

**Facility Layout Design Case-Study:  
Common Conduit's New Layout**

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**Abstract:** This case requires the student to develop a material handling from-to chart based on a production flow chart. A facility layout must be designed for a multi-floor manufacturing facility considering material handling costs, material flow patterns, and department shapes. The student is also instructed to provide the analysis necessary to determine whether leasing or buying the facility in question is the better option. Facility issues like cafeteria, restroom, and personnel flow planning may also be considered.

## **Facility Layout Design Case-Study: Common Conduit's New Layout**

### Objectives:

To transform a description of material flow into a from-to material handling chart for use in solving a facility layout design problem. To use a methodological approach to generate alternative layouts and to select amongst them. To provide facility recommendations related to personnel requirements. To analyze the economic tradeoff between leasing and buying a new facility. To evaluate the economic impact of the final recommendation.

### Introduction:

Karen Kipper, the vice president of corporate real estate for Common Conduit, looks out of the Warren Lamp Plant main offices onto the gray day outside. It is November in Ohio, which means that she would have been pretty lucky to see the sun on her visit to the plant today. Not that it matters, sun or no sun, Common Conduit has outgrown the Warren Lamp Plant and now it will be her call as to what to do next. After touring the plant and discussing the issues with the staff there, she has given them until the beginning of the new year to propose their plan for the spring. She is expecting a report that analyzes whether CC should buy or lease the Studebaker Electric plant and details the new facility layout. She is thinking that maybe when she returns in January it will be sunny with some snow on the ground – and then her driver arrives to take her back to the airport in Youngstown.

### Background:

Common Conduit (CC) is one of the three largest incandescent lamp<sup>1</sup> manufacturers in the world, with manufacturing plants worldwide, but concentrated in the United States. CC manufacturers many different incandescent lamp varieties (at last count 45). Their plant in Warren, Ohio produces 13 of the 45 different lamp varieties. In general, each lamp includes a glass bulb, a metal base, and in between, the filament, some support wires, a support tube and a glass flange.

These 13 lamp varieties can be grouped into 3 product families (3-way light bulbs, decorative light bulbs, and parabolic aluminized reflector lamps). The three-way light bulbs have the highest demand. Current production rates of 384 bulbs per hour cannot meet the current demand. The decorative light bulbs (e.g., colored bulbs, “Gro and Sho,” etc.) are usually painted and their production rate is set at 192 bulbs per hour. Finally, the parabolic aluminized reflector (PAR) lamps, which are commonly referred to as spotlights, are not bulbs, but rather an open-topped reflector with a piece of round flat glass glued onto the top. The hourly production rate is set at 96 for the PARs.

CC's Warren plant (the Warren Lamp Plant, or WLP for short) currently occupies an older three-story facility. Since the lease will expire soon and the company is on a growth path, a new facility plan must be composed. Expanding the current facility would be costly due to its location, and CC isn't sure that the current owner would be willing to do so. The

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<sup>1</sup> Incandescent lamps are commonly known as light bulbs.

staff at WLP has entered into discussions concerning a two-story industrial facility located nearby, which was recently owned by Studebaker Electric. The facility is currently vacant and all the results obtained from an initial evaluation of the condition of the building indicate that it would be a suitable facility for the WLP. Moving into this 96,000 ft<sup>2</sup> facility, and increasing production from 8 hours to 12 hours per day with a part-time student line will allow WLP to meet increasing demand.

The building outline for the Studebaker facility is shown in Figure 1, where a 20' x 20' grid size has been used. Some modifications will have to be made to the facility so that it is useable to CC, but the current owner has indicated a willingness to work with CC on this matter if they decide to lease it. In the event that CC purchases the building, CC would be responsible for all expenses incurred in modification. One of the other positive aspects concerning the Studebaker facility is that there is sufficient room in the front of the facility (opposite receiving and shipping) to add an adjacent office building for clerical offices, restrooms, a cafeteria and meeting room, and a nursing station. There is not enough room in the plant for these departments and CC would like to keep them separated from the manufacturing departments as much as possible. More data are provided later on the Studebaker building lease vs. buy decision.

#### The Bulb Production System:

The three bulb product families, i.e., the 3-Ways, Decs, and PARs, are similar in components and share a few of the same storage departments. However, different processing departments are used in the production of the bulbs. Figure 2 illustrates the flow for each of the product families, with the PARs illustrated first, the Decs illustrated second, and the 3-Ways illustrated last. Note that each number outlined by a circle or a triangle in Figure 2 denotes a production department or a storage department, respectively. Figure 2 illustrates that the PARs have one main assembly routing and one sub-assembly routing (that corresponds to the glass top and metal reflector). Figure 2 also illustrates that the Decs have one main assembly routing and two sub-assembly routing. Finally, Figure 2 illustrates that the 3-Ways have one main assembly routing. The asterisks in Figure 2 explain the function of the numbers in front of the production routings (sub-assembly multipliers) and the numbers on top of the arrows between the departments (material handling unit load sizes).

The planning departments and the data associated for each department are shown in Table 1. Each department's data includes both a preferred area and a minimum area, which provides some flexibility in determining a layout. Also provided in Table 1 is the number of employees in each planning department. As seen from Table 1, there are a total of 15 planning departments. For now we have ignored personnel requirements (restrooms, cafeteria, breakrooms, offices, etc.). These necessary functions will be addressed in the second stage of the facilities design process when the adjacent office building is designed.

Departments 1, 2, and 5 are common to all product families. Departments 3, 4, 6, and 7 are exclusively for PAR production. Departments 8 – 13 are exclusively for Dec production. Departments 14 and 15 are exclusively for 3-Way production. Note that Department 1, the receiving/shipping department, has been fixed to a particular location due to the current location of docks in the facility. This location is shown in Figure 1.

The material handling cost for the daily production of light bulbs is the main criterion used

by CC to evaluate the effectiveness of a layout. The horizontal cost to travel one grid (20') is assumed to be \$0.10 – except for when the receiving/shipping department is involved – where we assume a cost of \$0.025 for one grid of horizontal travel due to more efficient material handling methods. In the new facility the distance between the two floors is 18 feet and the vertical cost is \$0.50 and \$0.125 per 18 feet (the less expensive cost applies to flows involving the receiving/shipping department).

### Facility Issues:

Note that Figure 1 indicates the location of the existing lifts in the facility. We may decide to close some of them later, but for now, we can assume that they are all “open.”

Studebaker is willing to sell their building or lease it to CC. The annual lease cost is \$4.00 per square foot net<sup>2</sup> and the selling price will probably be approximately \$3.5M<sup>3</sup>. In the case of the lease, Studebaker indicated that they would spend up to \$150,000 to customize the space to suit CC's needs if CC signs a 10-year lease. Studebaker indicated that the lease would contain a cost of living increase after five years. Ms. Kipper indicated that lease payments are 100% tax-deductible<sup>4</sup> and the interest payments on the mortgage are also tax-deductible. The principal payments on the mortgage are not tax-deductible, but as owner, CC would depreciate the building over 39 years. In either case, annual maintenance costs are predicted to be \$50,000.

Within CC, Ms. Kipper bases economic decisions on NPV<sup>5</sup> calculations. The WLP plant manager, Fred Meyer, uses a payback period analysis when recommending projects. Since the two methods aren't always consistent, this has been a source of friction between the two. In fact, Mr. Meyer doesn't believe that Ms. Kipper understands other plant issues.

In the office building that CC will build adjacent to the Studebaker facility, they will need to provide 1,250 ft<sup>2</sup> for the offices<sup>6</sup>, but the requirements for a cafeteria (which will also be used as a meeting room), the restrooms, and a nurse's station must still be determined.

### Your Layout Assignment:

You are to develop a block layout for CC in the Studebaker facility and assess the economic impact of your recommendation (i.e., what is the NPV of the projected maintenance and material handling costs). To do so, you must first develop a from-to chart. The from-to chart will be used as the main method for representing the material handling flow in the WLP facility.

Note that multi-floor facility layout algorithms are available, as discussed in *Facilities Planning* (Tompkins, *et al.*, 2e, 1996). Practical issues in multi-floor facility layout are also discussed in Bozer, Meller and Erlebacher (*Management Science*, 1994).

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<sup>2</sup> Under a net lease the tenant pays a base rent and is responsible for all the operating expenses except, for example, the repair and replacement of the building structure and the roof.

<sup>3</sup> At current, capital can be secured for a 30-year mortgage at 8% assuming the standard 20% down payment.

<sup>4</sup> Profits of CC are subject to a 40% corporate tax rate.

<sup>5</sup> CC's internal after-tax rate of return is 21%.

<sup>6</sup> Approximately 12 employees occupy the offices.

Your final layout will be generally evaluated on the following points (presented in their order of importance):

1. Hourly material handling cost of your final layout.
2. Department shapes.
3. Overall production flow pattern for the two products.

In addition to the from-to chart, your final layout, and the net present value of your final layout material handling costs, also present a detailed report to Ms. Kipper and her engineering staff on the advantages and disadvantages of your layout, and the general methodology that you used to arrive at the final layout that you are recommending. She has provided the following notes for the format of the report.

- The entire report should be typed single-sided on 8.5" by 11" paper with cover sheet, page numbers, table of contents, references, appendices, and ample margins.
- Your final layout should be a block layout, drawn either using the blank building outline provided along with this handout or a duplicate layout that you produce on your own. Each department in the layout should be CLEARLY labeled by the department **name and number**, and the BOUNDARIES for all departments should be CLEARLY shown.
- Make three additional copies of the final layout. On each copy show the overall flow pattern in color for one of the three product families.
- You are encouraged (but not required) to show intermediate layouts that you obtain as you progress toward your final layout. Intermediate layouts need not be drawn precisely as long as they are presented clearly. Regardless of the number of intermediate layouts or alternative layouts you generate, you have to select ONLY ONE OF THEM as your final layout and present it as stated above.
- Graphs or tables that summarize key results should be presented in the main body of the report.
- All detailed NPV computations and support for your layout methodology should be presented in appropriate appendices.

#### Your Facility Assignment:

In addition to the facility layout concerns above, the following items should be incorporated into your final report.

1. Provide the NPV-analysis for Ms. Kipper to make the lease vs. buy decision on the Studebaker facility. You cannot consider all of the risk factors, that is her job, but you can provide her with an analysis of the tradeoff.
2. What dimensions would you recommend for the office building that will be built adjacent to the Studebaker facility? Provide the analysis regarding the area

requirements of the various office building components.

3. Modify your facility layout to account for restroom placement within the manufacturing facility. Provide the analysis regarding the area requirements for the restrooms.
4. Develop a plan to account for material handling and personnel flow in the facility. This plan should include main aisle placement, emergency exit placement, and personnel vertical travel.

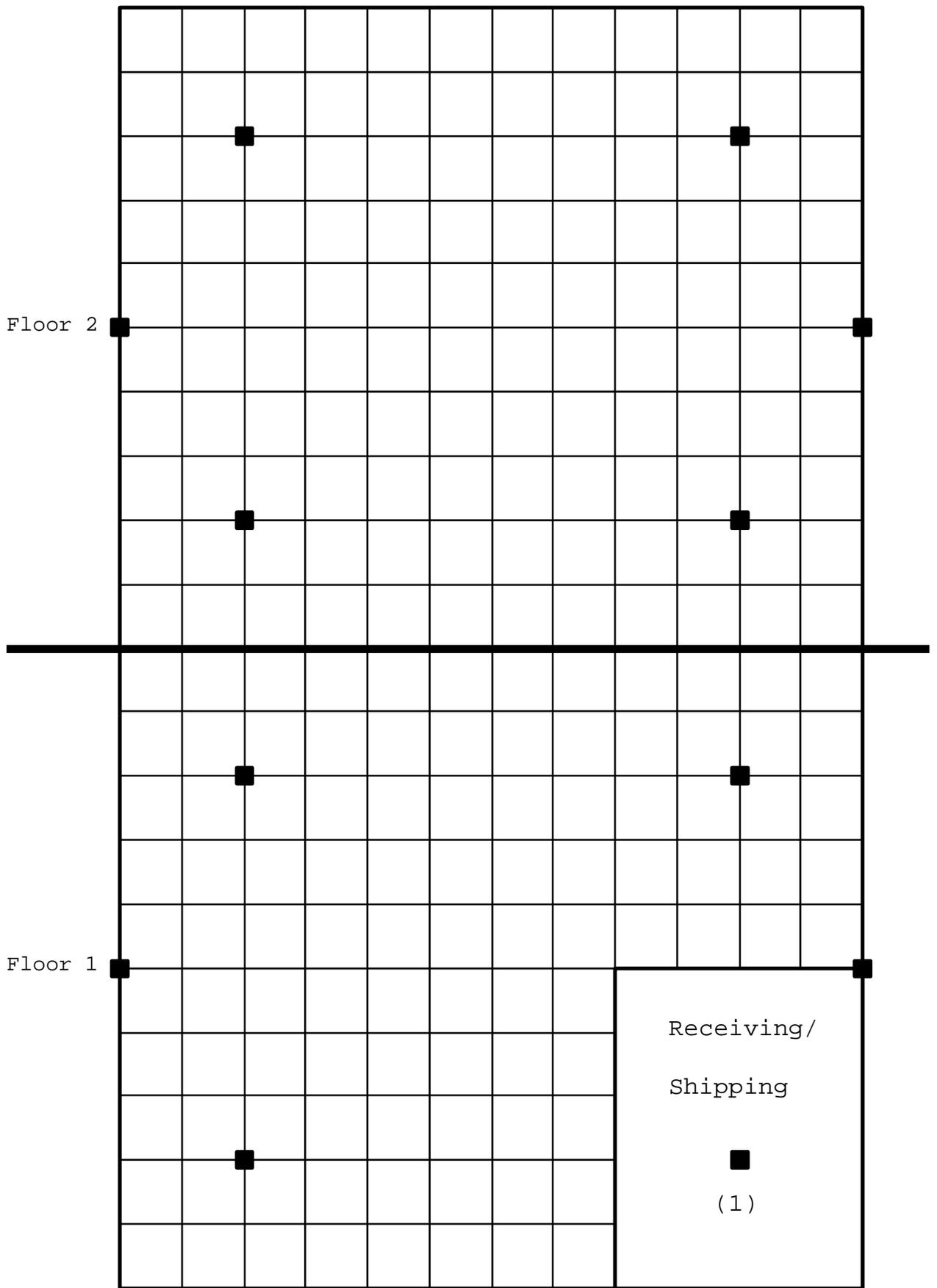
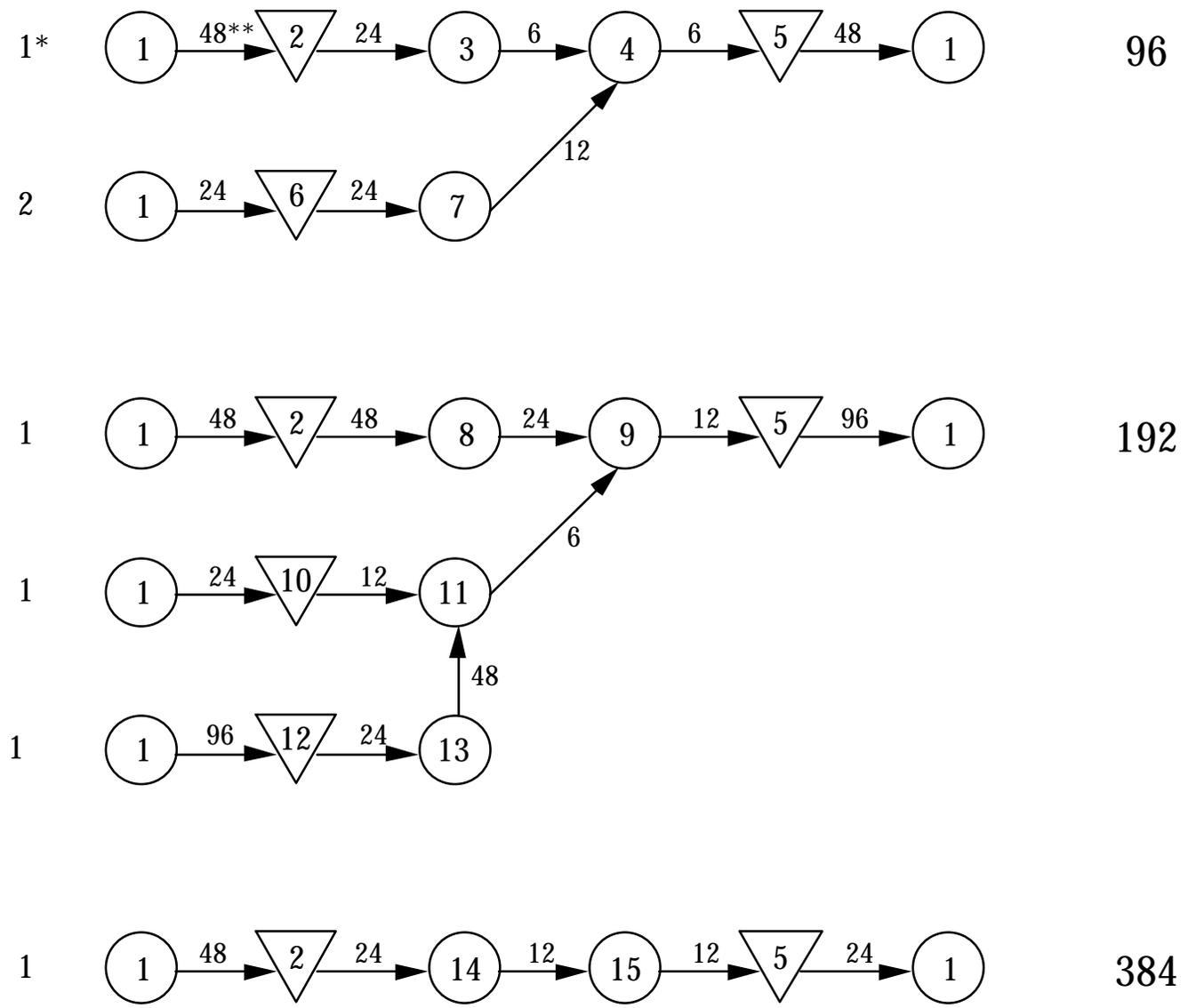


Figure 1: Studebaker Building Outline, Receiving/Shipping and Lift Locations.

Subassembly Department Sequence

Production Rate



 denotes storage department
  denotes production department

- \* Number in front of subassembly department sequence corresponds to the number of subassemblies in the final product.
- \*\* Number on top of the arrow between two departments corresponds to the size of the unit load moved between the two departments.

Figure 2: Product Flow Chart for the Ohio Lamp Plant.

*Table 1: Area (in 20' by 20' grids) and Personnel Requirements for the Ohio Lamp Plant Planning Departments. (\* Indicates a fixed department.)*

	Department	Preferred Area	Minimum Area	# of Personnel
1*	Receiving/Shipping	20	20	20
2	Incoming Storage	12	8	4
3	PAR Assembly I	10	8	5
4	PAR Assembly II	10	8	6
5	Finished Goods Storage	10	8	4
6	PAR Reflector Storage	24	20	2
7	PAR Reflector Marriage	24	24	4
8	Decorative Storage I	16	12	2
9	Decorative Storage II	10	8	2
10	Decorative Bulb Storage	24	20	2
11	Decorative Painting	10	10	4
12	Decorative Base Storage	16	12	2
13	Decorative Base Assembly	10	8	3
14	Electrostatic Coating	20	20	6
15	3-Way Assembly	24	24	12