

How to Lay Out a Warehouse or Distribution Center

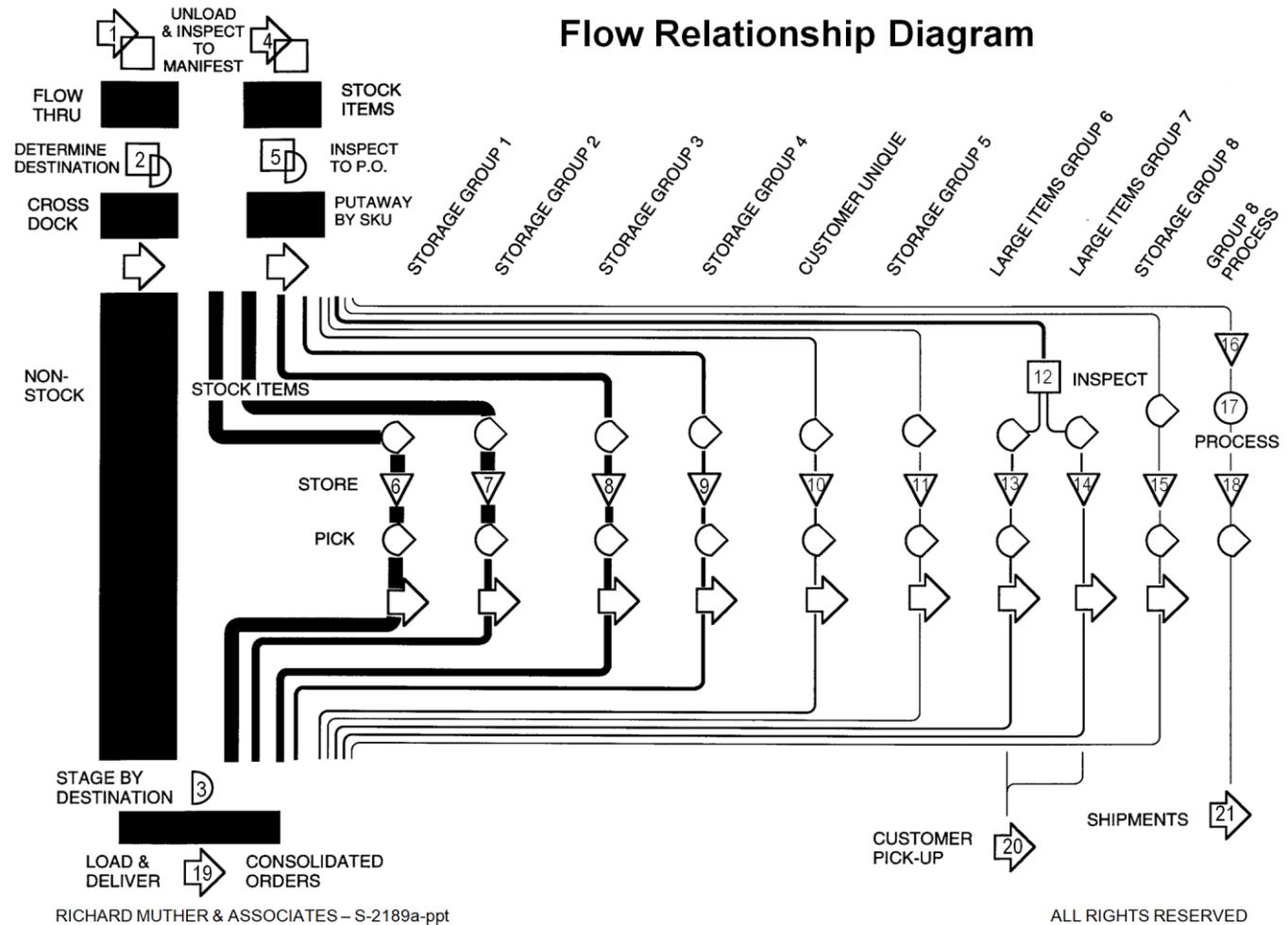


Diagramming Activity Relationships

Main Points

1. When there are no significant relationships other than flow, a quantified flow process chart can be used to visualize activity relationships.
2. This process chart uses line widths to show the relative flows of materials and thus the closeness desired between pairs of activity areas.
3. Note that areas such as battery charging, packaging materials, employee services and offices are not considered. The planners are presuming that these can be fitted in without the need to record and visualize their relationships.
4. And, for employee services and offices, their location may be fixed by existing facilities.

Flow Relationship Diagram



Notes

Main Points

1. This chart uses a template in Microsoft Excel available at www.RichardMuther.com (Form 131).
2. The template is sized for up to 37 activity-areas. The illustration here has been trimmed to show only the portion needed for the 15 activity-areas in the Homart Distributors layout.
3. Because Excel can only auto-fill rectangular cells, the relationship colors are bleeding to the left, into the adjacent reason code box.
4. The Excel template lists target percentages for each relationship value. Because this workshop example is small and has been simplified, its relationships do not conform to the pre-printed ranges. In actual practice, there would normally be a much higher percentage of "O" ratings and often one or more "X" ratings.
5. Note that relationships other than flow (Reasons 2 – 6) are found in 8 of the 20 recorded relationships (3 A's + 3 E's + 6 I's + 8 O's). This is about 40% of the total rated higher than U.

RELATIONSHIP CHART

Combined Flow and Other Relationships

Plant (Company)

Homart Distributors

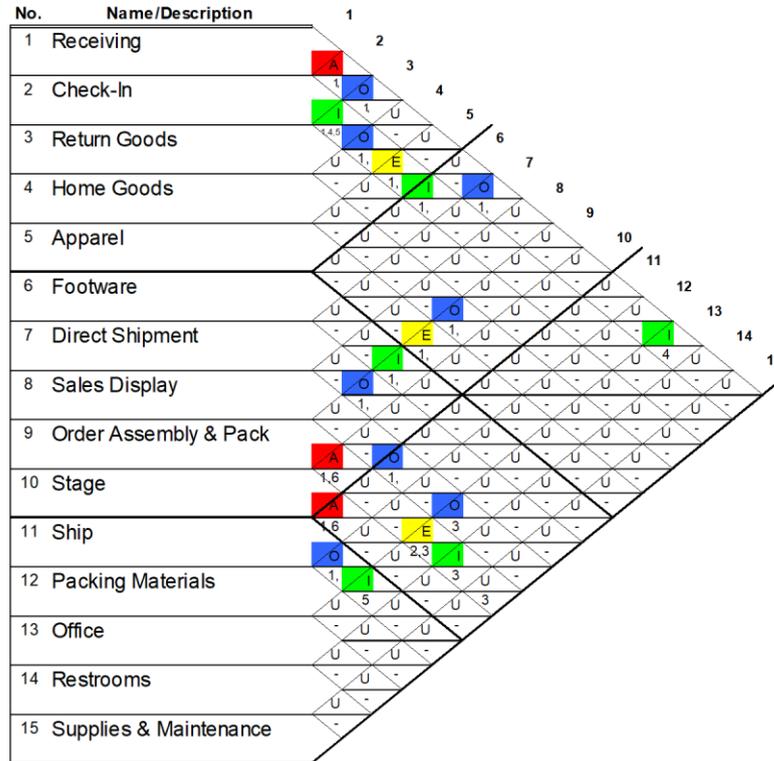
Project *Rearrangement*

Source - Reference

Team meeting: HK, RM, EP

Date 4/20

Charted by LH



Value	Closeness	Target
A	Absolutely Necessary	3
E	Especially Important	3
I	Important	6
O	Ordinary Closeness	8
U	Unimportant	85
X	Not Desirable	0
Total	$= (N(N-1))/2$	105

1 to 2%
3 to 5%
5 to 15%
20% to 25%
mostly
several %

CODE	REASON
1	Material Flow
2	Supervision
3	Employee convenience
4	Personal contact
5	Paperwork
6	Visual control

RICHARD MUTHER & ASSOCIATES – 7139-11-ppt

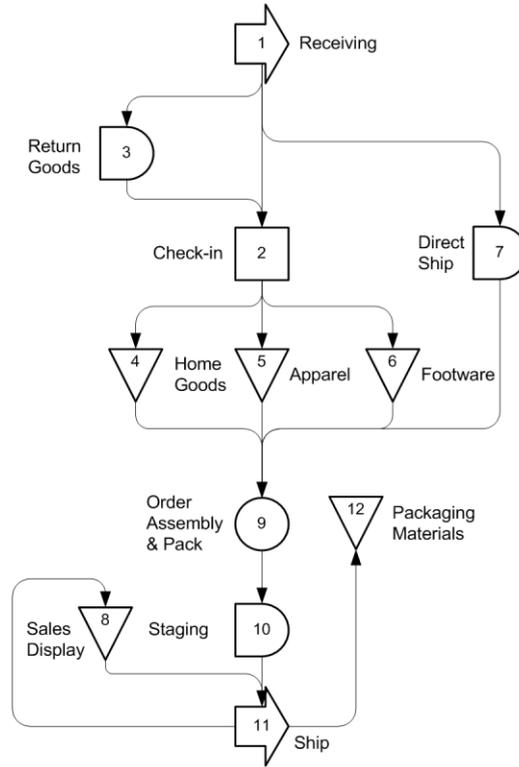
ALL RIGHTS RESERVED

Notes

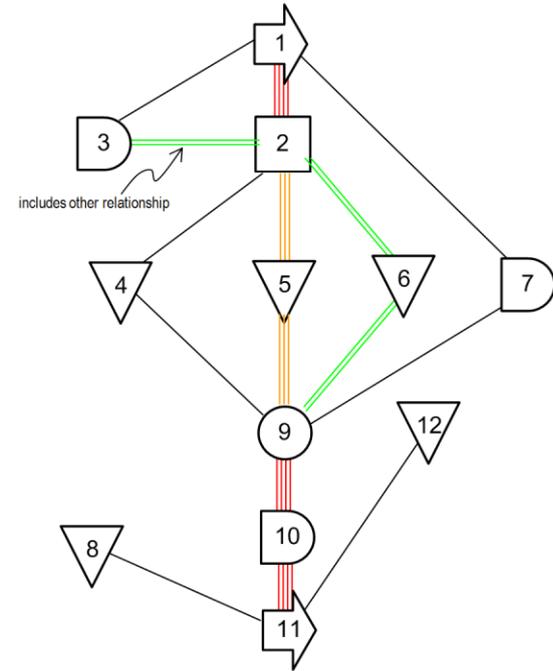
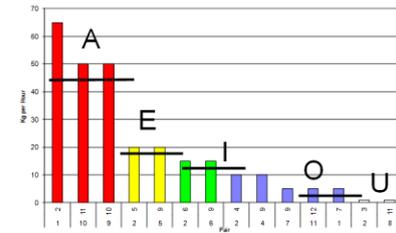
Main Points

1. In warehouse layout, most activity relationships are based upon flow.
2. SLP's vowel-letter ratings and associated number-of-lines code can be used to draw a relationship diagram based solely upon flow.
3. Reading the calibration bar chart from left to right, we can first draw the A relationships, followed by the E's, the I's and O's.
4. Because we are only diagramming flow, it makes sense to place activity symbols in roughly the same positions as in our earlier flow process chart – typically with Receiving at the top and Shipping at the bottom.
5. The result is a “*flow* relationship diagram.”
6. It ignores relationships based upon reasons other than flow. And it will typically leave out support activities that must still be placed. For these reasons, it is only a starting point . Missing activities and relationships must be added for a complete picture of closeness desired.

Homart Distributors – Flow Relationship Diagram



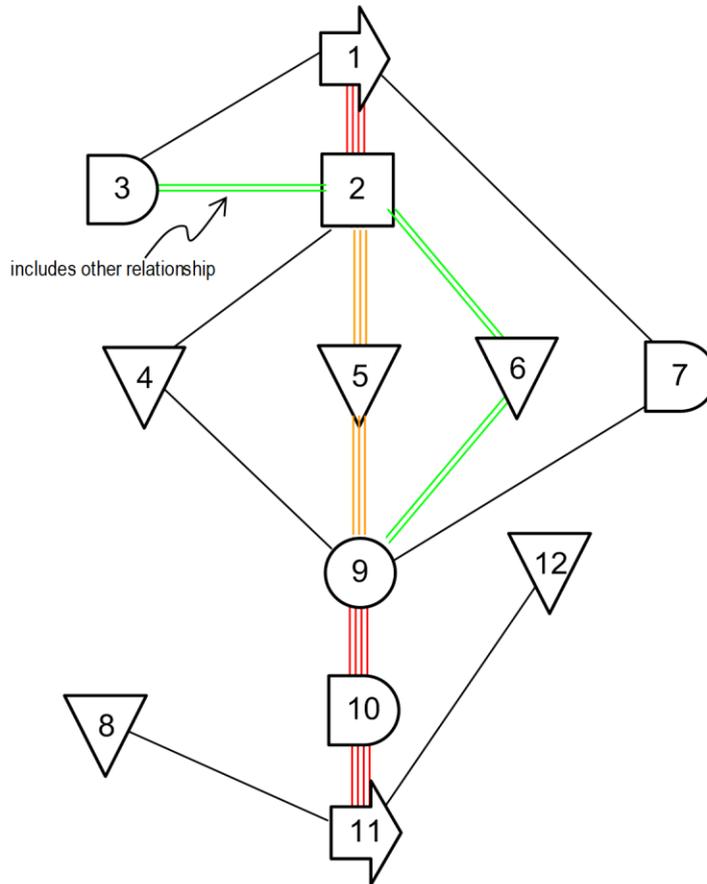
RICHARD MUTHER & ASSOCIATES - 7139-12-ppt



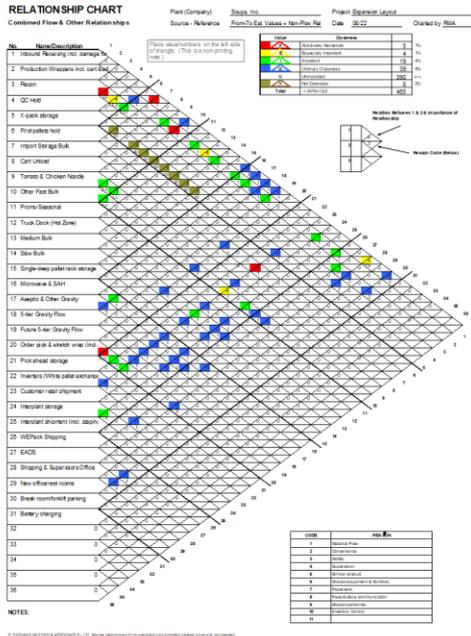
ALL RIGHTS RESERVED

Notes

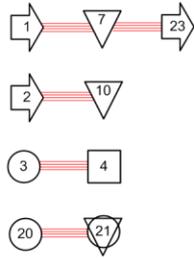
Homart Distributors – Activity Relationship Diagram



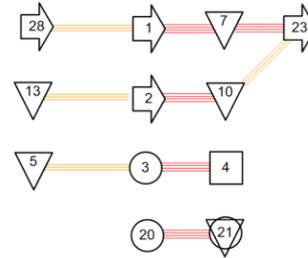
1. Which activity-areas and relationships are not yet shown? Refer to Relationship Chart of Combined Flow & Other Relationships
2. Add these in a new diagram, adjusting this one as needed.



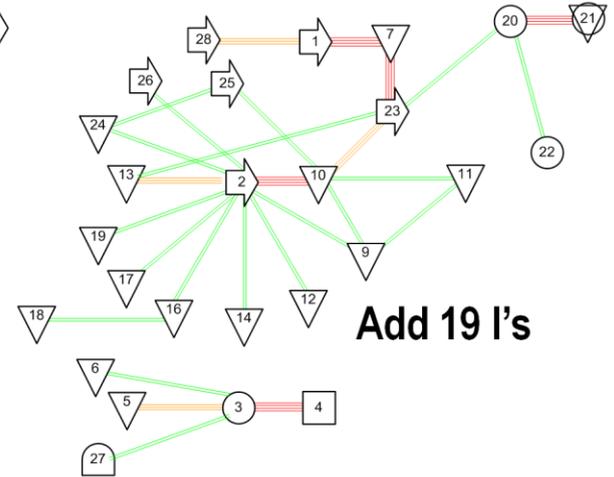
Activity Relationship Diagramming Many Relationships Other-than-flow



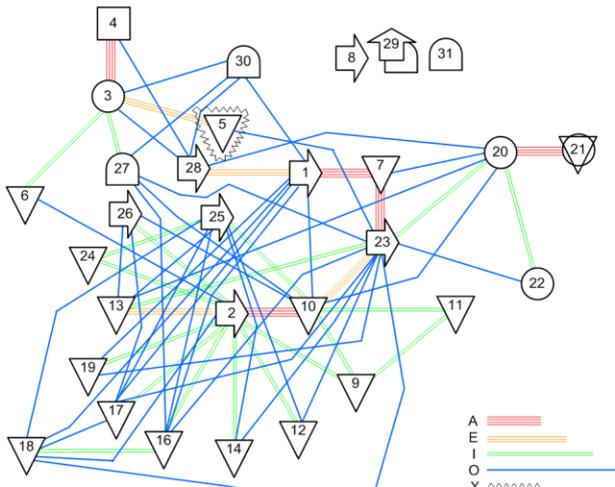
5 A's



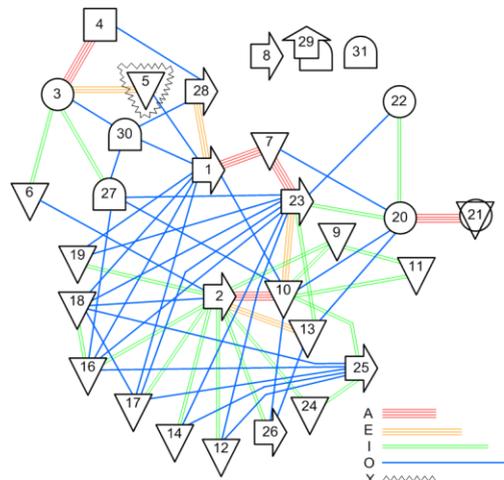
Add 4 E's



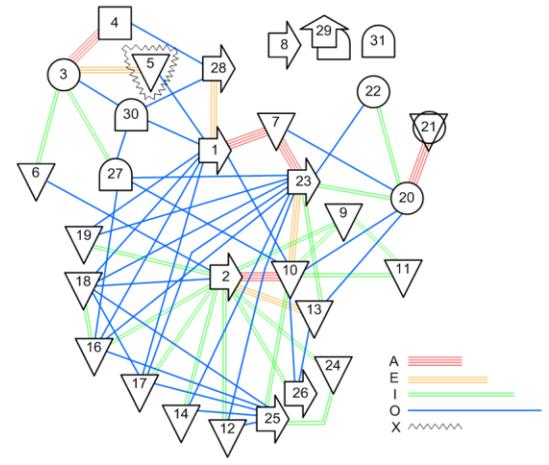
Add 19 I's



Add 39 O's & 8 X's (all Act. 5)



1st Refinement

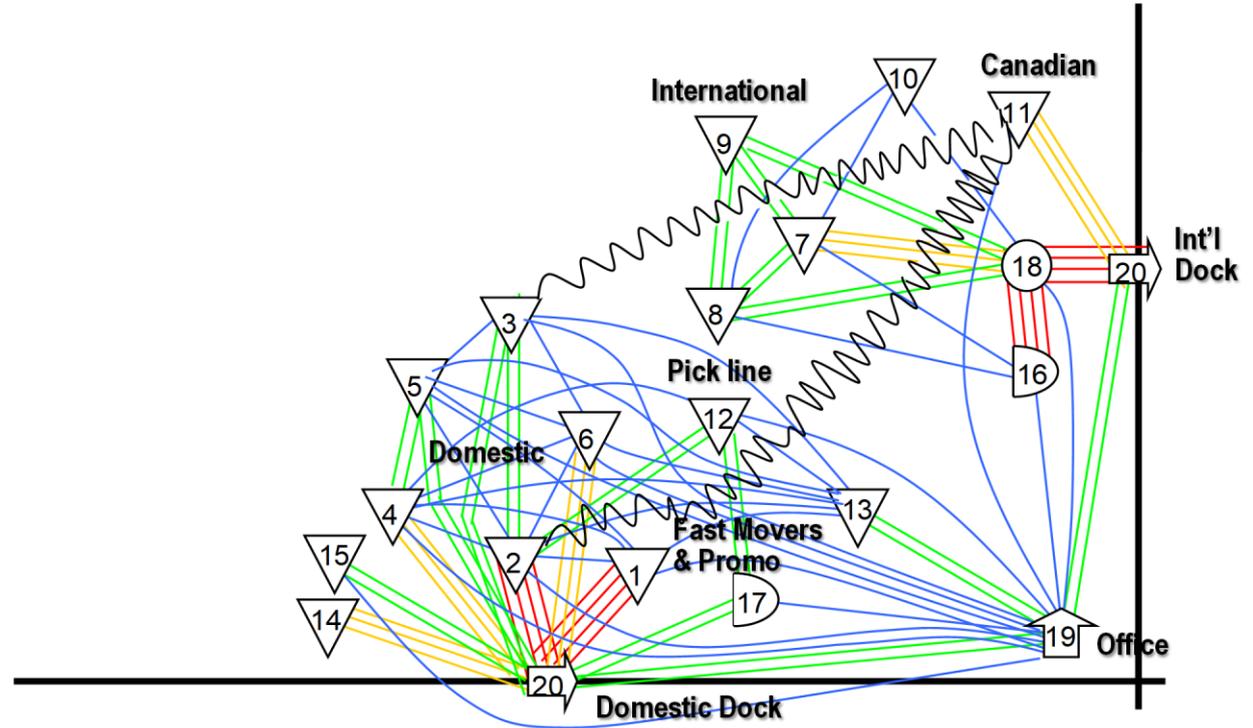


2nd (Final) Refinement

Main Points

1. Often, the location of activity-areas in a current or planned layout will be fixed and known when drawing the activity relationship diagram.
2. In rearrangement projects, fixed locations may be due to the cost or impracticality of moving the areas. Examples: docks, offices, employee services, multi-level picking lines, conveyor mezzanines, battery charging, masonry enclosures...
3. In new facilities, the site plan may fix the locations of docks, entrances and offices.
4. The same is true when laying out an existing building for initial occupancy.
5. The activity-relationship diagram can be drawn to reflect fixed locations as illustrated here.
6. In this rearrangement project the office must remain in the corner, with domestic dock on one side and the international dock opposite. The pick line in the center of the layout cannot be moved.

Activity Relationship Diagram Example Fixed Activity Locations



RICHARD MUTHER & ASSOCIATES - S-2118-2-pp

ALL RIGHTS RESERVED

7

Notes

Main Points

1. If our closeness ratings are mathematically linear, then we should place symbols according to the theoretically desired separations shown here on the left.
2. This will equalize the areas under the “bands” of connecting lines. That is, the area under an “A” will be equal to that under an “E, I or O.”
3. But in practice, 1.33 vs. 1 is difficult to discern, so 1.5 to 2 is a better degree of separation for E-rated pairs, as is 2 to 3 for I-rated pairs.
4. And relationships are not linear, with “O” ratings often of little importance. For these, it is not worth the effort to achieve the theoretical separation of 4 times “A.” So, we may let O-rated pairs drift to be “4 or more” the separation of A’s, especially in complex diagrams.
5. When “X” truly means “distance desired,” then symbols should be widely spaced. But if “X” means that one or both areas need to be enclosed or somehow separated physically but without the need for distance, then X-rated pairs may be close.

Spacing symbols in an activity-relationship diagram

Rating	Theoretical separation to equalize areas under connecting lines (between “bands”)			Practical separation for ease of recall and effective visualization
	Number of lines (width & “strength” or “intensity”)	Desired separation in diagram (length or “distance”)	Areas under connecting lines	Desired separation in diagram (length or “distance”)
A	4 x	1 =	4	1
E	3 x	1.33 =	4	1.5 to 2
I	2 x	2 =	4	2 to 3
O	1 x	4 =	4	4 or more
U	Not shown			
X & XX	Should be long if the X means that distance is actually required (and not merely enclosure of one or both activity-areas).			

RICHARD MUTHER & ASSOCIATES – 1112-3-ppt

ALL RIGHTS RESERVED

Notes

SLP Procedure for Diagramming Relationships

1. Identify by number and name the activities (areas or features) to be diagrammed. Code these by type-of-activity symbol – preferably right on the relationship chart.
2. If not already done in making the relationship chart, calibrate or other-wise relate flow-of-material intensities to the vowel-letter closeness-rating values, combine them with other-than-flow relationships, and record the combined relationship ratings.
3. Diagram the A (4-line) relationships first, as diagram one.
4. Rearrange to get approximately equal lengths of all 4-line relationships, then add the E (3-line) relationships. This will usually be diagram two. Add any XX (double zig-zag or double wiggly line) relationships at this time.
5. Rearrange, trying to get approximately equal lengths of the 3-line relationships but making them visibly longer than the 4-line relationships – theoretically 1.33 times as long, but more likely 1.5 to 2.
6. Then add the I (2-line) relationships and rearrange as necessary. Try to equalize the lengths of the 2-line relationships and make them visibly longer than the 4-line and 3-line. Target 2 to 3 times the length of the 4-line relationships.
7. Add the X (one wiggly line) relationships when adding the O (1-line) relationships. Then rearrange, perhaps by making two or three more diagrams to get the most acceptable fit – the arrangement having the single lines approximately four times as long as the four lines, and the other lines in similar reverse proportion.
8. Check and recopy the final diagram. It will become the basis for the layout when space is added and adjustments are made for modifying considerations and practical limitations.

Relationship Diagramming Tools

- Pencil & Paper
- Marker on Flip Chart or Whiteboard
- Sticky-Notes on a wall

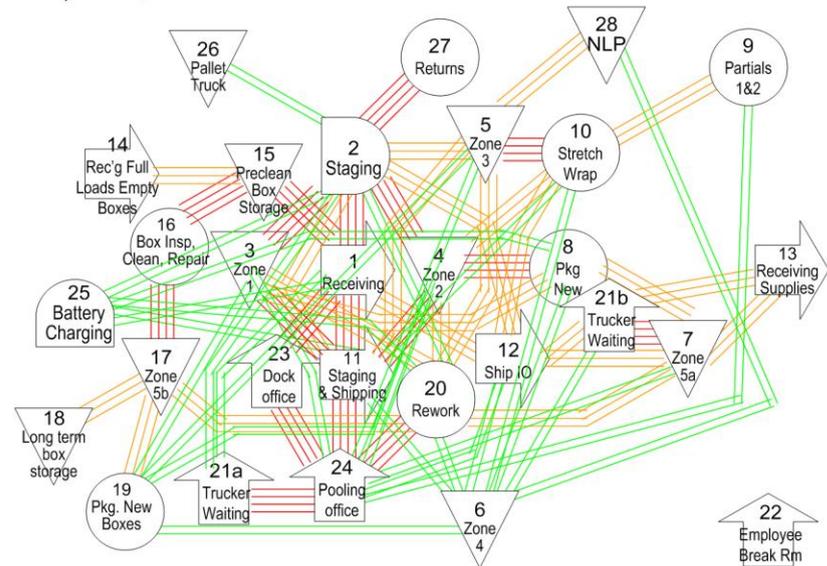


Symbol Key

- Operation
- ▽ Store
- Inspection
- ◇ Handling
- ⊖ Delay
- ⇒ Transport Entrance/Exit

Closeness Key

- ▬ Absolutely Necessary
- ▬ Especially Important
- ▬ Important
- ▬ Ordinary
- ▬ Less Than Ordinary
- ▬ Not Desirable



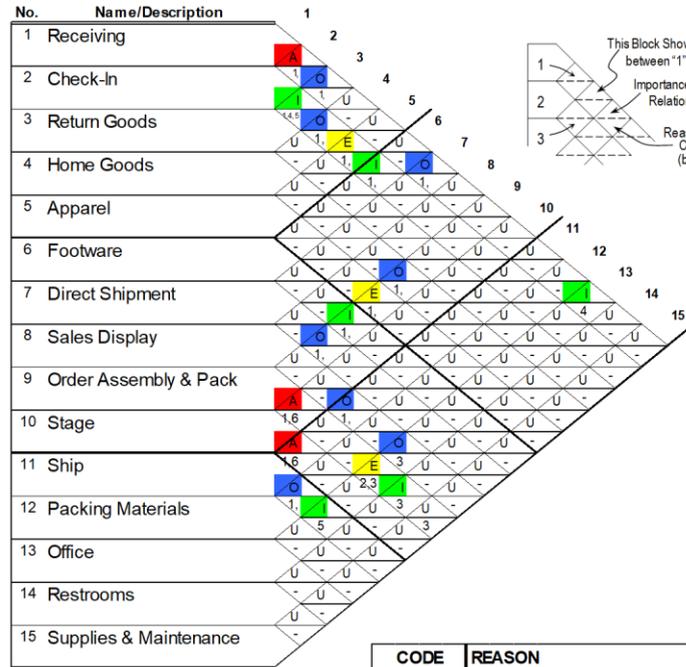
- Graphic editor
- CAD

Main Points

1. The Relationship Chart records the relative closeness desired between each pair of activity-areas in a layout.
2. Relative closeness is recorded using a vowel code rating convention.
3. Each rated relationship is supported by one or more reasons for closeness. For compactness of the chart, reasons are indicated by a reference number. Reason 1 is generally reserved for flow of materials.
4. Flow can be measured and rated before posting to the chart, or it can simply be rated subjectively along with other reasons.
5. The Activity Relationship Diagram represents the ratings in the relationship chart. It uses number-of-lines, length of lines, and colors to represent relative closeness desired. "A" and "E" relationships should be the shortest.
6. In this way, the diagram represents the theoretically ideal arrangement of activity-areas without regard to their size or to fixed features.

RELATIONSHIP CHART

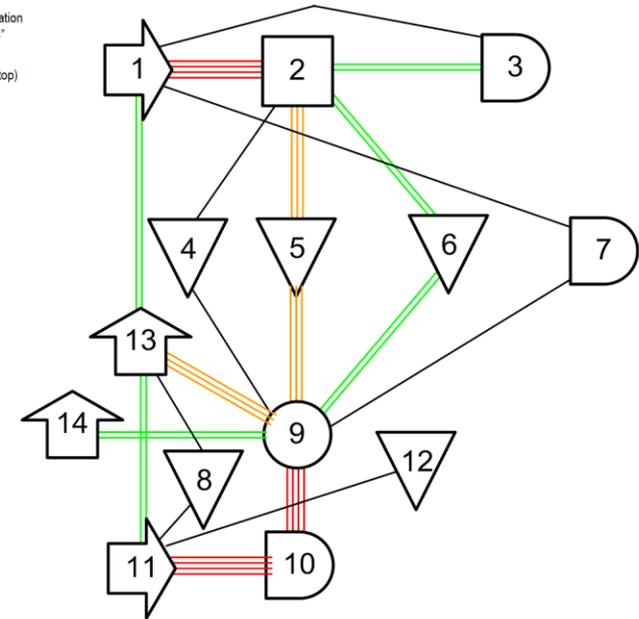
Combined Flow and Other Relationships



Value	Closeness	
A	Absolutely Necessary	3
E	Especially Important	3
O	Important	6
C	Ordinary Closeness	8
U	Unimportant	85
X	Not Desirable	0
Total	$=(N(N-1))/2$	105

CODE	REASON
1	Material Flow
2	Supervision
3	Employee convenience
4	Personal contact
5	Paperwork
6	Visual control

Activity-Relationship Diagram



RICHARD MUTHER & ASSOCIATES - S-2118-3-ppt

ALL RIGHTS RESERVED

Notes

Here's What I Know

Question	Which Answer Is (Most) Correct	Got It
1. When flow dominates the reasons for closeness between activities, relationships can be visualized in a flow diagram – typically by showing intensity of flow in numbers or thickness of lines.	A. True. B. False.	
2. The Activity Relationship Diagram is more appropriate when there are important reasons for closeness (or separation) other than flow.	A. True B. False	
3. The Activity Relationship Diagram shows an ideal arrangement of activity-areas without regard to their sizes or shapes.	A. True B. False	
4. An Activity Relationship Diagram visualizes vowel-letter ratings on a Relationship Chart.	A. True. B. False.	
5. Relevant fixed features such as docks may be included in a relationship diagram.	A. True B. False	
6. Special software is needed to prepare relationship diagrams.	A. True B. False	