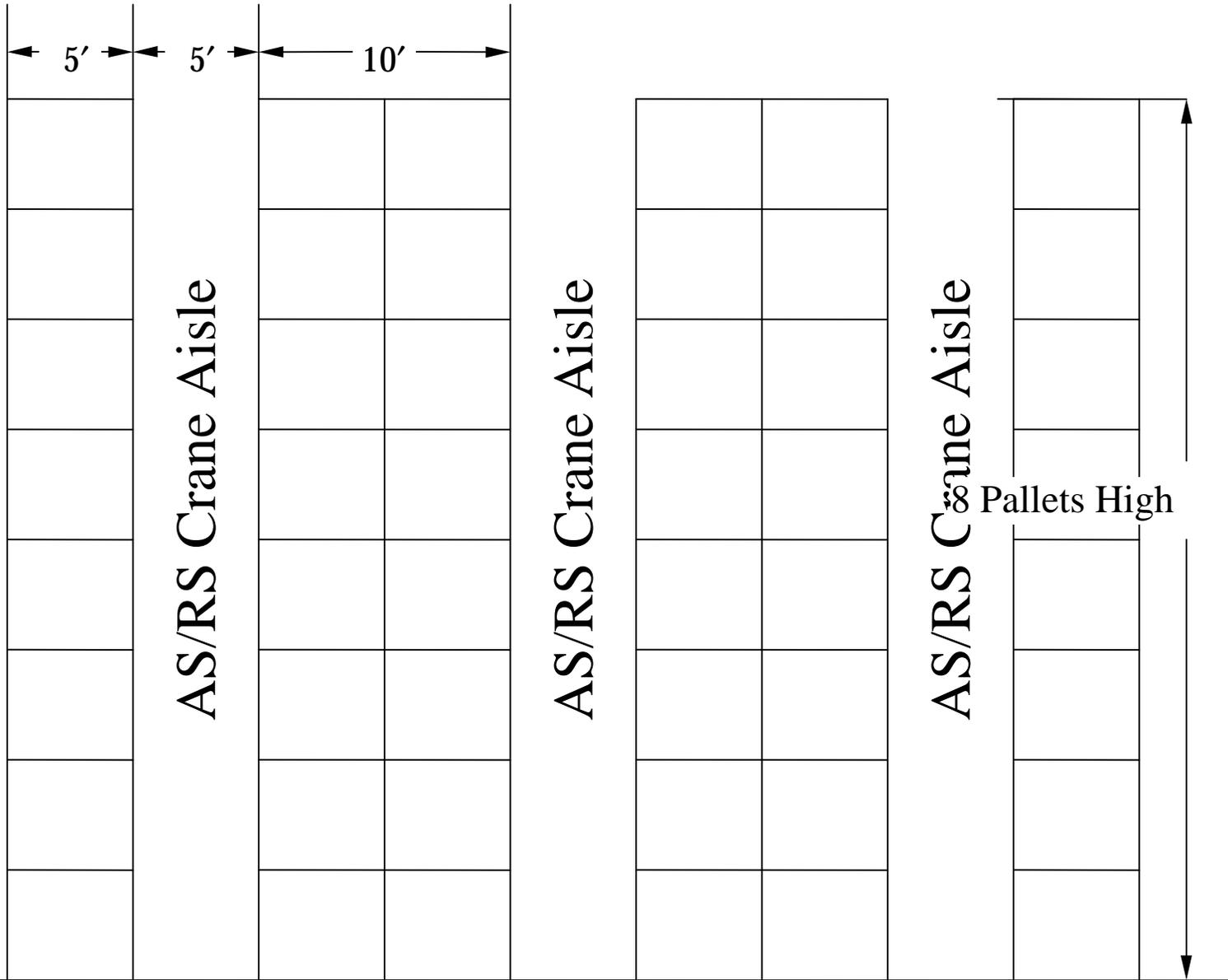


Figure 3. Elevation of AS/R System

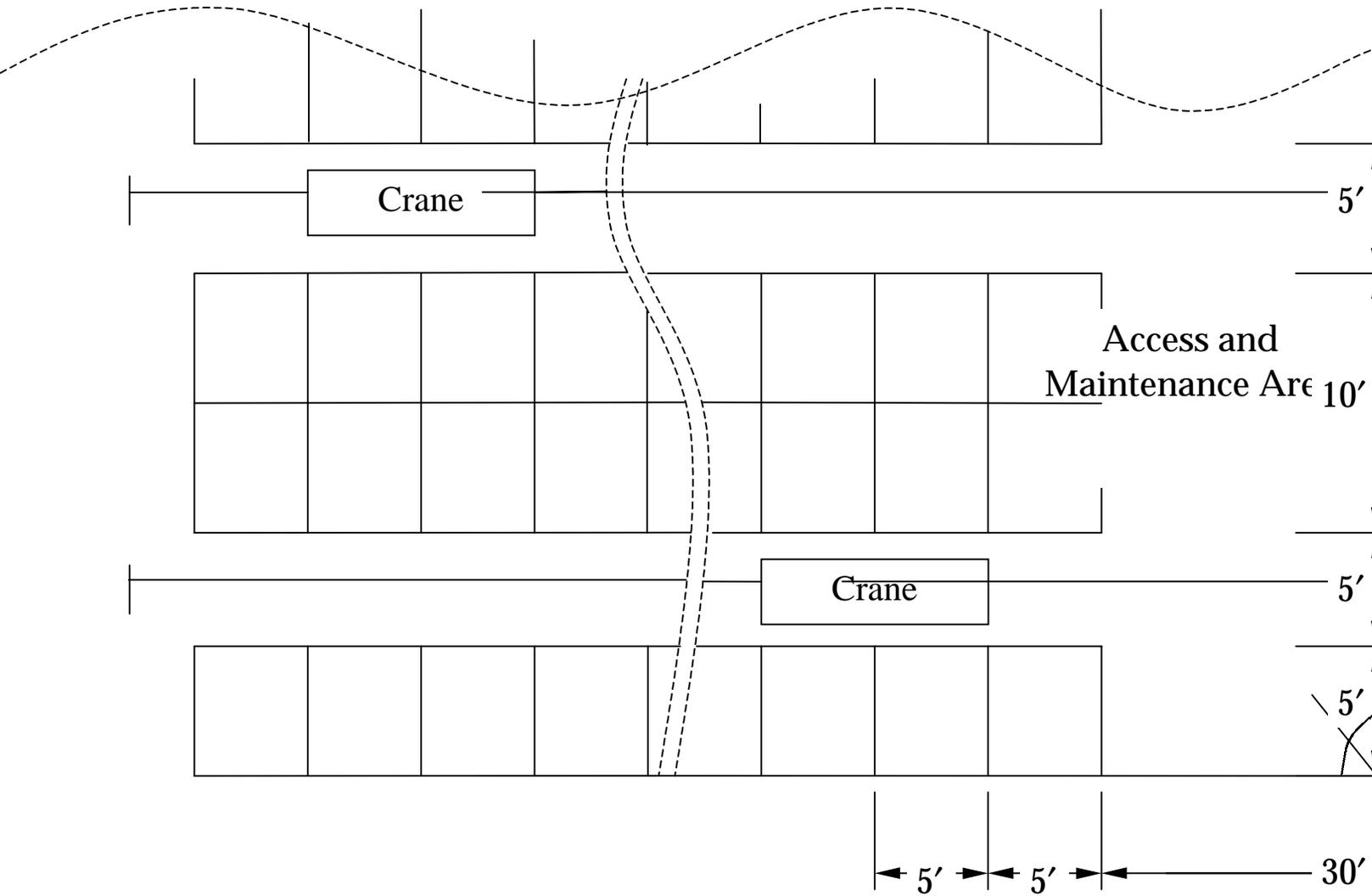


Figure 4. Layout of AS/R System

Directions - Part 2

A revolutionary inventory management system has just been installed at your company. As a result of this, the Materials Department has determined that inventory levels can be reduced by 60% while maintaining current customer service levels.

Incorporate the above change into your analysis and report on your new findings. Support your conclusion with key points and highlight any changes in your recommendation.

Directions- Part 3

The marketing department has lost faith in their ability to accurately forecast new product demand. You have been secretly suspecting this inability for a long time but you must still determine the best alternative. Based upon your manager's estimates, the current product demand projections had a 50% probability of being correct. However, there is a 50% probability that they are overstated by 60% and the labor and storage requirements will actually only be 40% of that planned for. However, management has insisted that the new product distribution center be designed for the original forecast in the event that Marketing's forecast is correct. Assume that the actual new product demand will be determined upon start-up of the new system. Also, assume that the \$1,000,000 savings can be realized regardless of the outcome.

Initial results of the new inventory management system have been disappointing. To be on the safe side, your boss has strongly recommended that you plan on a five-day inventory level.

Assume that you can sublet the leased warehouse space for the market rate of \$4/ft.²/year. You cannot sublet the automated or owned conventional warehouse space because they have been designed to your specific product requirements and are not flexible enough to adapt to the specific needs of others

Incorporate the above changes into your analysis and report on your findings. Support your conclusion with key points and highlight any changes in your recommendation.