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Systematic Layout Planning (SLP)

Solutions to Exercises and Case Problems

RICHARD MUTHER & ASSOCIATES

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Summary of Anticipated Moves

Route	Pallet Loads Per Day*	Trays/Pans Per Day**	Equivalent Pallets/Day
Flow in one direction			
1. Receiving – In Storage	12	--	12
2. In-Storage – Press	11	--	11
3. In Storage – Machine	8	--	8
4. Press – Machine	3	--	3
5. Machine – Assemble	13	--	13
6. Press – Assemble	7	--	7
7. Assemble – Finished Storage	18	--	18
8. Finished Storage – Shipping	19	--	19
9. Machining – Shipping	2	4	3
10. In-Storage – Assemble	3	9	5
Flow in both directions			
11. Test – Press	--	8	2
12. Test – Machine	--	35	7
13. Service – Press	--	40	8
14. Service – Machine	--	9	2

* Pallets can be used for transport of all raw and processed materials in the process sequence.

* * Trays and pans of various sizes will also be for small purchased items and for test samples and tools-and-supplies service. Trays are approximately 12” x 18” in size. Pans also vary but are about the same size as trays, a little smaller but deeper. Assume 5 trays/pans equal one pallet load.

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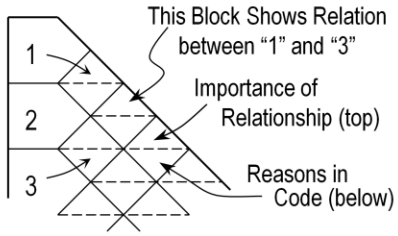
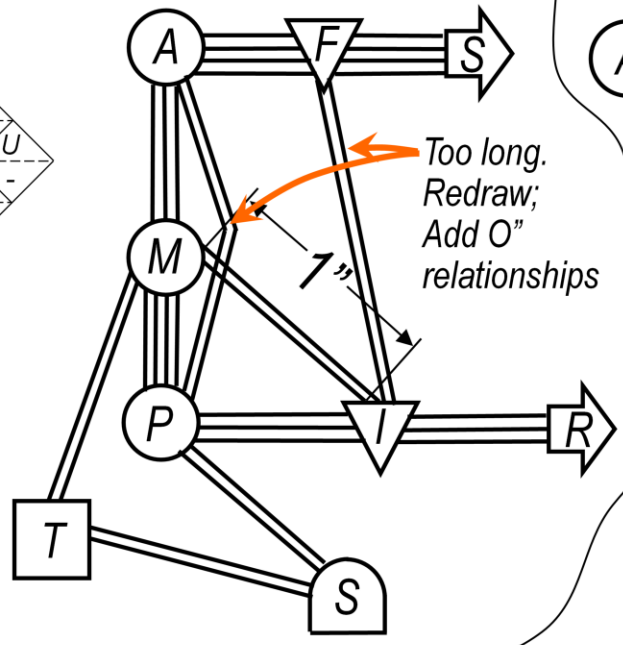
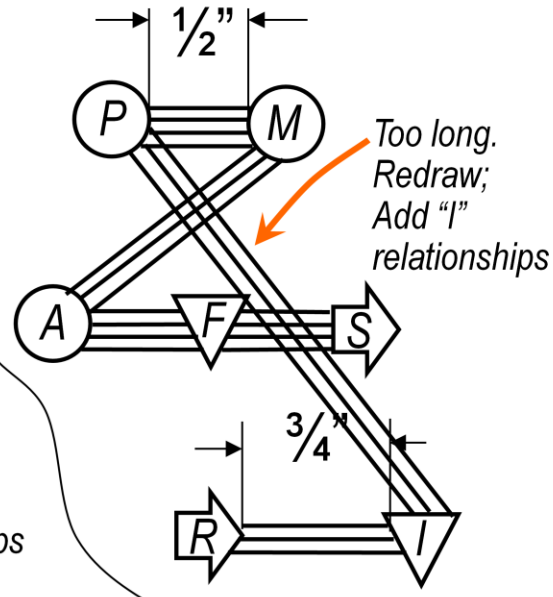
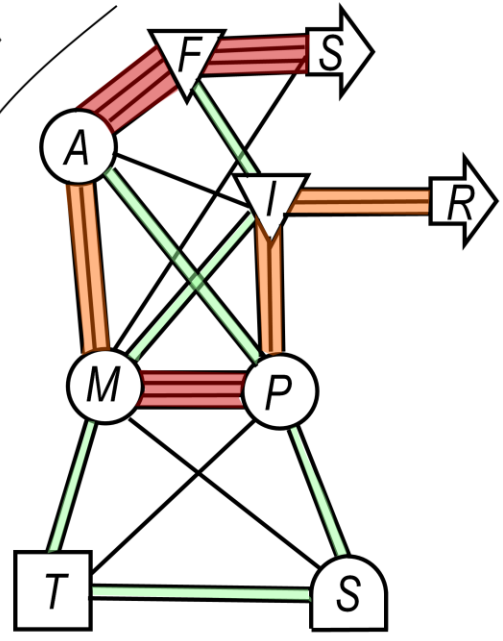
Buildmore Chassis – Activity-Relationship Diagram

Space sq. ft.		Combined Relationships (Flow and Other/Service)
0	1 R	Receiving
3600	2 I	Incoming Storage
7200	3 P	Press
7200	4 M	Machine
12000	5 A	Assembly
5400	6 F	Finished Storage
0	7 S	Shipping
1800	8 T	Test
1800	9 S	Service









Code	REASON
1	*Flow of Material*
2	*Same Supervisor*
3	*Same Personnel*
4	*Share Space*

"Closeness" Rating

Value	CLOSENESS	No. of Ratings
A	Absolutely Necessary	3
E	Especially Important	3
I	Important	6
O	Ordinary Closeness OK	4
U	Unnecessary	20
X	Not desirable	0
	Total = $\frac{N \times (N-1)}{2}$	36

Problem: Using the data above Buildmore Chassis planning team, follow the SLP procedure to develop an Activity Relationship Diagram in the space provided on the right.

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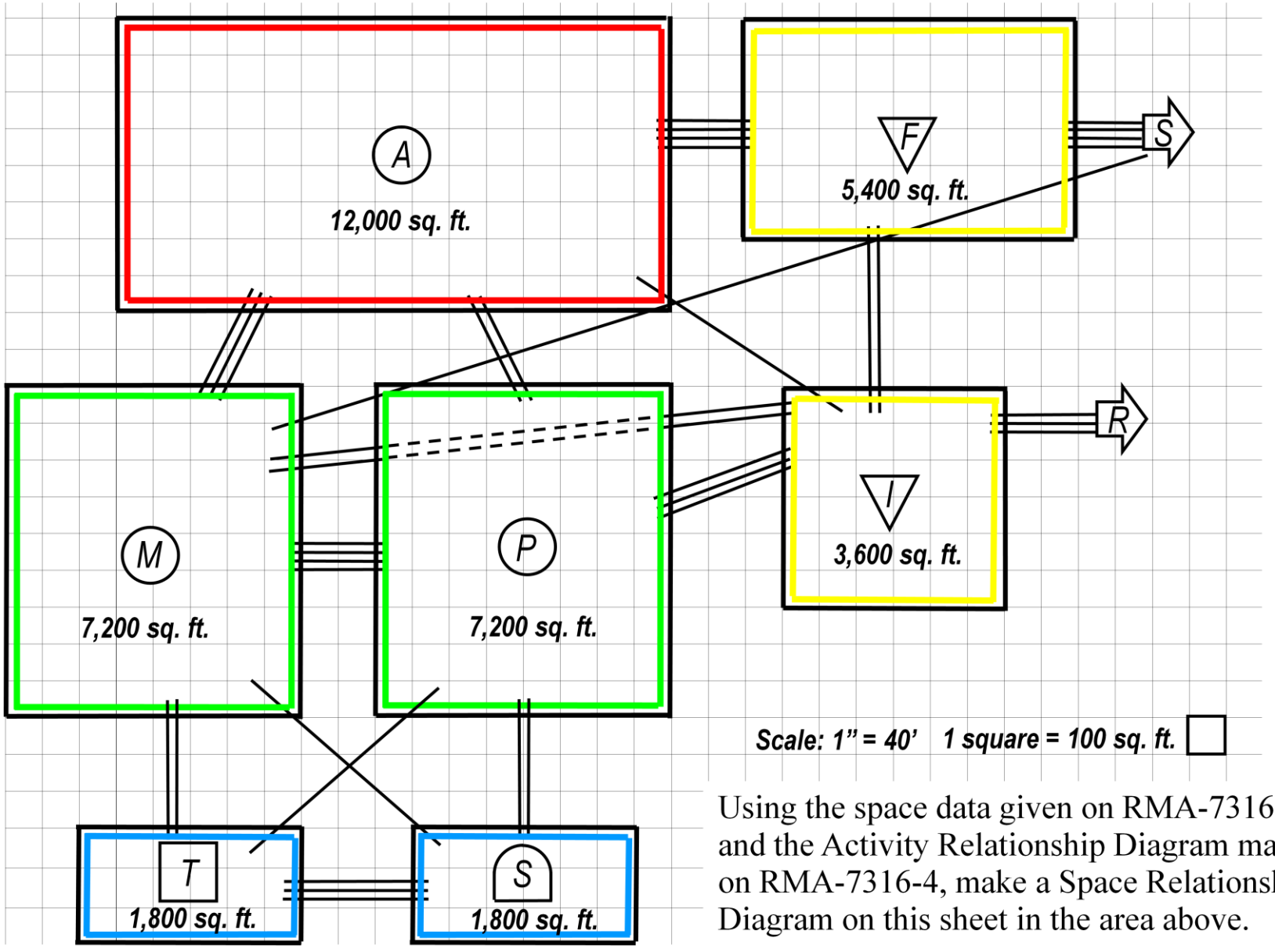
Space Relationship Diagram



Using the space data given on RMA-7316-1a and the Activity Relationship Diagram made on RMA-7316-4, make a Space Relationship Diagram on this sheet in the area above.

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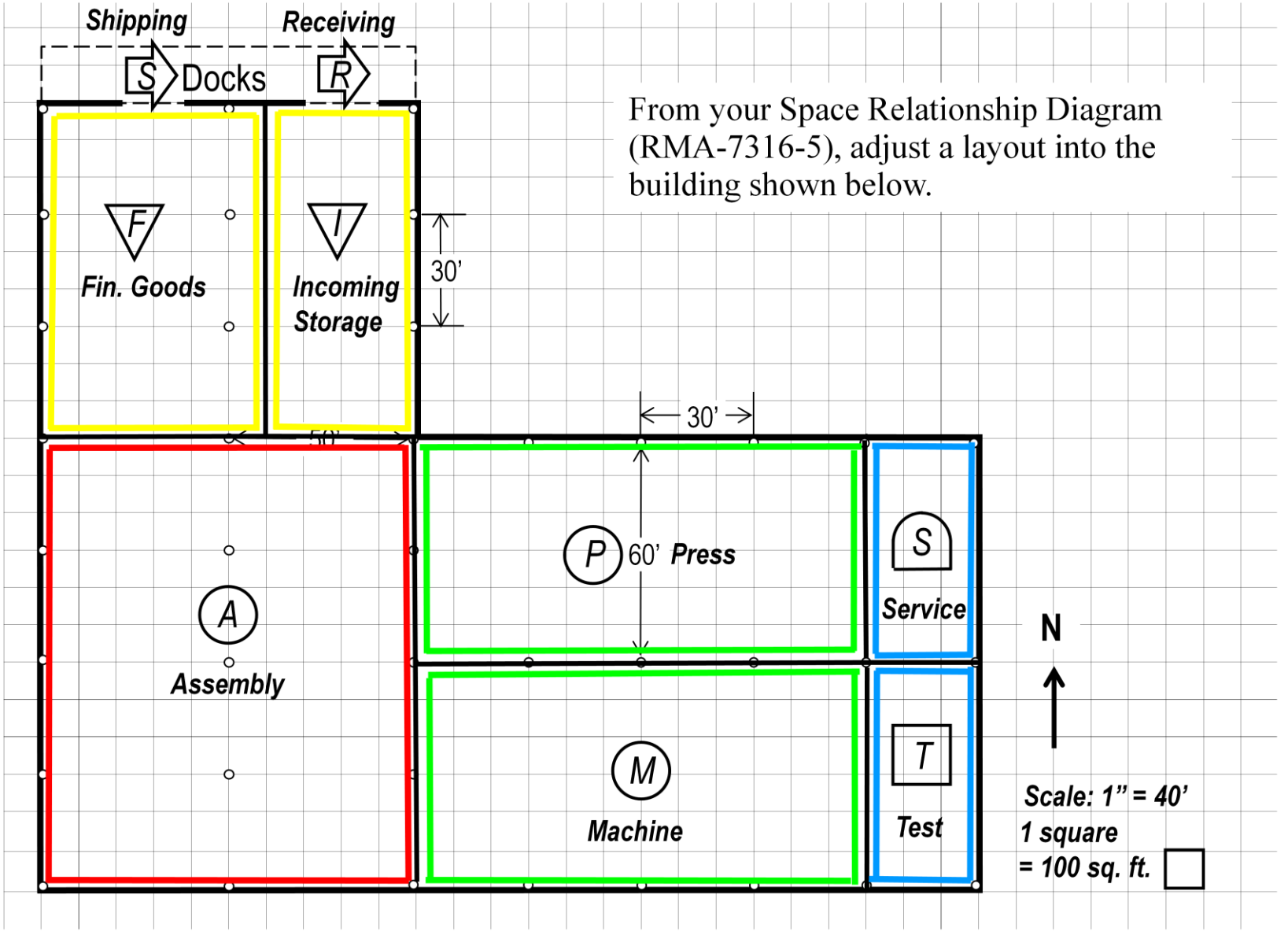
Buildmore Chassis New Plant Layout



From your Space Relationship Diagram (RMA-7316-5), adjust a layout into the building shown below.

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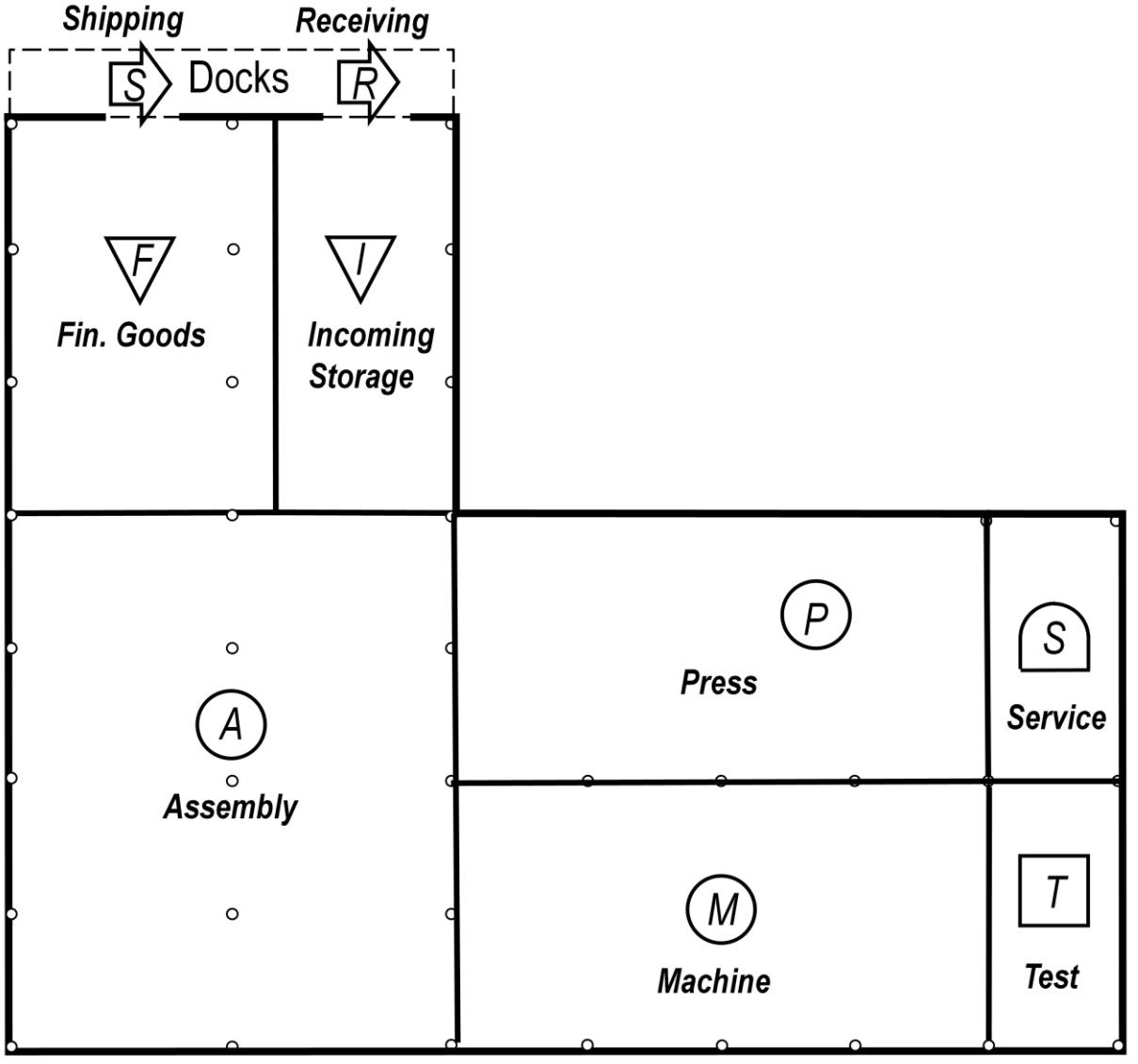
Buildmore Chassis Quantified Flow Diagram



Equivalent Pallets/Day

ROUTE	a. Pallets	b. Trays/ Pans
R – I		
I – P	11	--
I – M	8	--
P – M	3	--
M – A	13	--
P – A	7	--
A – F	18	--
F – Sh	19	--
M – Sh	2	1
I – A	3	2
T – P	--	2
T – M	--	7
Sv – P	--	8
Sv – M	--	2

Make a Quantified Flow Diagram on this layout.

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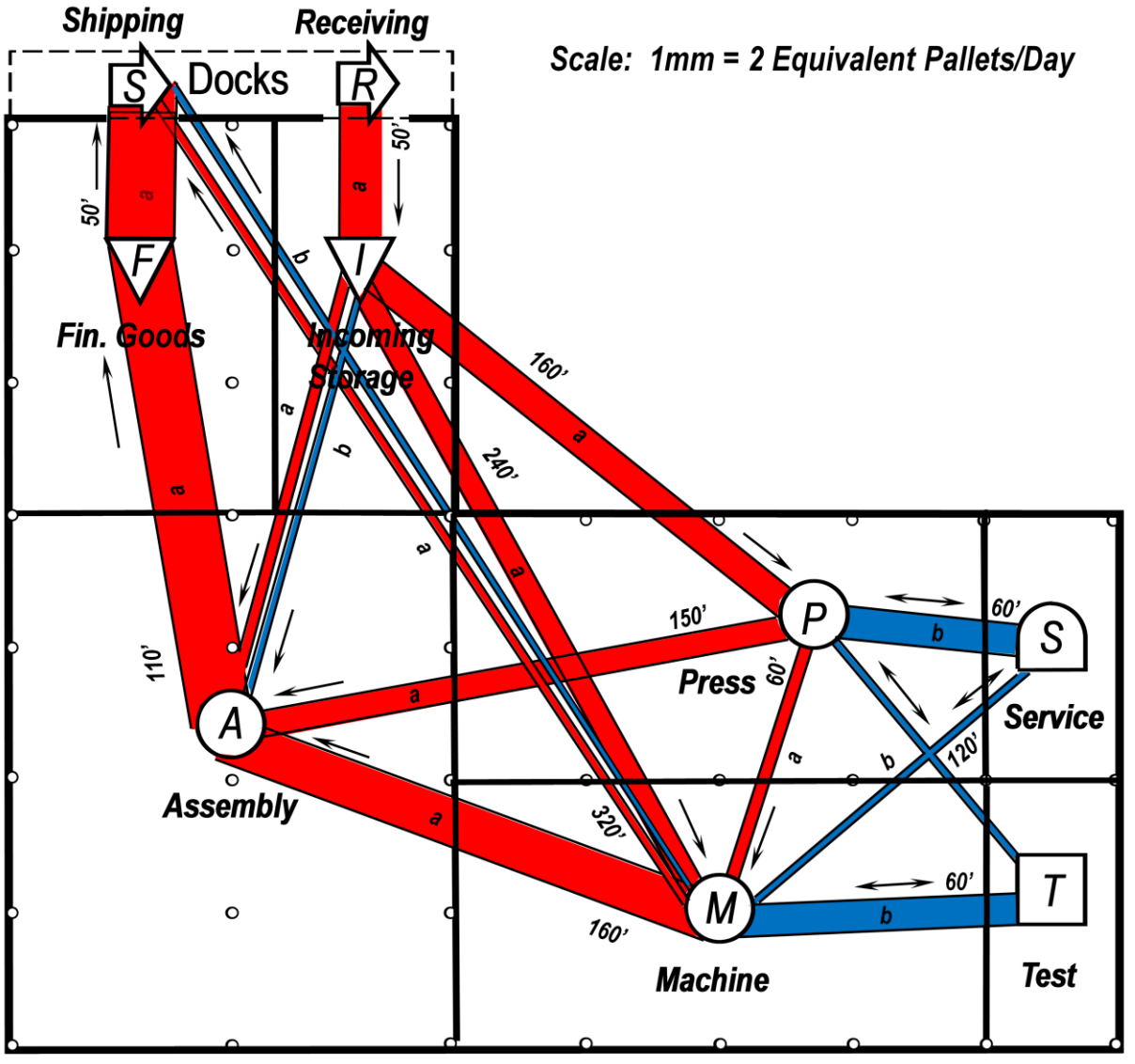
Buildmore Chassis Quantified Flow Diagram



Scale: 1mm = 2 Equivalent Pallets/Day

Equivalent Pallets/Day

ROUTE	a. Pallets	b. Trays/ Pans
R – I		
I – P	11	--
I – M	8	--
P – M	3	--
M – A	13	--
P – A	7	--
A – F	18	--
F – Sh	19	--
M – Sh	2	1
I – A	3	2
T – P	--	2
T – M	--	7
Sv – P	--	8
Sv – M	--	2

Make a Quantified Flow Diagram on this layout.

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From-To Chart

Questions

1. What is the flow from Material Storage to Fluorescent Assembly? **22**
2. What is the total flow between these two areas? **24**
3. What is the total flow into Small Parts Sub-Assembly? **9**
4. What is the total flow out from Small Parts Sub-Assembly? **7**
5. What explains more flow into an area than coming out? **Assembly; densification** **Change in form**
6. What is the total flow into Wire Stringing? **4**
7. The total flow from Wire Stringing? **6**
8. What explains more coming out of an area than went in? **Loss of density; disass'y** **Change in form**
9. What explains balanced flows to and from Material Storage? **No chg in form (no picking)**
10. Why might the "equivalent flow" coming out of Painting be higher than going in? **Risk of damage** **Difficulty**

FROM-TO-CHART

Item(s) Charted: *All Items* Basis of Values: *Equivalent skids per year x 1000*

Plant: *White Lighting Co.* By: *K.W.M* Date: *22 June*

No.	Activity-Area (FROM \ TO)	1 Receiving	2 Material Storage	3 Machining	4 Wire Stringing	5 Small Parts Sub-Assembly	6 Fluorescent Assembly	7 Mercury Vapor Assembly	8 Façade Light Assembly	9 Finished Fixture Storage	10 Pipe Receiving & Storage	11 Pipe Bending	12 Welding	13 Painting	14 Outside Pole Storage	15 Shipping	TOTALS
1	Receiving		60	0	0	0	0	0	0	0	0	0	0	0	0	0	60
2	Material Storage	0		9	4	0	22	1	30	0	0	0	0	0	0	0	66
3	Machining	0	1		0	9	0	0	0	0	0	0	0	0	1	0	11
4	Wire Stringing	0	0	0		0	2	1	3	0	0	0	0	0	0	0	6
5	Small Parts Sub-Assembly	0	0	0	0		6	1	0	0	0	0	0	0	0	0	7
6	Fluorescent Assembly	0	2	0	0	0		0	0	24	0	0	0	0	0	0	26
7	Mercury Vapor Assembly	0	0	0	0	0	0		0	2	0	0	0	0	0	0	2
8	Façade Light Assembly	0	3	0	0	0	0	0		25	0	0	0	0	0	0	28
9	Finished Fixture Storage	0	0	0	0	0	4	0.5	5		0	0	0	0	0	50	60
10	Pipe Receiving & Storage	0	0	0	0	0	0	0	0	0		60	40	0	0	0	100
11	Pipe Bending	0	0	0	0	0	0	0	0	0	0		80	0	0	0	80
12	Welding	0	0	0	0	0	0	0	0	0	0	0		120	0	0	120
13	Painting	0	0	0	0	0	0	0	0	0	0	0	0		140	0	140
14	Outside Pole Storage (b)	0	0	0	0	0	0	0	0	0	0	0	0	0		140	140
15	Shipping	0	0	0	0	0	0	0	0	10 (a)	0	0	0	0	0		10
16	(a) Packing materials are best stored in the finished fixture storage area.																0
17	(b) Including scrap accumulation depot.																0
	TOTALS	0	66	9	4	9	34	4	38	61	0	60	120	120	141	190	856

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Relationships Other-Than-Flow

Production supervisors, Maintenance, QA and Materials Management have expressed their desires for closeness between several activity-areas. Their reasons do not involve the flow of materials. Before developing layouts, you want to be sure that these other relationships are identified and considered.

Questions:

1. How will you proceed?

   Meet with appropriate supervisors and engineers.

   Post their ratings to a Relationship Chart.

   Combine or integrate with flow of materials ratings.

2. What do these relationships suggest? (See RMA – 7145-7b)

   Keep assembly areas together.
   Need physical separation of pipe welding and paint.
   Keep services and general office away from pipe welding.
   No important reasons to keep Receiving & Shipping together.

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Construction Fasteners Co. – Type of Space Ratios & Projections

10-year land requirement

U-space Mfg. + U-space Dist. = 5,400 + 16,400 = 21,800

+ Parking for U-Mfg. & U-Dist. = 21,800 x 0.33 = 7,194

+ Main Office = 800

+ Parking for Main Office = 800 x 1.0 = 800

+ Truck Loading & Parking = (U-Mfg. + U-Dist.) x 0.10 = 2,180

+ Drives & Roadways = 0.5 x Total U = 0.5 x 22,600 = 11,300

Total Site before Set-back allowance =

21,800 + 7,194 + 800 + 800 + 2,180 + 11,300 = 44,074

+ Set back allowance @ 15% of total area = 44,074 / 0.85 = 51,852

Or 52,000 square meters (about 12 acres)

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Construction Fasteners Co. – Type of Space Ratios & Projections

Underroof U-Space History & Projections in Square Meters

	Manufacturing Space						Distribution Space								
Year	Fastener Mfg	Pistol Mfg	Connector Mfg	Mfg. Support	Total Mfg	Mfg % of Total	Fastener Distribution	Pistol Repair	Connector Distribution	Total Distribution	Dist % of Total	Main Office Space	Total Area (Occupied) Underroof	Sales @ Mfg Cost	Annual Growth Rate
-15	1500	600	0	800	2900	59%	1600	200	0	1800	37%	200	4900	10	12%
-10	2400	800	0	2000	5200	62%	2400	400	0	2800	33%	400	8400	18	10%
-5	2400	1200	1200	2000	6800	58%	2800	800	600	4200	36%	800	11800	28	7%
Current	0	1200	2400	2400	6000	42%	4200	800	2400	7400	52%	800	14200	40	6%
+5	0	0	3200	2200	5400	31%	7200	800	3200	11200	64%	800	17400	53	6%
+10	0	0	3200	2200	5400	24%	10400	1600	4400	16400	73%	800	22600	71	5%
+15	0	0	3200	2400	5600	20%	14000	1200	7000	22200	78%	800	28600	91	
			Assumes connector production in-house	Support: Offices, Svcs, Lab, QC, Maint., Docks, Raw Stores			Incl. share of Rec'g., Pick, Pack, Stage, Ship					No growth	Does not include vacant space	Per Business Plan	

Y-Space Ratios

Parking for Plant and Distribution Center	0.33	to U-Space for Mfg and Distribution
Parking for Main Office	1.00	to U-Space for Main Office
Truck Loading & Parking	0.10	to U-Space for Mfg. and Distribution
Drives and Roadways	0.50	to total Underroof space
Set-back from property lines	0.15	of total site area

Exercise:

1. Roughly, how many square meters of land are needed to support projected growth in Year 10?

   52,000 sq. m.

2. In Year 15?

   About 25% more

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White Lighting Company

The Company is basically an assembly operation. Although some machining is done, most of the light fixture components are purchased from outside suppliers. The present facilities are three old buildings right in the heart of the city. Their layouts are very poor due to building constrictions such as differences in floor levels, ceiling heights, and types of architecture. Also, the buildings are far too small for the projected level of business. The conglomerate management has given the Company permission to lease a building now under construction on the outskirts of the city and to transfer its operations. The building area is 40,000 sq. ft. and measures 160 by 250 ft. Column spacing is 40 by 50 feet and the effective head room is 18 feet. Shipping and receiving doors have not been located, so the Company can place them where it likes, and also establish its own dock specifications.

Problem:

You are a special project engineer for the conglomerate and have been assigned to work with the Company in developing its overall layout plans. What other information do you feel will be required? What will be your approach?

Get key input data: P Q R S T

Define activity-areas

Block layout: Relationships, space, adjustment

Evaluate and select

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White Lighting Company – Processes and Supporting Services

All raw materials are received by truck and stored inside.

Manufacture of all fixtures is relatively simple. Simple machining (turning, drilling, milling) is performed on small aluminum castings. Smaller components are sub-assembled. Wiring is cut-to-length and strung into harness assemblies for later installation at final assembly. Finished fixtures are held at the plant for shipment to customers or distributors.

Poles are fabricated from steel pipe in lengths up to 20 feet. Pipe should be received and stored in a separate area. About 60% of the poles must be bent. All poles require welding operations and prime paint. Painted poles can be stored outside. All poles are wired at the installation site.

In addition to manufacturing, the plant's activities include: tool making and maintenance, a block for employee services, tool tryout and weld-testing laboratory, and the general offices.

Problem:

How would you split and/or combine these operations into various activity areas for this plant? What classical type(s) of layout make the most sense?

Layout by product type: Lighting (Fluorescent, Façade, Merc-Vap) and Poles

Layout by process: Machining, Wire-stringing, sub- assy, final assy

Possibly by cell?: Machine, sub and final for a specific model of lamp

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White Lighting Company – Flow-of-Materials Analysis

Before we can measure the flow of materials on a realistic quantitative basis, we must determine the comparative ease or difficulty of transporting each item through the plant. We can then multiply this by the quantity of items moving over a given period of time.

At the present time, most items used in the manufacture of White Lighting Company products are moved within the plant on 3' by 4' wooden-deck skids. Purchased items are occasionally received on pallets. Very small items are transported in metal tote pans. Some items, like painted poles, must be handled individually.

Problem:

What unit of measure will you use to indicate the flow of materials? How do you arrive at this unit of measure?

Most-handled unit is a skid.

Equate tote pans and poles to skids based on relative size, ease of movement, effort, speed, etc.

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From-To Chart

Questions

1. What is the two-way flow between Painting and Outside Pole Storage? **140**
2. Is this the activity pair with the highest flow between them? **No**
3. What is the two-way flow between Finished Fixtures Storage and Shipping? **60**
4. Does the flow from Shipping to Finished Fixtures Storage appear on the operation process chart? **No**
5. What about the flow from Facade Light Assembly to Material Storage? **No**
6. What material movements appear to be missing in the operation process chart? **Packaging Material Back flows**
7. Why might these kinds of flows be left off the process chart? **Exclusive focus on value-adding process; Not enough input from Materials organization**

FROM-TO-CHART

Item(s) Charted: *All Items* Basis of Values: *Equivalent skids per year x 1000*

Plant: *White Lighting Co.* By: *K.W.M* Date: *22 June*

No.	Activity-Area (FROM \ TO)	1 Receiving	2 Material Storage	3 Machining	4 Wire Stringing	5 Small Parts Sub-Assembly	6 Fluorescent Assembly	7 Mercury Vapor Assembly	8 Façade Light Assembly	9 Finished Fixture Storage	10 Pipe Receiving & Storage	11 Pipe Bending	12 Welding	13 Painting	14 Outside Pole Storage	15 Shipping	TOTALS
1	Receiving		60	0	0	0	0	0	0	0	0	0	0	0	0	0	60
2	Material Storage	0		9	4	0	22	1	30	0	0	0	0	0	0	0	66
3	Machining	0	1		0	9	0	0	0	0	0	0	0	0	1	0	11
4	Wire Stringing	0	0	0		0	2	1	3	0	0	0	0	0	0	0	6
5	Small Parts Sub-Assembly	0	0	0	0		6	1	0	0	0	0	0	0	0	0	7
6	Fluorescent Assembly	0	2	0	0	0		0	0	24	0	0	0	0	0	0	26
7	Mercury Vapor Assembly	0	0	0	0	0	0		0	2	0	0	0	0	0	0	2
8	Façade Light Assembly	0	3	0	0	0	0	0		25	0	0	0	0	0	0	28
9	Finished Fixture Storage	0	0	0	0	0	4	0.5	5		0	0	0	0	0	50	60
10	Pipe Receiving & Storage	0	0	0	0	0	0	0	0	0		60	40	0	0	0	100
11	Pipe Bending	0	0	0	0	0	0	0	0	0	0		80	0	0	0	80
12	Welding	0	0	0	0	0	0	0	0	0	0	0		120	0	0	120
13	Painting	0	0	0	0	0	0	0	0	0	0	0	0		140	0	140
14	Outside Pole Storage (b)	0	0	0	0	0	0	0	0	0	0	0	0	0		140	140
15	Shipping	0	0	0	0	0	0	0	0	10 (a)	0	0	0	0	0		10
16	(a) Packing materials are best stored in the finished fixture storage area.																0
17	(b) Including scrap accumulation depot.																0
	TOTALS	0	66	9	4	9	34	4	38	61	0	60	120	120	141	190	856

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Flow-of-Materials Relationships

Question:

How will you convert these flow values into vowel letter ratings? What steps will you follow?

1. Add flows in both directions.
2. Rank or sort routes (activity-pairs) in descending order by 2-way flow.
3. Plot a bar chart and look for break points.
4. Assign vowels to intervals.

FROM-TO-CHART

Plant: White Lighting Co.
By: K.W.M
Date: 22 June

Item(s) Charted: All Items
Basis of Values: Equivalent skids per year x 1000

No.	Activity-Area (FROM \ TO)	1 Receiving	2 Material Storage	3 Machining	4 Wire Stringing	5 Small Parts Sub-Assembly	6 Fluorescent Assembly	7 Mercury Vapor Assembly	8 Façade Light Assembly	9 Finished Fixture Storage	10 Pipe Receiving & Storage	11 Pipe Bending	12 Welding	13 Painting	14 Outside Pole Storage	15 Shipping	TOTALS
1	Receiving		60	0	0	0	0	0	0	0	0	0	0	0	0	0	60
2	Material Storage	0		9	4	0	22	1	30	0	0	0	0	0	0	0	66
3	Machining	0	1		0	9	0	0	0	0	0	0	0	0	1	0	11
4	Wire Stringing	0	0	0		0	2	1	3	0	0	0	0	0	0	0	6
5	Small Parts Sub-Assembly	0	0	0	0		6	1	0	0	0	0	0	0	0	0	7
6	Fluorescent Assembly	0	2	0	0	0		0	0	24	0	0	0	0	0	0	26
7	Mercury Vapor Assembly	0	0	0	0	0	0		0	2	0	0	0	0	0	0	2
8	Façade Light Assembly	0	3	0	0	0	0	0		25	0	0	0	0	0	0	28
9	Finished Fixture Storage	0	0	0	0	0	4	0.5	5		0	0	0	0	0	50	60
10	Pipe Receiving & Storage	0	0	0	0	0	0	0	0	0		60	40	0	0	0	100
11	Pipe Bending	0	0	0	0	0	0	0	0	0	0		80	0	0	0	80
12	Welding	0	0	0	0	0	0	0	0	0	0	0		120	0	0	120
13	Painting	0	0	0	0	0	0	0	0	0	0	0	0		140	0	140
14	Outside Pole Storage (b)	0	0	0	0	0	0	0	0	0	0	0	0	0		140	140
15	Shipping	0	0	0	0	0	0	0	0	10 (a)	0	0	0	0	0		10
16	(a) Packing materials are best stored in the finished fixture storage area.																0
17	(b) Including scrap accumulation depot.																0
	TOTALS	0	66	9	4	9	34	4	38	61	0	60	120	120	141	190	856

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Calibration of Two-Way Flows

Steps

1. Add flows in both directions for each route (activity-pair).
2. Rank (sort) activity-pairs in descending order by two-way flow.
3. Plot a bar chart of sorted two-way flow.
4. Inspect the chart for natural break points and assign vowel letter ratings to the intervals: A-E-I-O-U.

FROM-TO-CHART

Item(s) Charted: *All Items* — Basis of Values: *Equivalent skids per year x 1000*

Plant: *White Lighting Co.* By: *K.W.M* Date: *22 June*

No.	Activity-Area (FROM \ TO)	1 Receiving	2 Material Storage	3 Machining	4 Wire Stringing	5 Small Parts Sub-Assembly	6 Flourescent Assembly	7 Mercury Vapor Assembly	8 Façade Light Assembly	9 Finished Fixture Storage	10 Pipe Receiving & Storage	11 Pipe Bending	12 Welding	13 Painting	14 Outside Pole Storage	15 Shipping	TOTALS
1	Receiving		60	0	0	0	0	0	0	0	0	0	0	0	0	0	60
2	Material Storage	0		9	4	0	22	1	30	0	0	0	0	0	0	0	66
3	Machining	0	1		0	9	0	0	0	0	0	0	0	0	1	0	11
4	Wire Stringing	0	0	0		0	2	1	3	0	0	0	0	0	0	0	6
5	Small Parts Sub-Assembly	0	0	0	0		6	1	0	0	0	0	0	0	0	0	7
6	Flourescent Assembly	0	2	0	0	0		0	0	24	0	0	0	0	0	0	26
7	Mercury Vapor Assembly	0	0	0	0	0	0		0	2	0	0	0	0	0	0	2
8	Façade Light Assembly	0	3	0	0	0	0	0		0	0	0	0	0	0	0	3
9	Finished Fixture Storage	0	0	0	0	0	4	0.5	0		0	0	0	0	0	0	4.5
10	Pipe Receiving & Storage	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0
11	Pipe Bending	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0
12	Welding	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0
13	Painting	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
14	Outside Pole Storage (b)	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
15	Shipping	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
16	(a) Packing materials are best stored in the finished fixture storage area.																
17	(b) Including scrap accumulation depot.																
	TOTALS	0	66	9	4	9	34	4									

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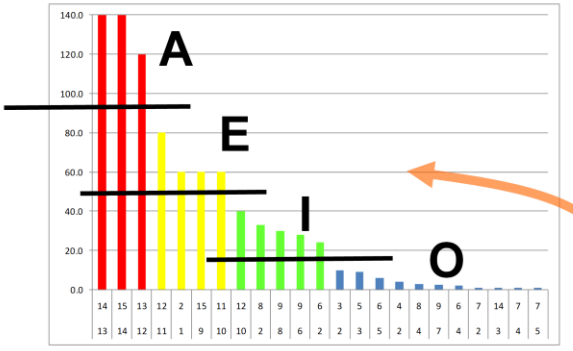

	Activity		Activity	From-To	To-From	2-Way	Ranking	Vowel Rating
13	Painting	14	Outside Pole Storage (incl. scrap)	140.0	0.0	140.0	1a	A
14	Outside Pole Storage (incl. scrap)	15	Shipping	140.0	0.0	140.0	1b	A
12	Welding	13	Painting	120.0	0.0	120.0	3	A
11	Pipe Bending	12	Welding	80.0	0.0	80.0	4	E
1	Receiving	2	Material Storage	60.0	0.0	60.0	5a	E
9	Finished Fixture Storage	15	Shipping	50.0	10.0	60.0	5b	E
10	Pipe Receiving & Storage	11	Pipe Bending	60.0	0.0	60.0	5c	E
10	Pipe Receiving & Storage	12	Welding	40.0	0.0	40.0	8	I
2	Material Storage	8	Façade Light Assembly	30.0	3.0	33.0	9	I
8	Façade Light Assembly	9	Finished Fixture Storage	25.0	5.0	30.0	10	I
6	Fluorescent Assembly	9	Finished Fixture Storage	24.0	4.0	28.0	11	I
2	Material Storage	6	Fluorescent Assembly	22.0	2.0	24.0	12	I
2	Material Storage	3	Machining	9.0	1.0	10.0	13	O
3	Machining	5	Small Parts Sub-Assembly	9.0	0.0	9.0	14	O
5	Small Parts Sub- Assembly	6	Fluorescent Assembly	6.0	0.0	6.0	15	O
2	Material Storage	4	Wire Stringing	4.0	0.0	4.0	16	O
4	Wire Stringing	8	Façade Light Assembly	3.0	0.0	3.0	17	O
7	Mercury Vapor Assembly	9	Finished Fixture Storage	2.0	0.5	2.5	18	O
4	Wire Stringing	6	Fluorescent Assembly	2.0	0.0	2.0	19	O
2	Material Storage	7	Mercury Vapor Assembly	1.0	0.0	1.0	20a	O
3	Machining	14	Outside Pole Storage (incl. scrap)	1.0	0.0	1.0	20b	O
4	Wire Stringing	7	Mercury Vapor Assembly	1.0	0.0	1.0	20c	O
5	Small Parts Sub- Assembly	7	Mercury Vapor Assembly	1.0	0.0	1.0	20d	O

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Notes

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Relationships Other-Than-Flow

Production supervisors, Maintenance, QA and Materials Management have expressed their desires for closeness between several activity-areas. Their reasons do not involve the flow of materials. Before developing layouts, you want to be sure that these other relationships are identified and considered.

Questions:

1. How will you proceed?

   Meet with appropriate supervisors and engineers.

   Post their ratings to a Relationship Chart.

   Combine or integrate with flow of materials ratings.

2. What do these relationships suggest? (See RMA – 7145-7b)

   Keep assembly areas together.
   Need physical separation of pipe welding and paint.
   Keep services and general office away from pipe welding.
   No important reasons to keep Receiving & Shipping together.

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RELATIONSHIP CHART

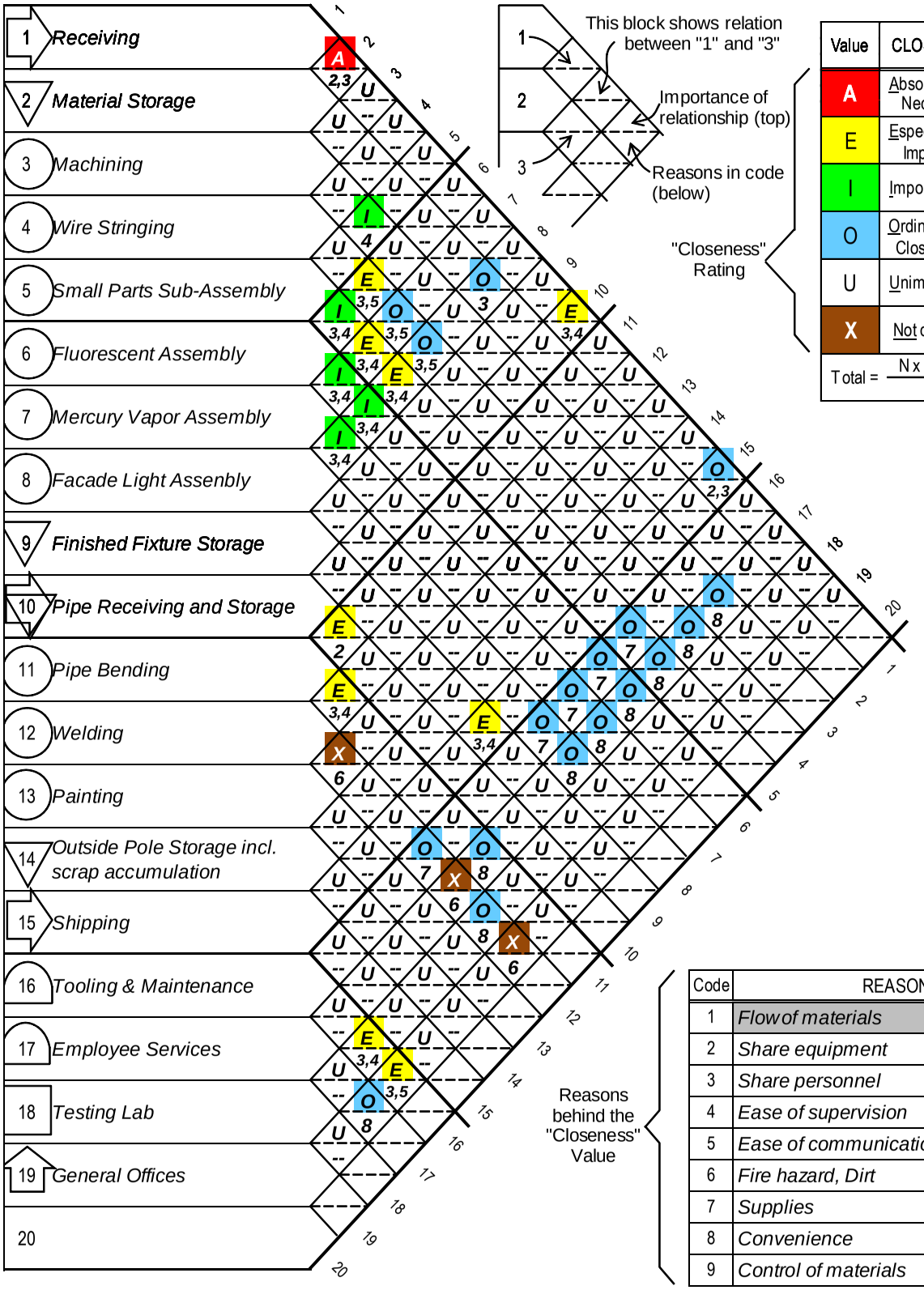
Other than flowrelationships

Plant (Company) *White Lighting* Project *New Plant Layout*

Charted by *KWM* With *Supervisors*

Date *23 June* Sheet *1* of *1*

Reference



Value	CLOSENESS	No. of Ratings
A	Absolutely Necessary	1
E	Especially Important	9
I	Important	5
O	Ordinary Closeness OK	18
U	Unimportant	135
X	Not desirable	3
Total = $\frac{N \times (N-1)}{2}$ =		171

Reasons behind the "Closeness" Value

Code	REASON
1	*Flow of materials*
2	*Share equipment*
3	*Share personnel*
4	*Ease of supervision*
5	*Ease of communication*
6	*Fire hazard, Dirt*
7	*Supplies*
8	*Convenience*
9	*Control of materials*

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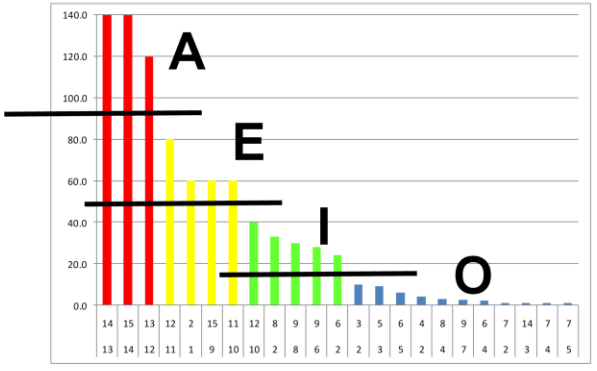
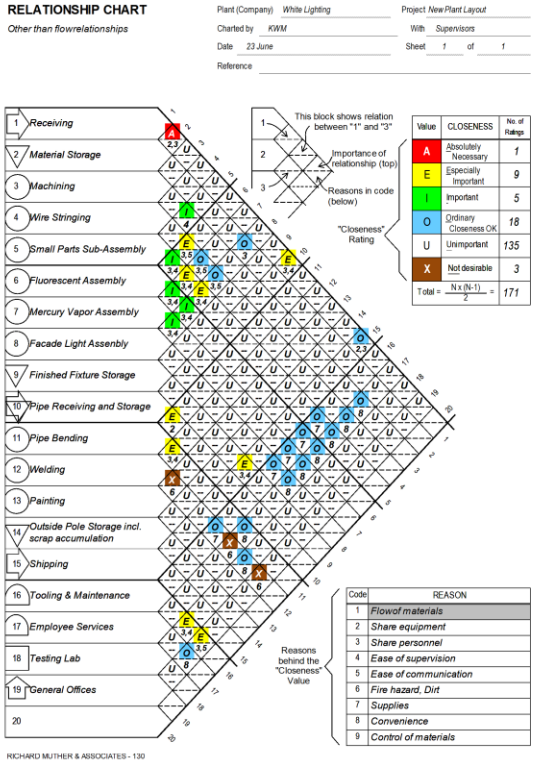
Combining Flow and Other Relationships





Question:

How will you combine flow ratings with other-than-flow ratings? What steps will you follow?

1. Convert vowel letters to point values:
4,3,2,1,-1

2. Decide on relative importance of flow and other. Then assign ratio:
1-to 1; 2 to 1, etc.

3. Add points for flow and other (after application of ratio).

4. Re-rate combined point values:
A, E, I, O, U, X

5. Apply judgment and adjust as needed.

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Ratio of Flow to Other-Than-Flow: 1 to 1

Line #	Activity-Pair		FLOW-OF-MATERIAL INTENSITY						OTHER-THAN-FLOW RELATIONSHIPS				RESULTANT COMBINED RELATIONSHIPS		
			From-To	To-From	2-Way	Vowel Rating	Value	Wt.	Vowel Rating	Reasons	Value	Wt.	Combined Value	Combined Rating	Final Assigned Rating
1	13	14	140.0	0.0	140.0	A	4	1				1			
2	14	15	140.0	0.0	140.0	A	4	1				1			
3	12	13	120.0	0.0	120.0	A	4	1				1			
4	11	12	80.0	0.0	80.0	E	3	1				1			
5	1	2	60.0	0.0	60.0	E	3	1				1			
6	9	15	50.0	10.0	60.0	E	3	1				1			
7	10	11	60.0	0.0	60.0	E	3	1				1			
8	10	12	40.0	0.0	40.0	I	2	1				1			
9	2	8	30.0	3.0	33.0	I	2	1				1			
10	8	9	25.0	5.0	30.0	I	2	1				1			
11	6	9	24.0	4.0	28.0	I	2	1				1			
12	2	6	22.0	2.0	24.0	I	2	1				1			
13	2	3	9.0	1.0	10.0	O	1	1				1			
14	3	5	9.0	0.0	9.0	O	1	1				1			
15	5	6	6.0	0.0	6.0	O	1	1				1			
16	2	4	4.0	0.0	4.0	O	1	1				1			
17	4	8	3.0	0.0	3.0	O	1	1				1			
18	7	9	2.0	0.5	2.5	O	1	1				1			
19	4	6	2.0	0.0	2.0	O	1	1				1			
31	6	7	0.0	0.0	0.0	--	0	1				1			
44	12	17	0.0	0.0	0.0	--	0	1				1			
45	16	18	0.0	0.0	0.0	--	0	1				1			
46	16	19	0.0	0.0	0.0	--	0	1				1			
47	17	19	0.0	0.0	0.0	--	0	1				1			

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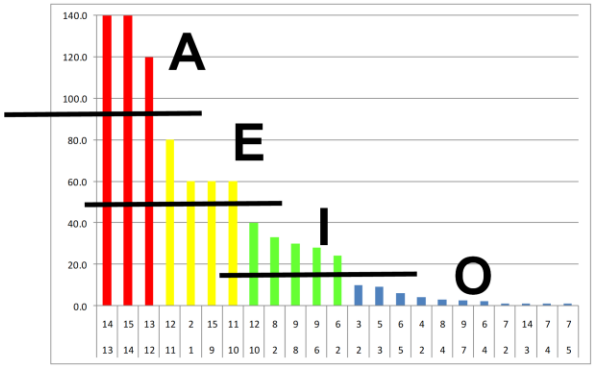
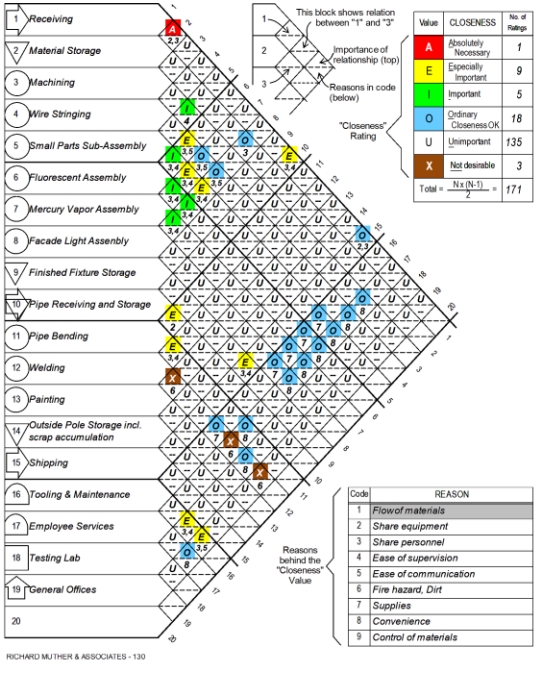
Combining Flow and Other Relationships



RELATIONSHIP CHART

Other than flowrelationships

Plant (Company) *White Lighting* Project *New Plant Layout*
Charted by *KWM* With *Supervisors*
Date *23 June* Sheet *1* of *1*
Reference



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COMBINING FLOW & SERVICE RELATIONSHIPS

Plant (Company) *White Ligting Company* Project *New Plant Layout*
Flow Source / Reference *From-To Summary 6/22* Date *6/24*
Other-Than-Flow Source *Relationship Chart 6/23* By *MDM, JWM*
Sheet *1* of *1*

Ratio of Flow to Other-Than-Flow: 1 to 1

Line #	Activity-Pair		FLOW-OF-MATERIAL INTENSITY: From-To	To-From	2-Way	Vowel Rating	Value	Wt.	OTHER-THAN-FLOW RELATIONSHIPS: Vowel Rating	Reasons	Value	Wt.	RESULTANT COMBINED RELATIONSHIPS: Combined Value	Combined Rating	Final Assigned Rating	Comments
1	1	2	60.0	0.0	60.0	E	3	1	A	2,3	4	1	7	A	A	Must be adjacent
2	11	12	80.0	0.0	80.0	E	3	1	E	3,4	3	1	6	A	A	Must be adjacent
3	9	15	50.0	10.0	60.0	E	3	1	E	3,4	3	1	6	A	A	Must be adjacent
4	10	11	60.0	0.0	60.0	E	3	1	E	2	3	1	6	A	A	Must be adjacent
5	13	14	140.0	0.0	140.0	A	4	1	U	0	0	1	4	E	E	
6	14	15	140.0	0.0	140.0	A	4	1	U	0	0	1	4	E	E	
7	4	6	2.0	0.0	2.0	O	1	1	E	3,5	3	1	4	E	E	
8	10	12	40.0	0.0	40.0	I	2	1	I	7	2	1	4	E	I	Only 40% of poles
9	5	7	1.0	0.0	1.0	O	1	1	E	3,4	3	1	4	E	I	Few operators in Act. 5
10	12	13	120.0	0.0	120.0	A	4	1	X	6	-1	1	3	E	E	Curtain wall separation
11	1	10	0.0	0.0	0.0	--	0	1	E	3,4	3	1	3	E	E	
12	16	18	0.0	0.0	0.0	--	0	1	E	3,4	3	1	3	E	E	
13	16	19	0.0	0.0	0.0	--	0	1	E	3,5	3	1	3	E	E	
14	2	8	30.0	3.0	33.0	I	2	1	O	3	1	1	3	E	I	Flow rating covers "other"
15	3	5	9.0	0.0	9.0	O	1	1	I	4	2	1	3	E	I	Few operators in Act. 5
16	5	6	6.0	0.0	6.0	O	1	1	I	3,4	2	1	3	E	I	Few operators in Act. 5
17	5	8	0.0	0.0	0.0	--	0	1	E	3,4	3	1	3	E	I	Few operators in Act. 5
18	4	8	3.0	0.0	3.0	O	1	1	O	3,5	1	1	2	I	E	Visual management
19	8	9	25.0	5.0	30.0	I	2	1	U	0	0	1	2	I	I	
20	6	9	24.0	4.0	28.0	I	2	1	U	0	0	1	2	I	I	
21	2	6	22.0	2.0	24.0	I	2	1	U	0	0	1	2	I	I	
22	4	7	1.0	0.0	1.0	O	1	1	O	3,5	1	1	2	I	I	
23	6	7	0.0	0.0	0.0	--	0	1	I	3,4	2	1	2	I	I	
24	6	8	0.0	0.0	0.0	--	0	1	I	3,4	2	1	2	I	I	
25	7	8	0.0	0.0	0.0	--	0	1	I	3,4	2	1	2	I	I	
26	2	3	9.0	1.0	10.0	O	1	1	U	0	0	1	1	O	O	
27	2	4	4.0	0.0	4.0	O	1	1	U	0	0	1	1	O	O	
28	7	9	2.0	0.5	2.5	O	1	1	U	0	0	1	1	O	O	
29	2	7	1.0	0.0	1.0	O	1	1	U	0	0	1	1	O	O	
30	3	14	1.0	0.0	1.0	O	1	1	U	0	0	1	1	O	O	
31	1	15	0.0	0.0	0.0	--	0	1	O	2,3	1	1	1	O	O	
32	3	17	0.0	0.0	0.0	--	0	1	O	8	1	1	1	O	O	
33	4	17	0.0	0.0	0.0	--	0	1	O	8	1	1	1	O	O	
34	5	16	0.0	0.0	0.0	--	0	1	O	7	1	1	1	O	O	
35	5	17	0.0	0.0	0.0	--	0	1	O	8	1	1	1	O	O	
36	6	16	0.0	0.0	0.0	--	0	1	O	7	1	1	1	O	O	
37	6	17	0.0	0.0	0.0	--	0	1	O	8	1	1	1	O	O	
38	7	16	0.0	0.0	0.0	--	0	1	O	7	1	1	1	O	O	
39	7	17	0.0	0.0	0.0	--	0	1	O	8	1	1	1	O	O	
40	8	16	0.0	0.0	0.0	--	0	1	O	7	1	1	1	O	O	
41	8	17	0.0	0.0	0.0	--	0	1	O	8	1	1	1	O	O	
42	11	17	0.0	0.0	0.0	--	0	1	O	8	1	1	1	O	O	
43	12	16	0.0	0.0	0.0	--	0	1	O	7	1	1	1	O	O	
44	12	18	0.0	0.0	0.0	--	0	1	O	8	1	1	1	O	O	
45	17	19	0.0	0.0	0.0	--	0	1	O	8	1	1	1	O	O	
46	12	19	0.0	0.0	0.0	--	0	1	X	6	-1	1	-1	X	X	
47	12	17	0.0	0.0	0.0	--	0	1	X	6	-1	1	-1	X	X	

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Combining Flow and Other Relationships

COMBINING FLOW & SERVICE RELATIONSHIPS

Plant (Company) *White Ligting Company* Project *New Plant Layout*

Flow Source / Reference *From-To Summary 6/22* Date *6/24*

Other-Than-Flow Source *Relationship Chart 6/23* By *MDM, JWM*

Sheet *1* of *1*

Ratio of Flow to Other-Than-Flow: **1** to **1**

Line #	Activity-Pair		FLOW-OF-MATERIAL INTENSITY						OTHER-THAN-FLOW RELATIONSHIPS				RESULTANT COMBINED RELATIONSHIPS			Comments
			From-To	To-From	2-Way	Vowel Rating	Value	Wt.	Vowel Rating	Reasons	Value	Wt.	Combined Value	Combined Rating	Final Assigned Rating	
1	1	2	60.0	0.0	60.0	E	3	1	A	2,3	4	1	7	A	A	Must be adjacent
2	11	12	80.0	0.0	80.0	E	3	1	E	3,4	3	1	6	A	A	Must be adjacent
3	9	15	50.0	10.0	60.0	E	3	1	E	3,4	3	1	6	A	A	Must be adjacent
4	10	11	60.0	0.0	60.0	E	3	1	E	2	3	1	6	A	A	Must be adjacent
5	13	14	140.0	0.0	140.0	A	4	1	U	0	0	1	4	E	E	
6	14	15	140.0	0.0	140.0	A	4	1	U	0	0	1	4	E	E	
7	4	6	2.0	0.0	2.0	O	1	1	E	3,5	3	1	4	E	E	
8	10	12	40.0	0.0	40.0	I	2	1	I	7	2	1	4	E	I	Only 40% of poles
9	5	7	1.0	0.0	1.0	O	1	1	E	3,4	3	1	4	E	I	Few operators in Act. 5
10	12	13	120.0	0.0	120.0	A	4	1	X	6	-1	1	3	E	E	Curtain wall separation
11	1	10	0.0	0.0	0.0	--	0	1	E	3,4	3	1	3	E	E	
12	16	18	0.0	0.0	0.0	--	0	1	E	3,4	3	1	3	E	E	
13	16	19	0.0	0.0	0.0	--	0	1	E	3,5	3	1	3	E	E	
14	2	8	30.0	3.0	33.0	I	2	1	O	3	1	1	3	E	I	Flow rating covers "other"
15	3	5	9.0	0.0	9.0	O	1	1	I	4	2	1	3	E	I	Few operators in Act. 5
16	5	6	6.0	0.0	6.0	O	1	1	I	3,4	2	1	3	E	I	Few operators in Act. 5
17	5	8	0.0	0.0	0.0	--	0	1	E	3,4	3	1	3	E	I	Few operators in Act. 5
18	4	8	3.0	0.0	3.0	O	1	1	O	3,5	1	1	2	I	E	Visual management
19	8	9	25.0	5.0	30.0	I	2	1	U	0	0	1	2	I	I	
20	6	9	24.0	4.0	28.0	I	2	1	U	0	0	1	2	I	I	

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RELATIONSHIP CHART

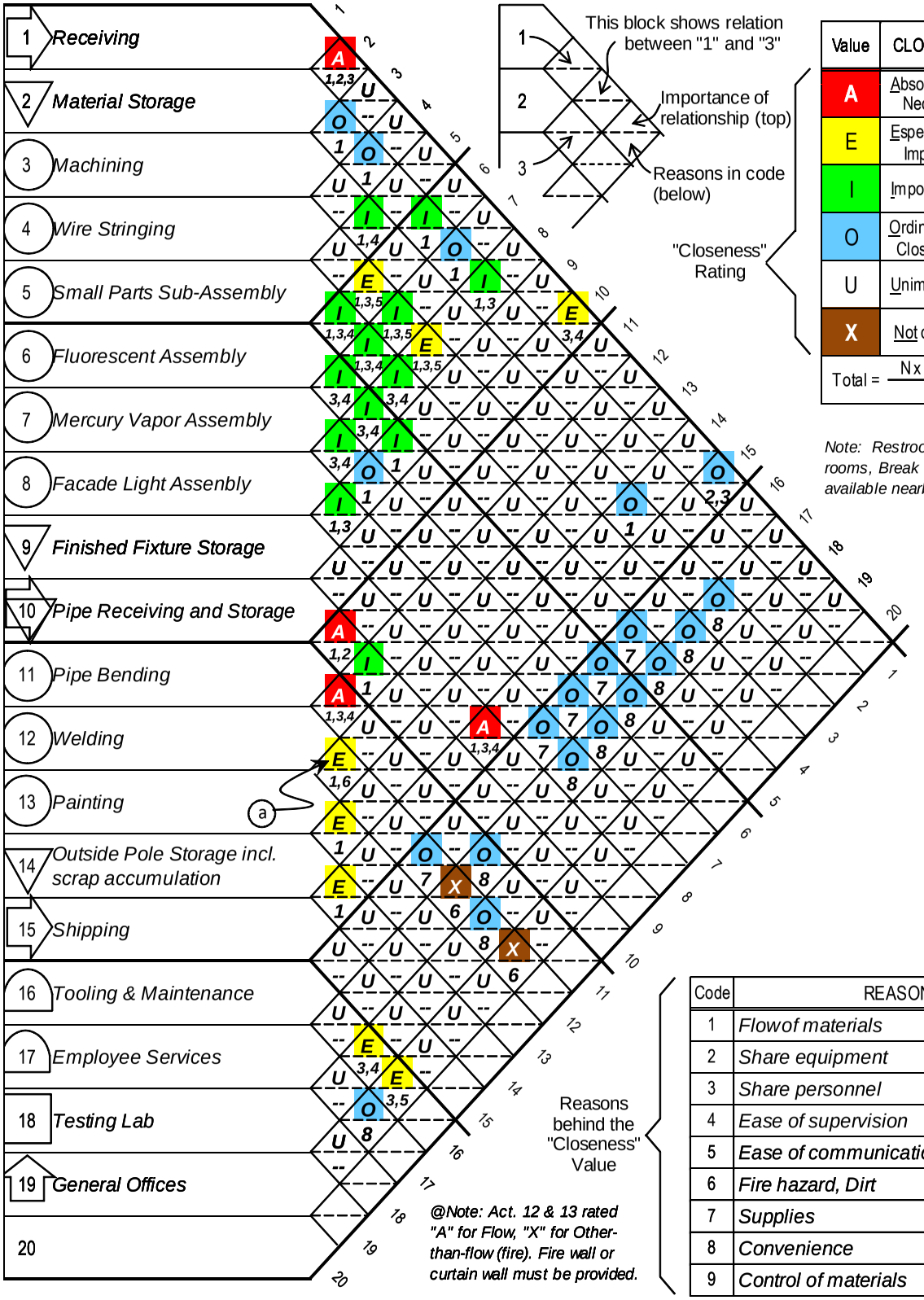
Combined: Flow& Other-than-flow

Plant (Company) *White Lighting* Project *New Plant Layout*

Charted by *MDM* With *JWM*

Date *24 June* Sheet *1* of *1*

Reference *Flow & Service Relationships*



Value	CLOSENESS	No. of Ratings
A	Absolutely Necessary	4
E	Especially Important	8
I	Important	13
O	Ordinary Closeness OK	20
U	Unimportant	124
X	Not desirable	2
Total = $\frac{N \times (N-1)}{2}$ =		171

Note: Restrooms, Locker rooms, Break and cafeteria available nearby.

Reasons behind the "Closeness" Value

Code	REASON
1	*Flowof materials*
2	*Share equipment*
3	*Share personnel*
4	*Ease of supervision*
5	*Ease of communication*
6	*Fire hazard, Dirt*
7	*Supplies*
8	*Convenience*
9	*Control of materials*

@Note: Act. 12 & 13 rated "A" for Flow, "X" for Other-than-flow (fire). Fire wall or curtain wall must be provided.

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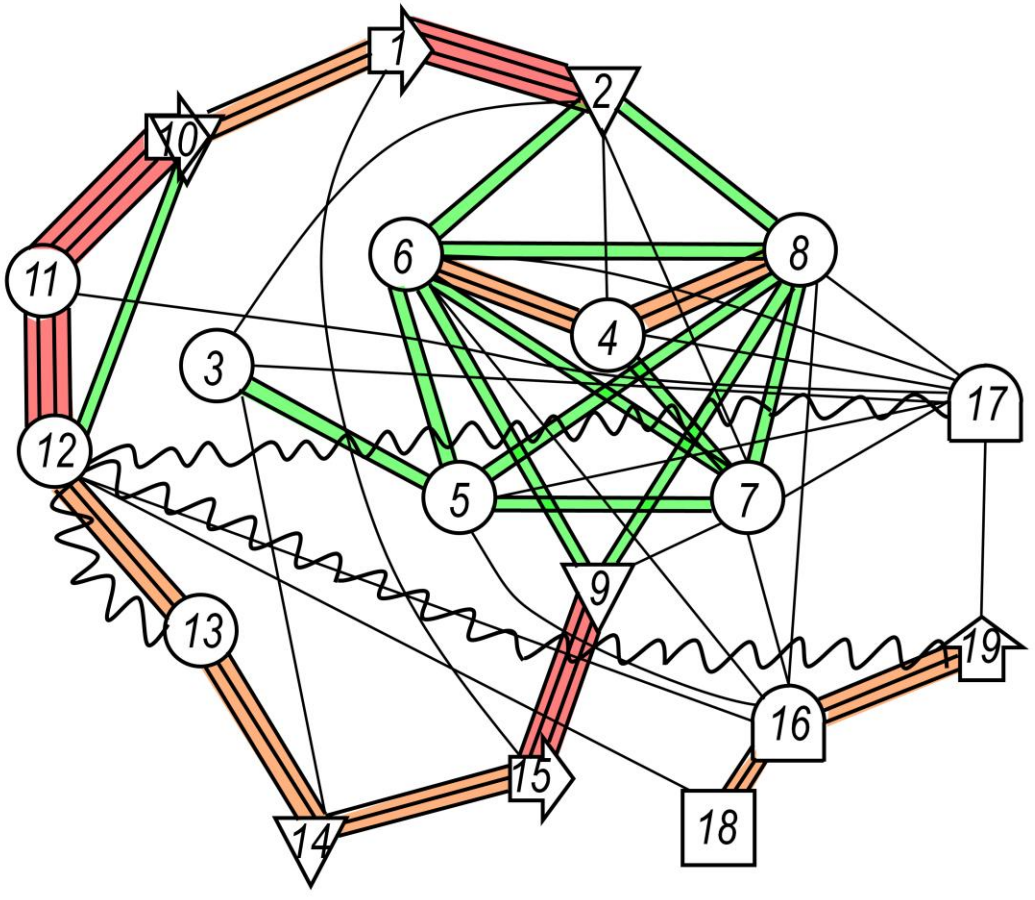
Activity Relationship Diagram



Closeness Rating

- Absolutely Necessary
- Especially Important
- Important
- Ordinary
- Not Desirable

Symbol Key

- Operation
- Store
- Inspection
- Handling
- Delay
- Transport Entrance/Exit
- Service, support
- Office, clerical

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White Lighting Company – Space Required & Available

The building under construction measures 160 by 250 ft. and provides 40,000 square feet. Requirements are for 40,100, including allowances for aisles in each area. The overage of 100 sq. ft. can be ignored in a building of such size.

The new owners have discussed producing a newly acquired product line in the White Lighting building. The production area would require about 3,000 square feet, initially, expanding to perhaps 4,000 in the second year.

Problem:

Suppose that you had to reduce the current space requirements by 4,000 square feet. What questions would you ask? Where would you look for reductions? How might such space be saved?

Reduce storage: Review sourcing, scheduling & inventory policies

Mixed model assembly? Assembly 2 or 3 models in same area?

Methods & productivity: Machining? Welding?

Outsourcing? Buy poles already bent

Number of shifts? Working hours?

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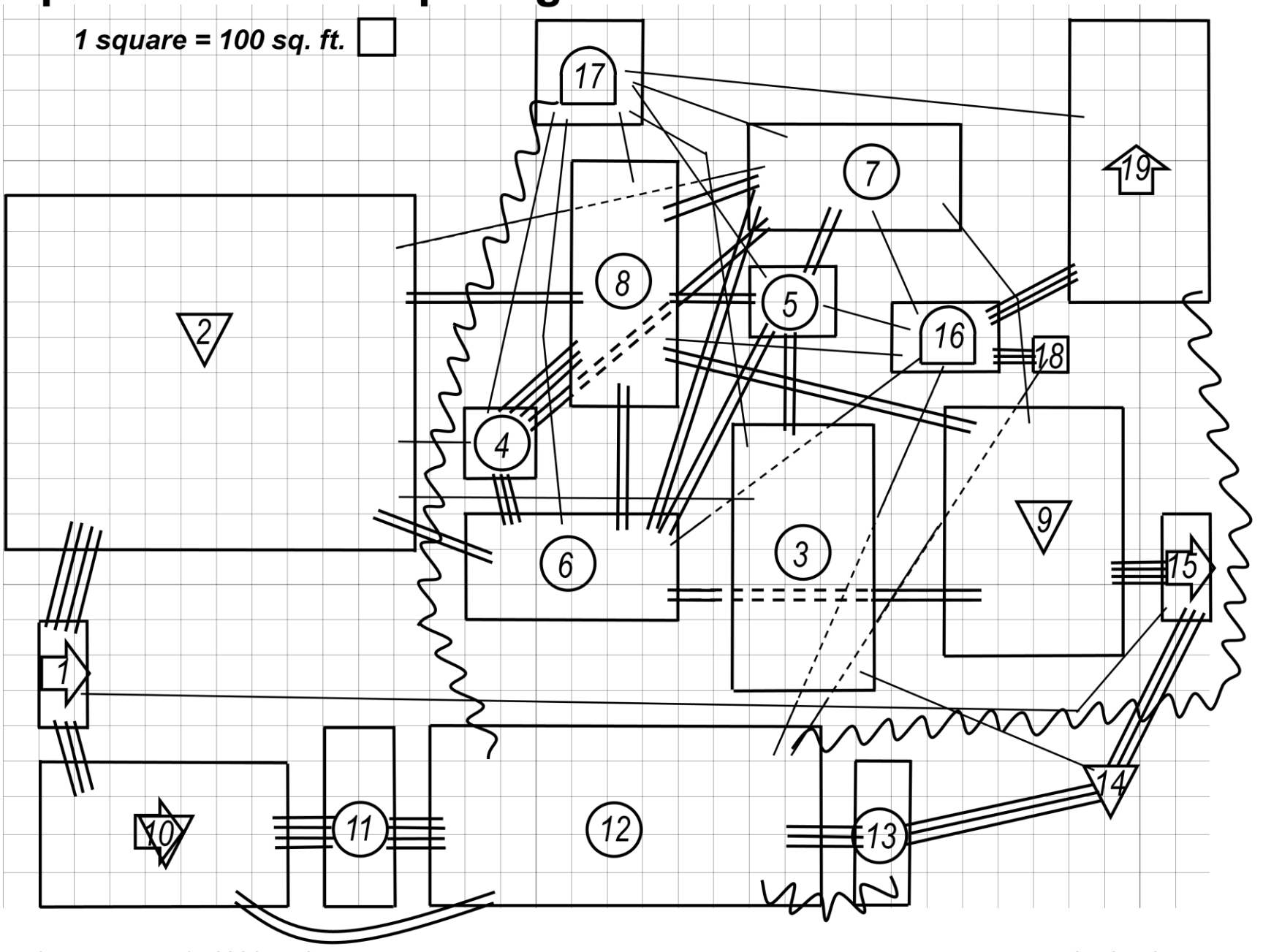
Space Relationship Diagram



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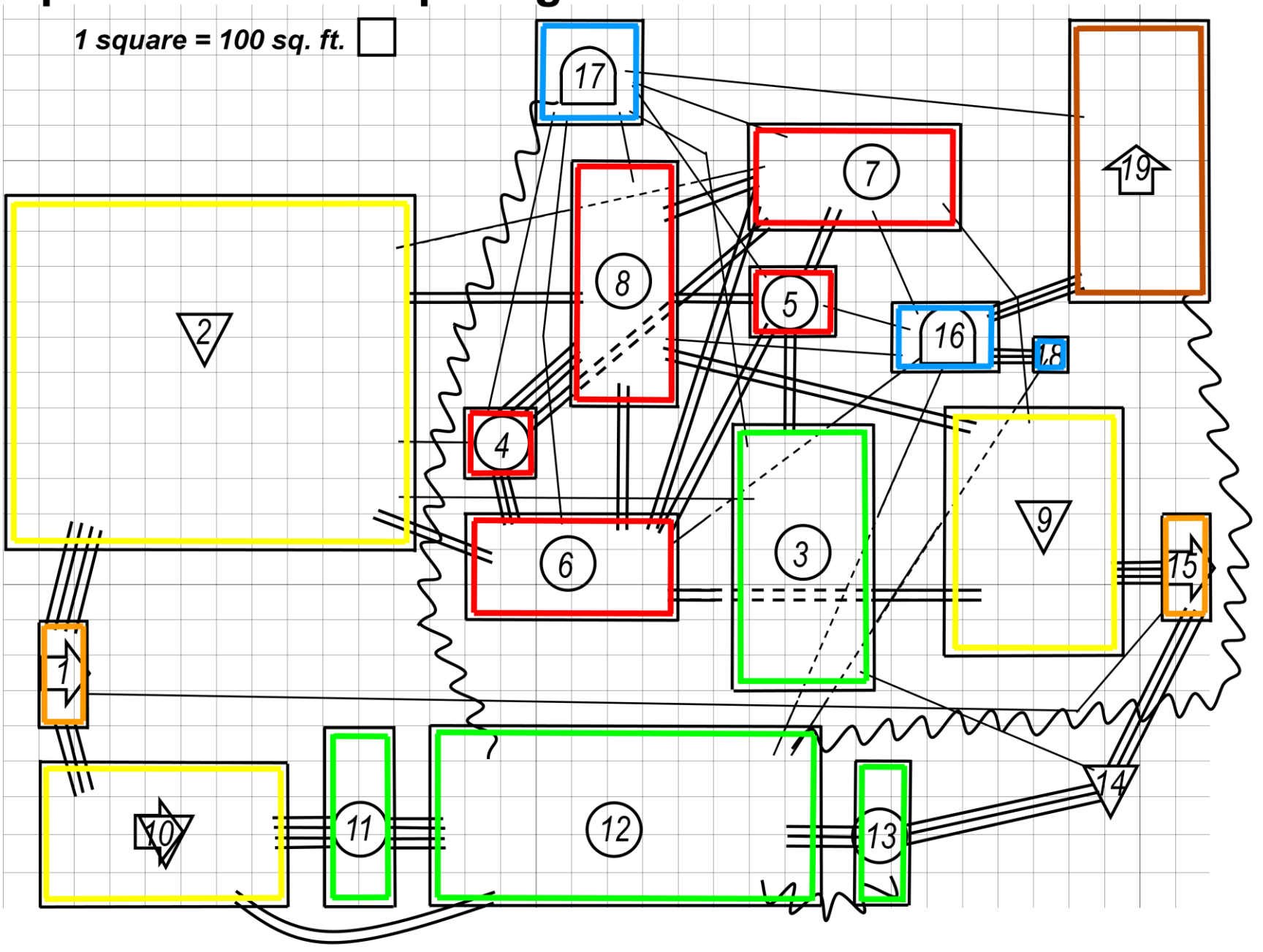
Space Relationship Diagram



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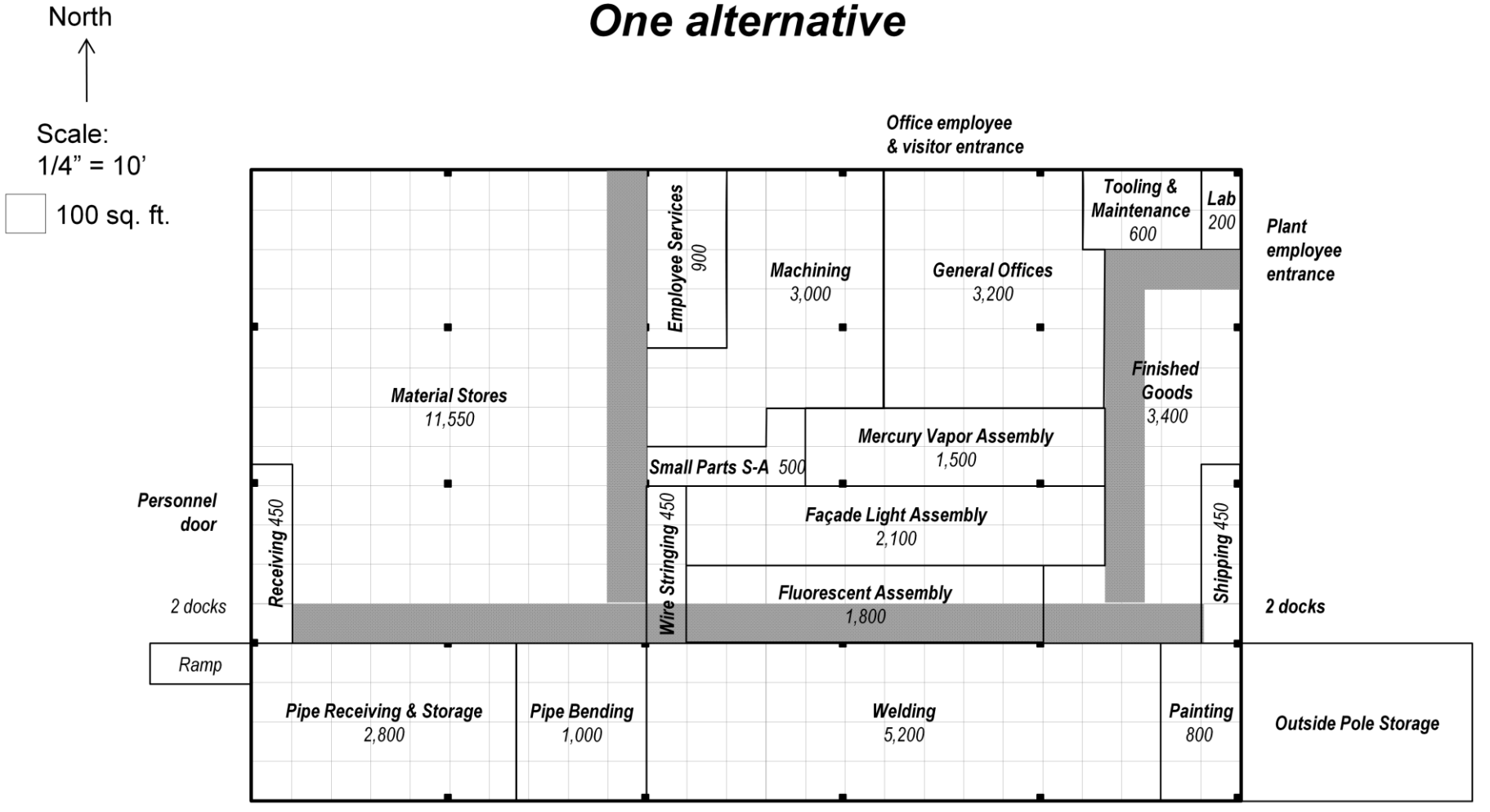
White Lighting Company – New Plant Layout

One alternative



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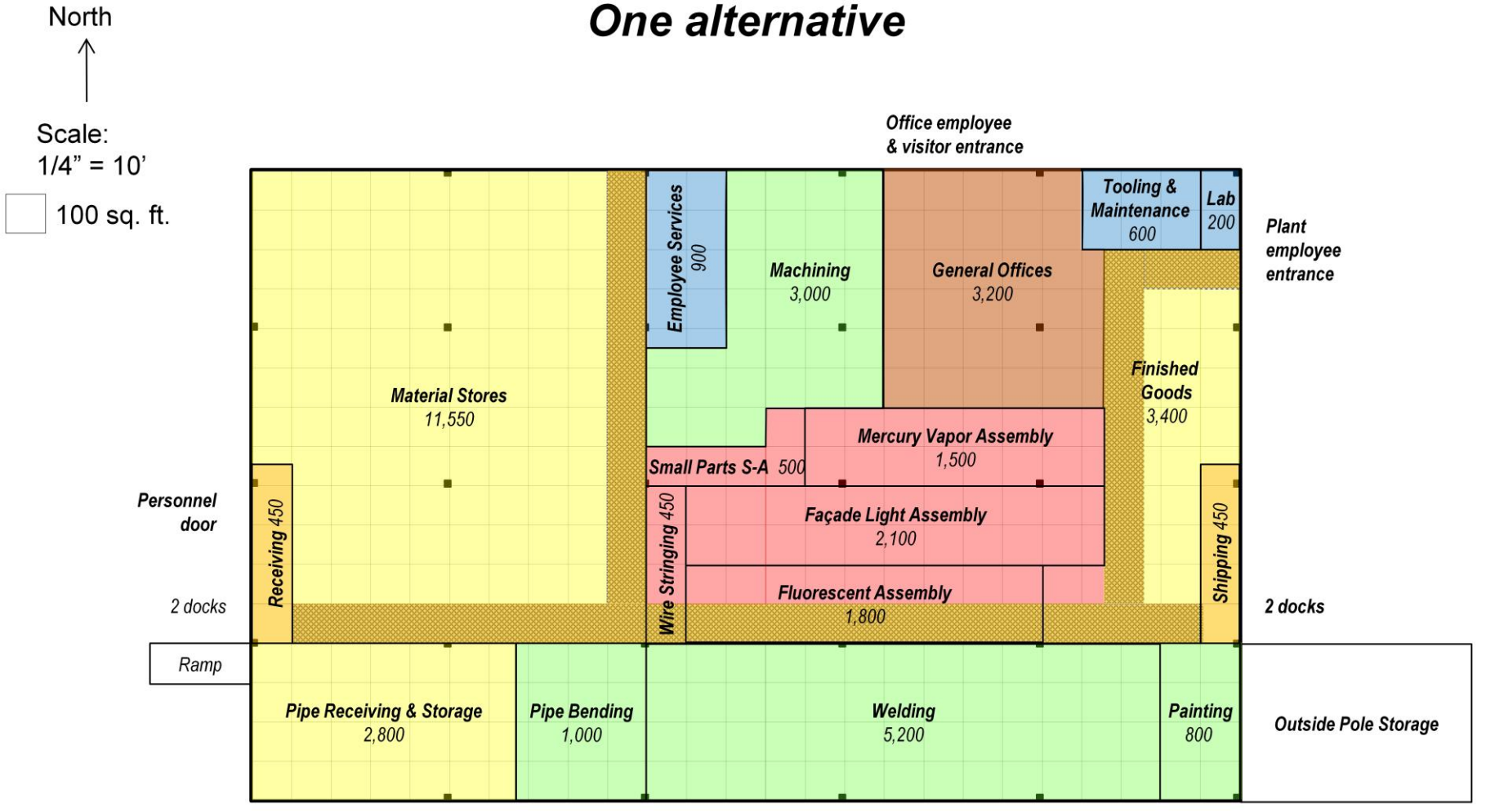
White Lighting Company – New Plant Layout

One alternative



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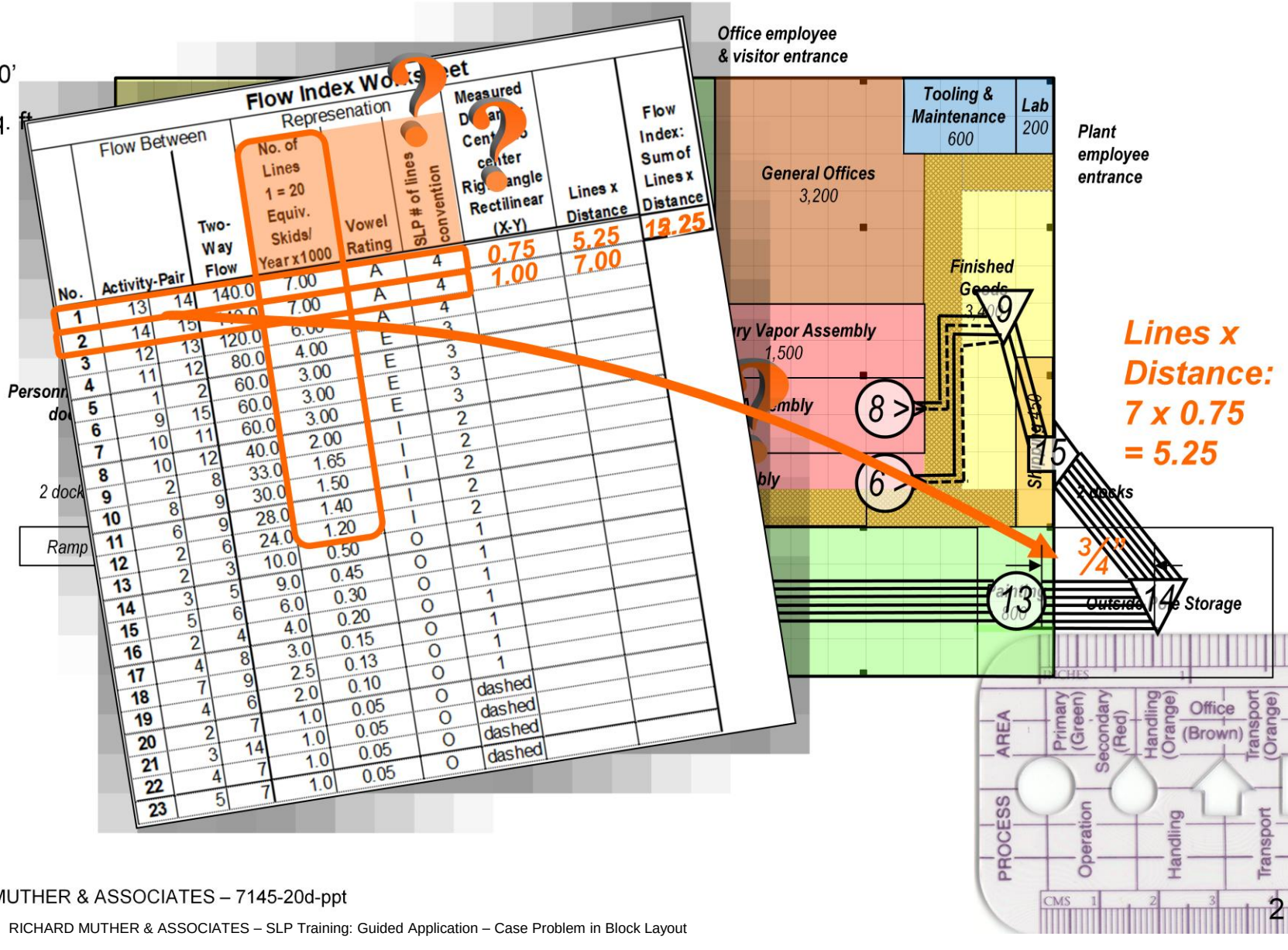
White Lighting Company – New Plant Layout

One alternative

North

Scale:
1/4" = 10'

100 sq. ft



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White Lighting Company – New Plant Layout

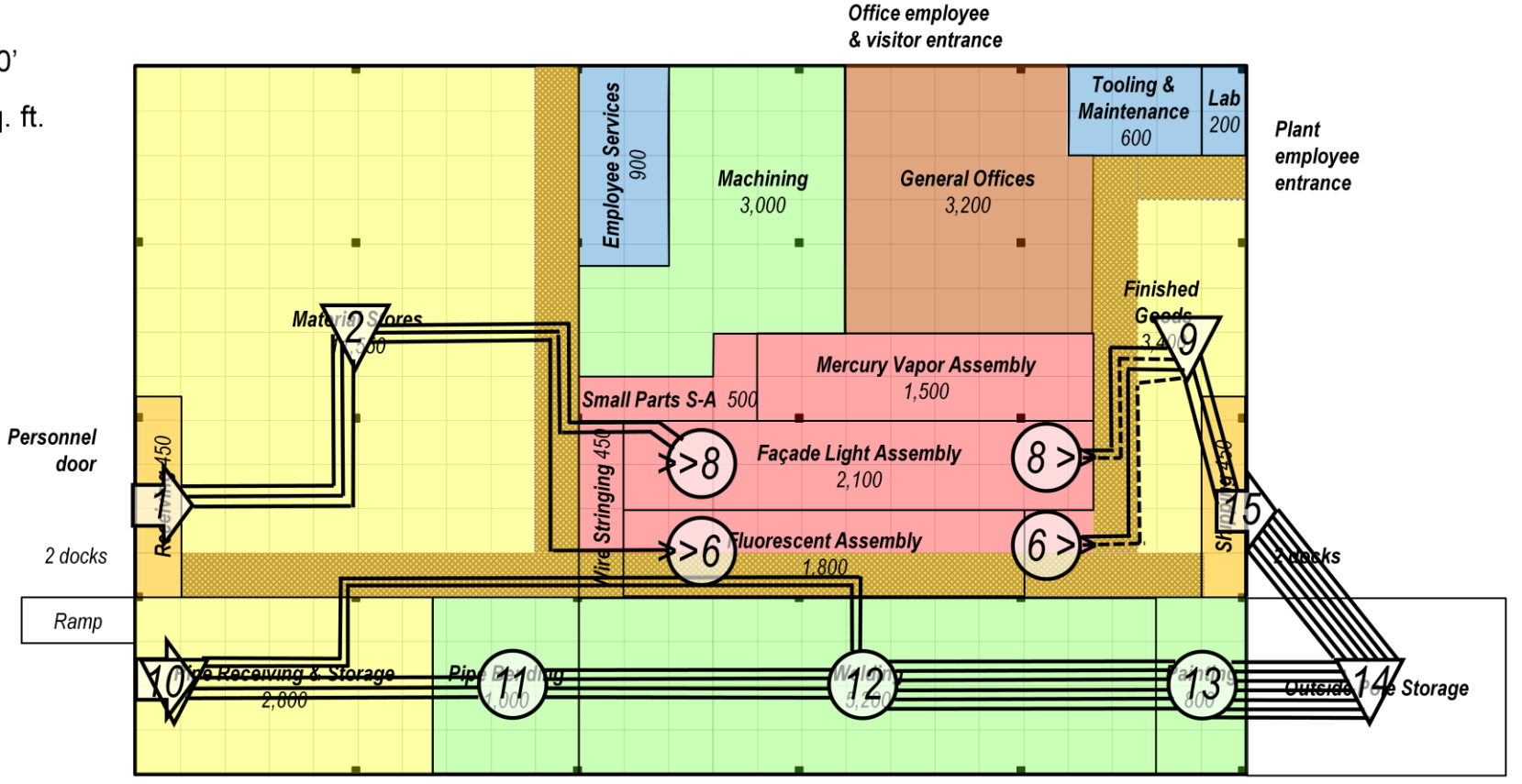
Quantified Flow Diagram Top 12 routes

1 line = 20,000 equiv. skids/yr.

North

Scale:
1/4" = 10'

100 sq. ft.



"Flow Index" = 61.25;
Transport Work = Sum of l x D (at scale)
= 49,000,000 equiv. skid feet per year
= 9,280 equiv. skid miles per year; (39 per day)

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White Lighting – Detailed Layout Planning

Your overall layout for White Lighting's new plant has been approved. You must now plan the equipment layouts for this new building.

Questions:

1. What additional information do you need?

   Key inputs: P, Q, R, S, T for each area to be planned in detail.

2. How will you proceed?

   Relationships, Space, Adjustment; Two or more alternatives; Evaluate differences in costs and intangible factors.

3. Which activity-areas can be laid out more or less directly from an operation process chart? (The process chart pictures the layout).

   Assembly areas

   Pipe & pole-making operations

4. Which activity-areas cannot be laid out in detail from flow of materials alone?

   Machining?

   Materials storage?

   Maintenance

   Offices & employee services

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Phase III (Detail) Layout of Fluorescent Fixture Assembly Department continued…

The time clock for all assembly departments is located in the Façade Light Assembly Department, immediately adjacent to the Fluorescent Assembly Department.

Paint touch-up for all assembly departments is done by one operator who is assigned to the Fluorescent Assembly Department. (A touch-up work area is provided in each department.) This paint operator orders replacement items and keeps records. Approximately one hour per day is required for paint touch-up in all departments and approximately one hour per day is required for record keeping in the Fluorescent Assembly Department.

One person does all materials handling (except moving of in-process assemblies) for all assembly departments.

All in-process storage should be held within the delineated area.

The fluorescent light fixtures are assembled in minimum lots of 50.

It is anticipated that only four people will be assigned to the department including the paint operator, but not including the part-time material handler.

Problem:

1. What additional information do you need? ***P,Q,R,S,T***
2. How will you proceed? ***Relationships>Space>Adjustment>Evaluation***
3. Which relationships will be most important: Flow or Other-than-flow? ***Flow***
4. Working in teams and using additional data or materials supplied by the session leader, prepare a detail layout plan for the Fluorescent Assembly Area.

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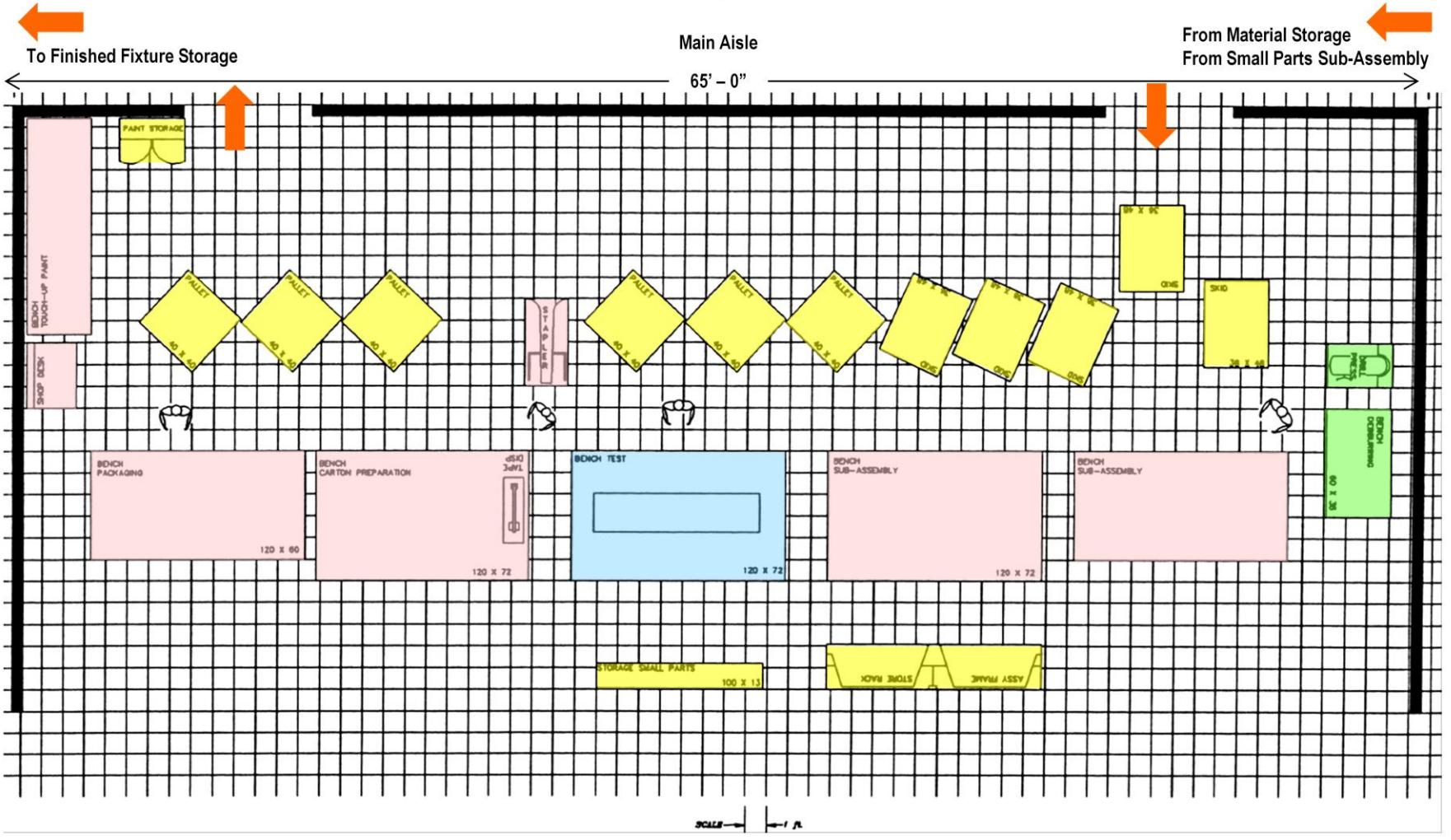
WHITE LIGHTING COMPANY

PHASE III LAYOUT OF FLUORESCENT FIXTURE ASSEMBLY

One Alternative



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SYSTEMATIC LAYOUT PLANNING (SLP) -- Capsule Summary

PHASES

I LOCATION

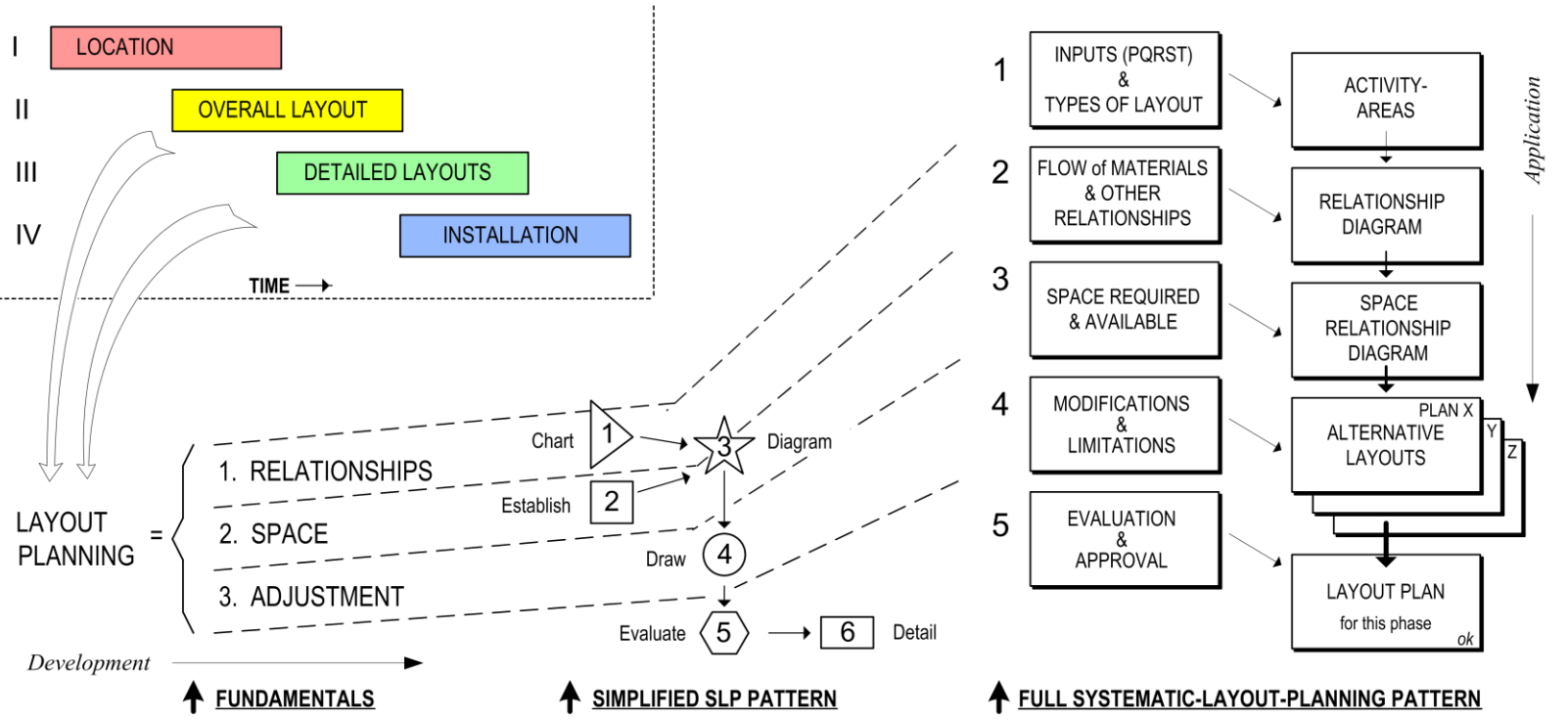
II OVERALL LAYOUT

III DETAILED LAYOUTS

IV INSTALLATION

TIME →

PROCEDURE



↑ **FUNDAMENTALS** ↑ **SIMPLIFIED SLP PATTERN** ↑ **FULL SYSTEMATIC-LAYOUT-PLANNING PATTERN**

CONVENTIONS

Process Chart Symbols & Action*	Symbols Extended to Identify Equipment & Space	Color Ident.	Black & White**
* Operation	Forming or Treating Equipment & Space	Green**	
	Assembly, Sub-Assembly, Dis-Assembly	Red**	
* Transportation	Transport-related Equipment & Space	Orange Yellow**	
Handling	Handling Areas -- Pick-up & Set-Down	Orange Yellow**	
* Storage	Storage Equipment and Space	Orange Yellow**	
* Delay	Set-down or Hold Areas	Orange Yellow**	
* Inspection	Inspect, Test, Check Equipment & Space	Blue**	
* A.N.S.I. Standard ** MHMS (IMMS) Standard (Adopted as basic to SLP procedure)	Service & Support Equipment & Space	Blue**	
	Office or Planning Areas, or Building Features	Brown** (Gray)	

Vowel Letter	No. Value	No. of Lines	Closeness Rating	Color Code
A	4		Absolutely Necessary	Red**
E	3		Especially Important	Orange Yellow**
I	2		Important	Green**
O	1		Ordinary	Blue**
U	0		Unimportant	Uncol-ored**
X	-1		Not Desirable	Brown**
XX	-2,-3, -4,?		Extremely Undesirable	Black

Evaluating Description	Letter / Value
Almost Perfect Results (Excellent)	A / 4
Especially Good Results (Very Good)	E / 3
Important Results (Good)	I / 2
Ordinary Results (Fair)	O / 1
Unimportant Results (Poor)	U / 0
Not Acceptable Results (Not Satisfactory)	X / ?

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