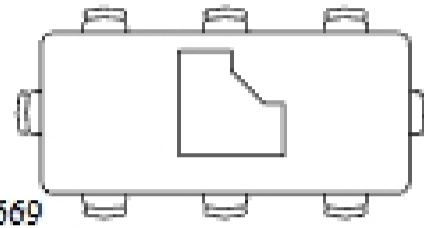


LAYOUT OF MACHINES AND FACILITIES

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Outline

- LAYOUT EXAMPLES
- SINGLE-ROW MACHINE LAYOUT
- DOUBLE-ROW MACHINE LAYOUT
- MULTIROW FACILITY LAYOUT
- ALGORITHMS



Latest layout software *Proplanner*

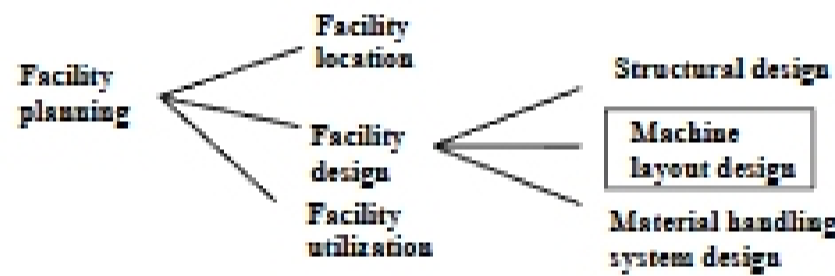
<http://www.proplanner.com/product/details/flowpath.aspx>



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Big Picture



Jobs: Facility Designer
 Facility Planner

AutoCAD Software
<http://www.autodesk.com/>



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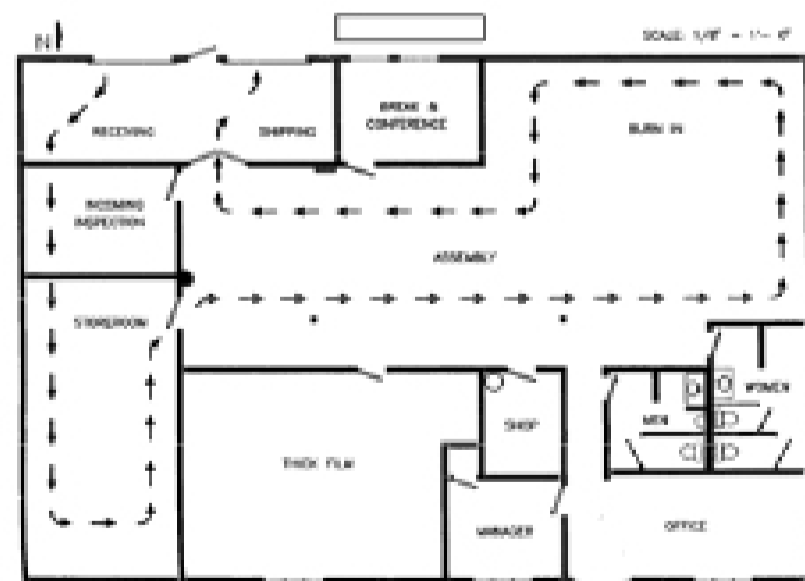
LAYOUT EXAMPLES



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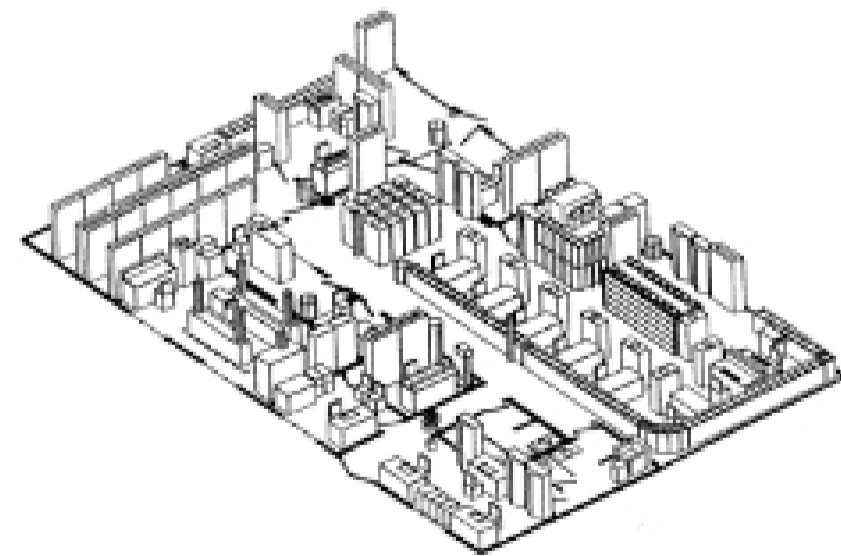
MANUFACTURING FACILITY LAYOUT



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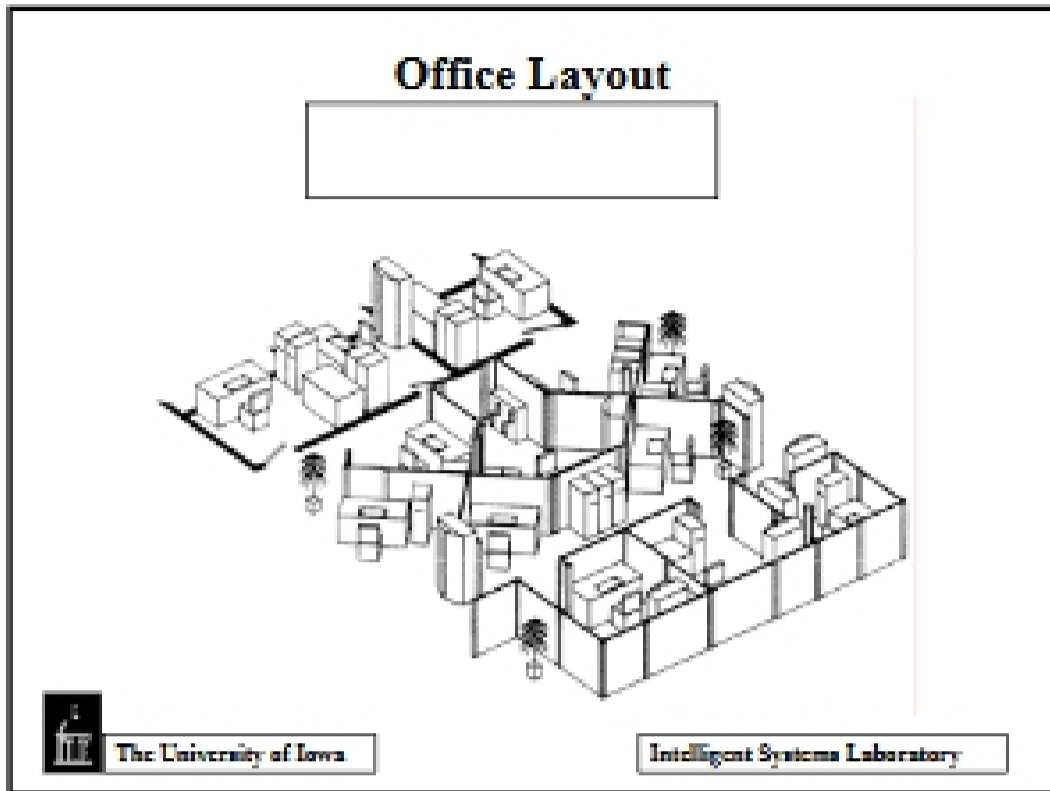
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ASSEMBLY AREA LAYOUT



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LAYOUT OF MACHINES

Methods:

- Visual, e.g., using templates
- Computer based (often an environment for evaluating various layout alternatives)
- Model based


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LAYOUT OF MACHINES

Visualization types:

- 2D
- 3D
- Virtual reality


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LAYOUT OF MACHINES Model Based Approach


Basic Layout Patterns


Single-Row Machine Layout

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Double-Row Machine Layout

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Multi-row Layout

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BASIC DATA

- UNIT DISTANCE TRAVEL COST (c)
- OR FREQUENCY OF TRIPS (f)
- DISTANCE (d)
- OR TRAVEL TIME (t)



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OBJECTIVE

Arrange machines on the shop floor in such a way that the total product of the travel cost per unit distance traveled [\$/m] and the distance traveled [m] is minimum.

Travel cost is often replaced with the number (frequency - f) of trips per time unit [1/sec] between any two machines.

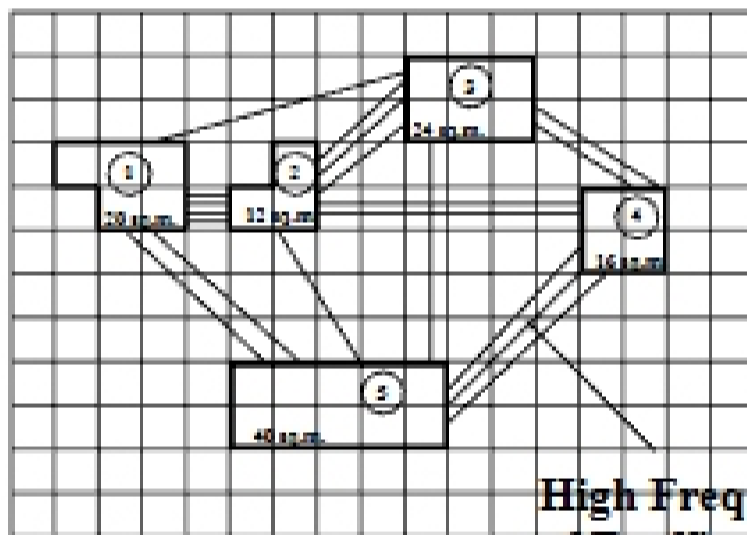
Distance is replaced with travel time - t [sec].

$$\text{Min} \sum_{i=1}^n \sum_{j=1}^n \sum_{k=1}^n f_{ijk} t_{ij} x_{ij} x_{kl}$$



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Example: Intuitive Machine Layout



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SINGLE-ROW MACHINE LAYOUT

Frequency of trips (traffic flow)

$$f_{ij} = \sum_{k=1}^n \left[\frac{v_{ij}^k}{u_k} \right]$$

- where:
- v_{ij}^k = volume of part type k to be moved from machine i to machine j in a given time horizon (for example, 1 year)
 - n_{ij} = number of different parts to be moved from machine i to machine j in a given time horizon
 - u_k = number of parts to be moved in a single trip of the material handling equipment
 - $[\cdot]$ = smallest integer greater than or equal to \cdot



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The AGV travel time involves:

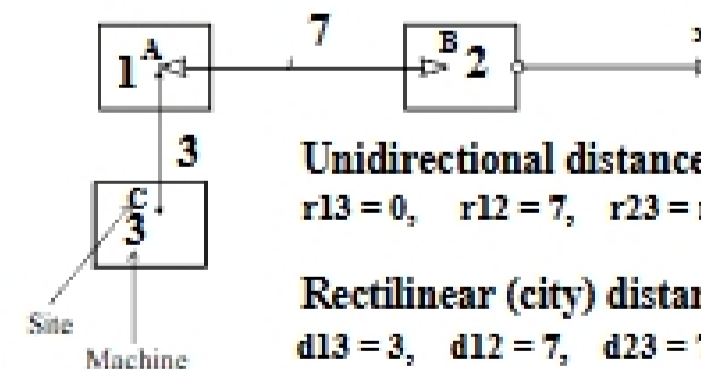
- loading time
- acceleration time
- travel time
- deceleration time
- unloading time



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DISTANCE CALCULATION

Consider 3 machines



Unidirectional distance (along x axis)
 $r_{13} = 0, r_{12} = 7, r_{23} = r_{12} = 7$

Rectilinear (city) distance
 $d_{13} = 3, d_{12} = 7, d_{23} = 7 + 3 = 10$

Euclidean distance
 $e_{12} = 7, e_{13} = 7.48$



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