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*Optimizing Your
Plant Layout*

**Architectural Woodwork Institute
New England Chapter**

**Vernon, CT
12 February 2004**

This Presentation's Purpose

Equip you to evaluate your layout's efficiency...

- **Assessing your plant layout**
- **Selecting the optimal organization**
- **Matching handling equipment to the process**

Why Evaluate Your Layout?

To improve your overall productivity by...

- Reducing labor
- Lowering product damage
- Increasing throughput speed
- Incorporating new processes
- Improving safety and morale

Tools for Analyzing Your Plant's Flow

- From-To Chart
- Travel Chart
- Activity Relationship Chart

The From-To Chart

		TO								
		In	Rip Saw	Resaw	RA Saw	Planer	Molder	DET	Band Saw	TOTAL
FROM	In		62	4	45		5			116
	Rip Saw				20			42		62
	Resaw						30	9	20	59
	RA Saw			5		25		60		90
	Planer			20	20			5	76	121
	Molder					67				67
	DET			30	5	29	32		20	116
	Band Saw									0
	TOTAL	0	62	59	90	121	67	116	116	631

Constructing a From-To Chart

1.

		TO								
		1	2	3	4	5	6	7	8	TOTAL
FROM	1									
	2									
	3									
	4									
	5									
	6									
	7									
	8									
	TOTAL									

Constructing a From-To Chart

To build a From-To Chart...

1. List your operations in identical order across the top of the columns and down the row on the left hand side of the chart.

If possible arrange the list in the order or direction of your current layout from beginning to end.

Constructing a From-To Chart

2.

Process Information

Product	Process	Parts/ Month	Parts/ Load	Loads/ Month
1	1,2,4,7,5,3,8	4,000	200	20
2	1,4,5,4,7,8	10,000	500	20
3	1,2,7,3,6,5,8	6,000	200	30
4	1,3,7,5,8	2,000	500	4
5	1,4,7,6,5,8	8,000	400	20
6	1,6,5,7,4,5,8	3,000	600	5
7	1,4,3,7,5,8	4,000	800	5
8	1,2,7,6,5,8	12,000	1,000	12

Constructing a From-To Chart

2. Compile the process sequences for a group of representative products using information from your route sheets or process charts.

Calculate the volume of parts required per period.

Determine the number of parts per standard load –
For example if you handle parts on factory carts,
calculate the parts per cart.

Calculate the flow volume:

No. of parts per period ÷ Parts per load

Constructing a From-To Chart

3.

		TO								
FROM	NO.	1	2	3	4	5	6	7	8	TOTAL
	1		62	4	45		5			116
	2				20			42		62
	3						30	9	20	59
	4			5		25		60		90
	5			20	20			5	76	121
	6					67				67
	7			30	5	29	32		20	116
	8									0
	TOTAL	0	62	59	90	121	67	116	116	631

Constructing a From-To Chart

3. Track the flow of loads through each process sequence.

Enter the loads per period in the proper cell for each activity pair.

Sum the number of loads in each cell.

Total each row and column to check for accuracy.

Constructing a From-To Chart

Other instructions...

- Complete a chart for each product or part family.
- Don't forget to track the movement of waste, rework, empty containers, and supplies.

Analyzing a Layout Using a From-To Chart

A From-To Chart tells you...

- Sequence of Flow – the paths that products take through your plant
- Intensity of Flow – the rate of flow on the various paths
- Amount of Backtracking – the operations pairs that require reversing flow

Note that entries below the diagonal line indicate backtracking.

The Travel Chart

The Travel Chart **considers these points...**

- The best layout minimizes total handling cost
- Cost is related to travel distance

And enables comparison of layout alternatives.

Constructing a Travel Chart

1.

		TO								
		1	2	3	4	5	6	7	8	TOTAL
FROM	1		64	64	89	92	129	132	164	
	2	64		44	69	72	109	112	144	
	3	64	44		69	72	109	112	144	
	4	89	69	69		47	84	87	119	
	5	92	72	72	47		81	84	116	
	6	129	109	109	84	81		47	79	
	7	132	112	112	87	84	47		76	
	8	164	144	144	119	116	79	76		
	TOTAL									

Constructing a Travel Chart

1. List the move distance on a clean From-To Chart for each active operation pair.

Constructing a Travel Chart

2.

		TO								
FROM	NO.	1	2	3	4	5	6	7	8	TOTAL
	1		3968	256	4005		645			8874
	2				1380			4704		6084
	3						3270	1008	2880	7158
	4			345		1175		5220		6740
	5			1440	940			420	8816	11616
	6					5427				5427
	7			3360	435	2436	1504		1520	9255
	8									0
	TOTAL	0	3968	5401	6760	9038	5419	11352	13216	55154

Constructing a Travel Chart

2. Multiply the number of moves on the From-To Chart by the move distance for each active operation pair.

Record the resulting total move distance on the Travel Chart in the cell for that pair.

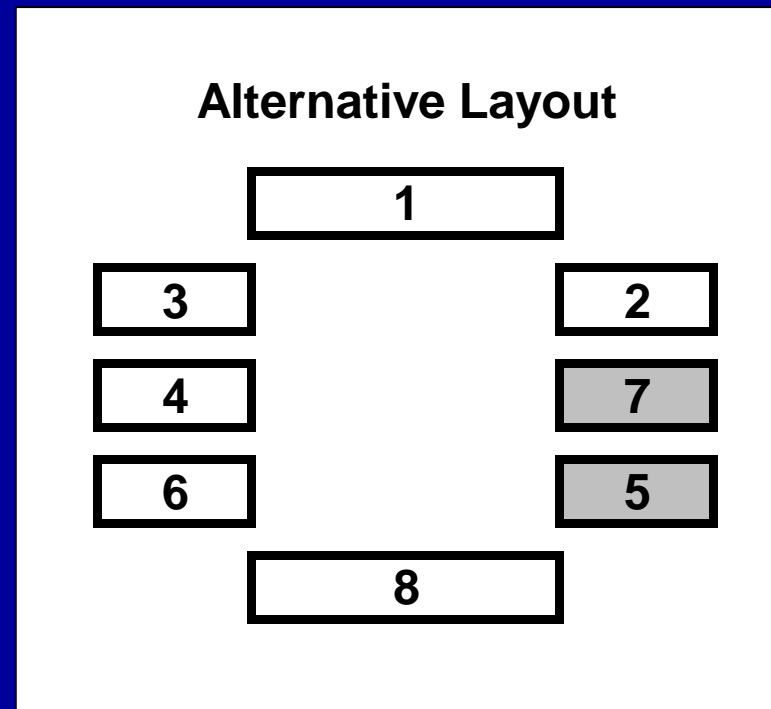
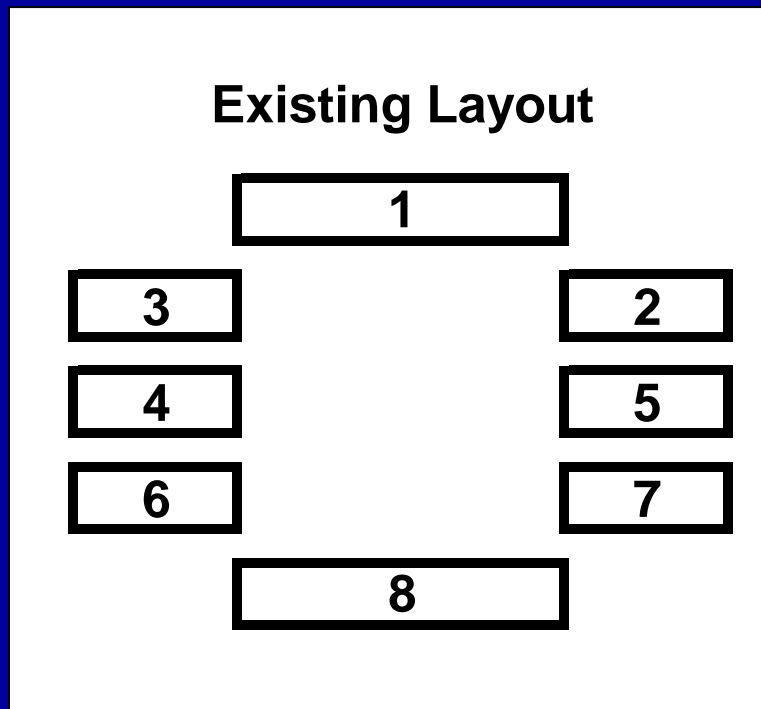
Total each row and column to check for accuracy.

Record the total move distance for the layout in the lower right hand cell.

Comparing Layouts With The Travel Chart

3. Identify potential layout revisions that reduce the total travel distance.

Measure new travel distances.



Comparing Layouts With The Travel Chart

3.

		TO								
		1	2	3	4	7	5	6	8	TOTAL
FROM	1		64	64	89	78	92	129	164	
	2	64		44	69	36	72	109	144	
	3	64	44		69	57	72	109	144	
	4	89	69	69		60	47	84	119	
	7	78	36	57	60		36	123	146	
	5	92	72	72	47	36		81	116	
	6	129	109	109	84	123	81		79	
	8	164	144	144	119	146	116	79		
	TOTAL									

Comparing Layouts With The Travel Chart

4.

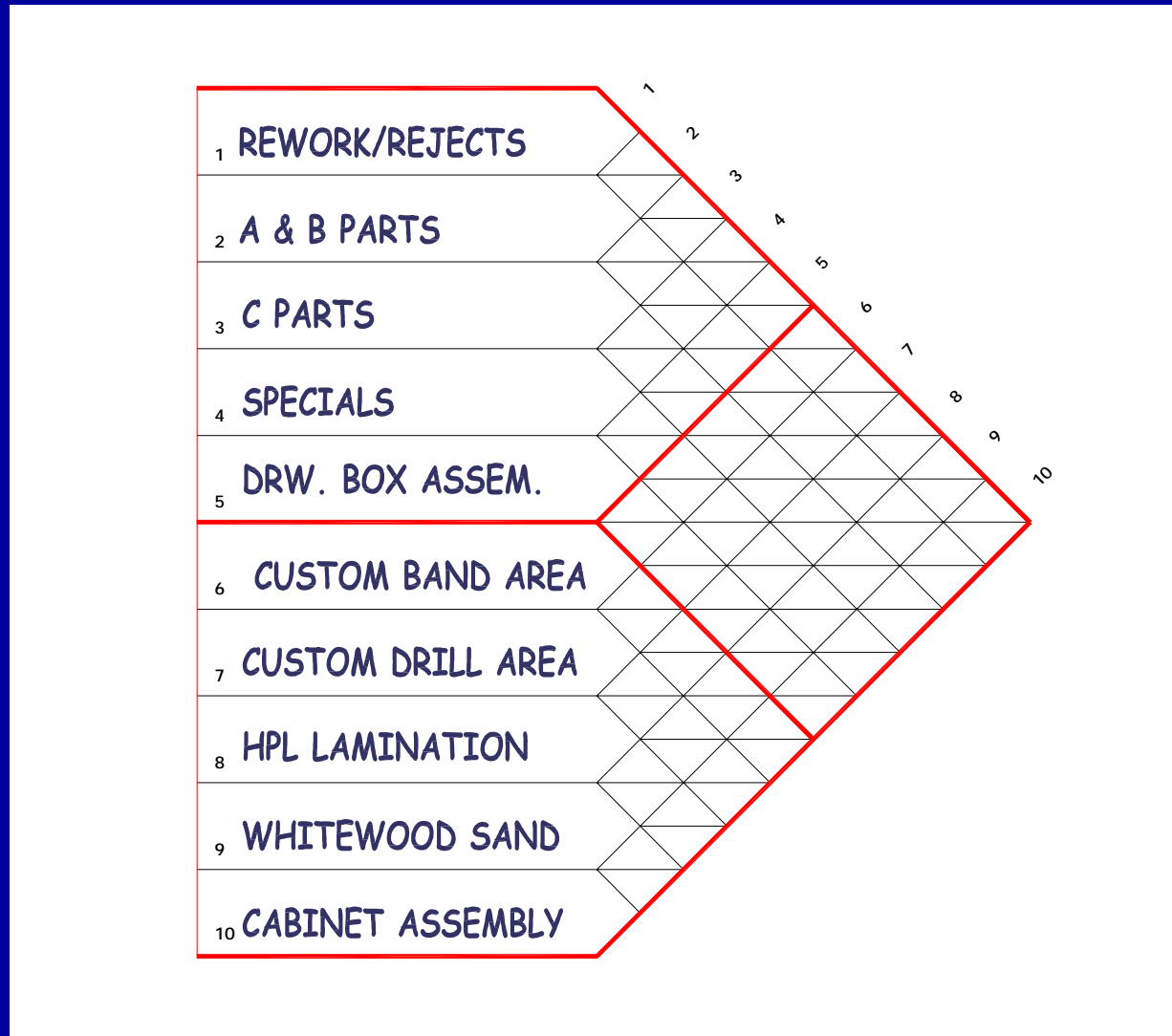
		TO								
FROM	NO.	1	2	3	4	7	5	6	8	TOTAL
	1		3968	256	4005			645		8874
	2				1380	1512				2892
	3					513		3270	2880	6663
	4			345		3600	1175			5120
	7			1710	300		1044	3936	2920	9910
	5			1440	940	180			8816	11376
	6						5427			5427
	8									0
	TOTAL	0	3968	3751	6625	5805	7646	7851	14616	50262

Comparing Layouts With The Travel Chart

4. Compare the total move distances in the lowermost right hand cell for each layout alternative.

Select the alternative with the lowest total move distance.

The Activity Relationship Chart



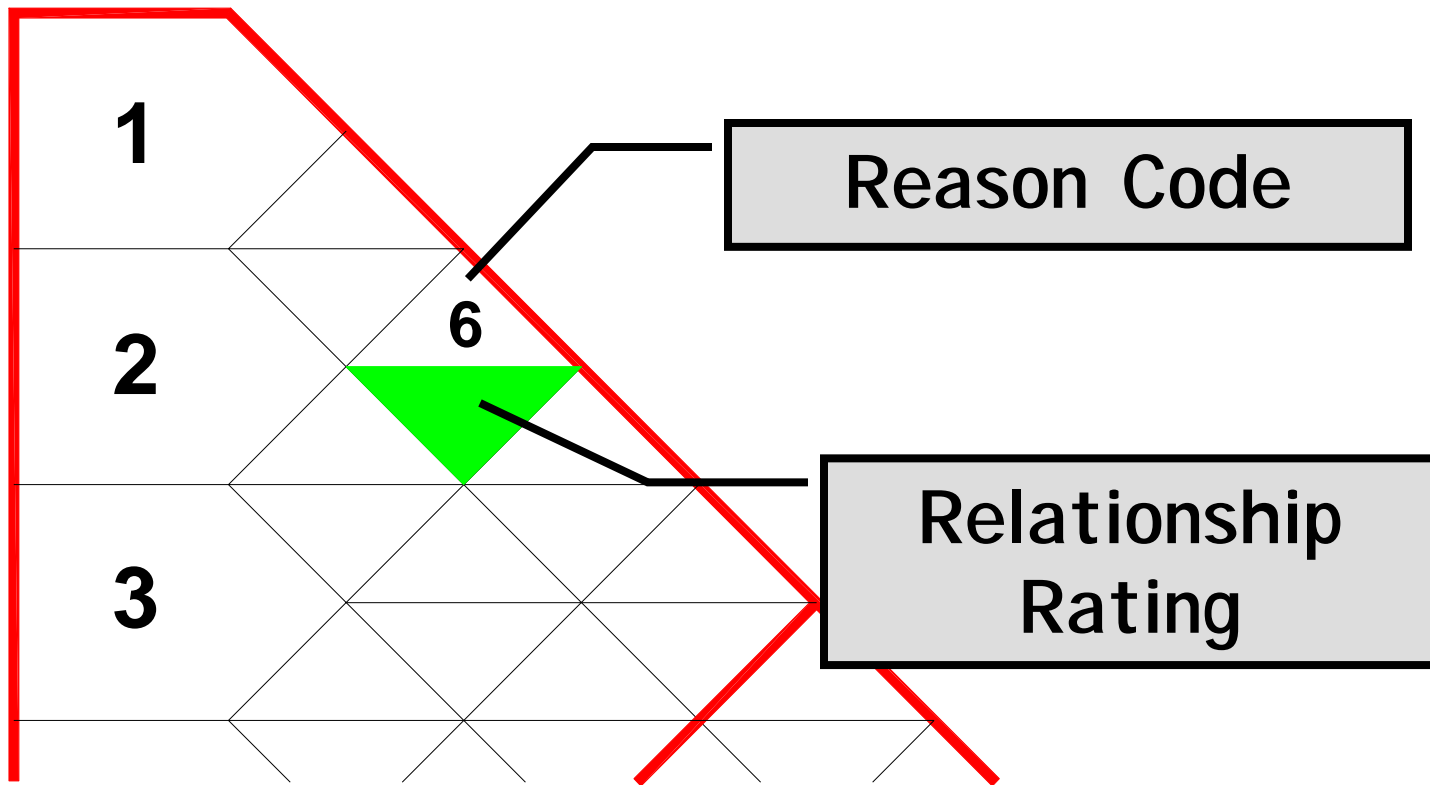
The Activity Relationship Chart

An Activity Relationship Chart considers layout factors beyond the flow of material...

- Support Services - Maintenance, utilities, and other infrastructure activities must often be located close to certain production functions.
- People - Management and communication needs can often dictate the arrangement of production activities.
- Environmental Issues - Hazardous or dirty operations must often be located away from a related function.

The Activity Relationship Chart

Relationship Between Operations 1 & 3



The Activity Relationship Chart

An Activity Relationship Chart contains two vital pieces of information...

- Relationship Rating - The importance of the relationship between two departments or activities is tabulated with a color-coded entry:

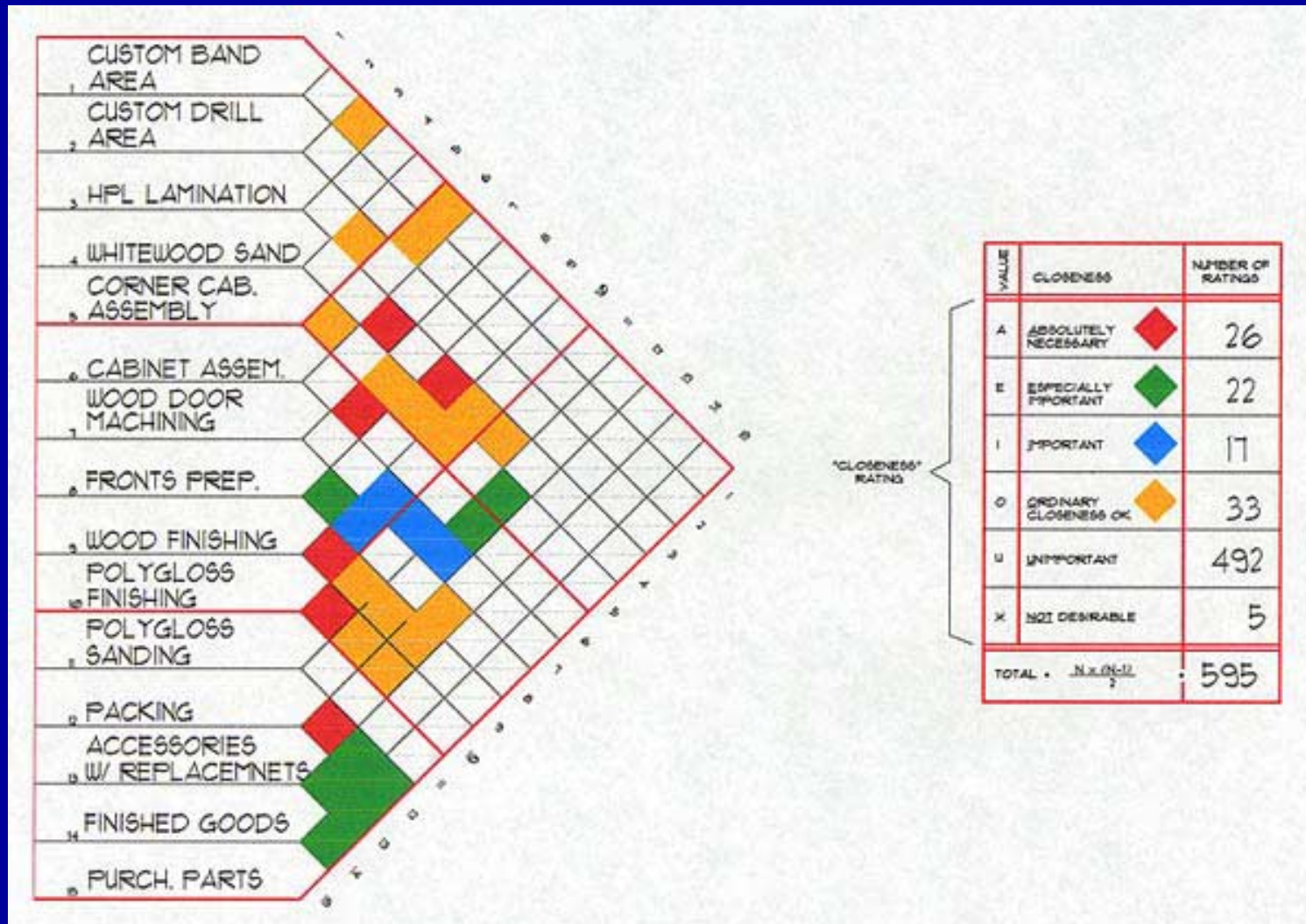
Red	closeness absolutely necessary
Green	closeness especially important
Blue	closeness important
Yellow	ordinary closeness OK
Uncolored	closeness unimportant
Orange	closeness not desirable

The Activity Relationship Chart

- Relationship Reason - The reason for a ranking is tabulated with a numerical code:

- 1 - materials flow
- 2 - communications
- 3 - equipment sharing
- 4 - personnel sharing
- 5 - supervision
- 6 - utilities sharing
- 7 - safety

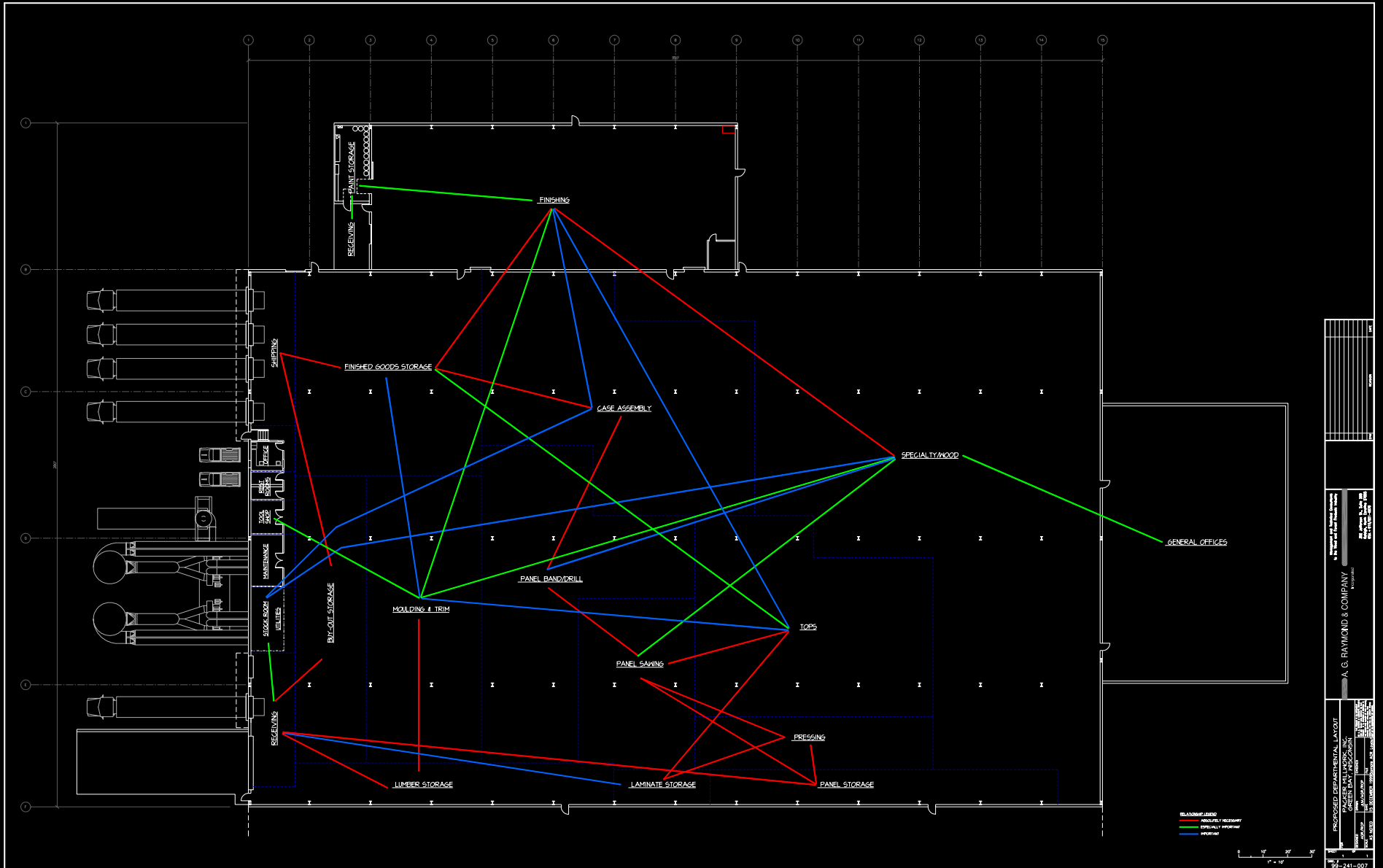
The Activity Relationship Chart



Completing an Activity Relationship Chart

Other advice...

- Do not over assign A ratings.
- Involve all relevant personnel.
- Map the relationships graphically.



Layout Tools for Download

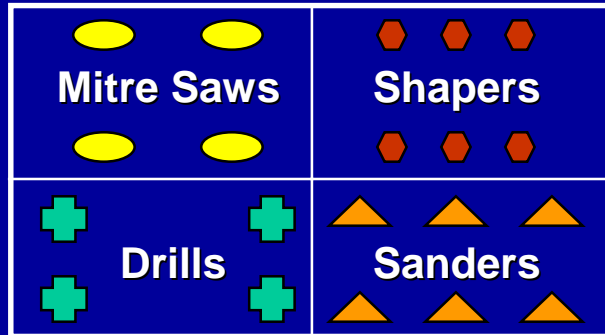
- From-To Chart

[Click here to download a copy](#)

- Activity Relationship Chart

[Click here to download a copy](#)

Organization Types



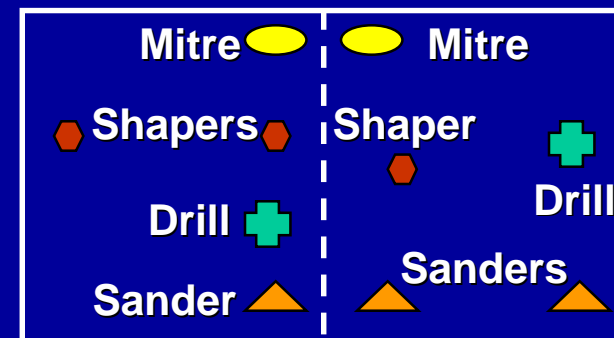
PROCESS LAYOUT

Like machines grouped together

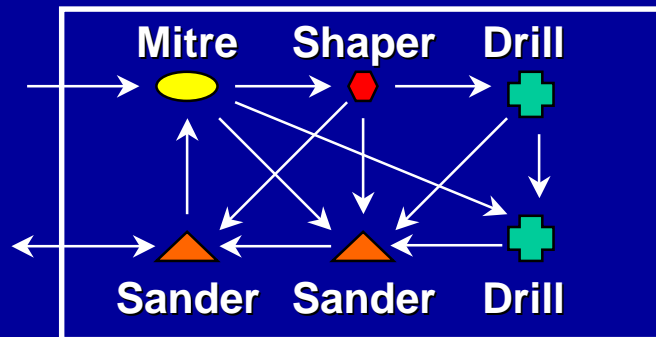
PART-FOCUSED JOB SHOP

Provides basic specialization

Type A Parts *Type B Parts*



Organization Types

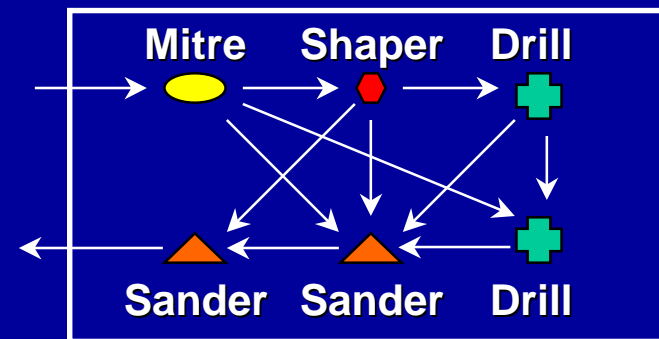


CELL

Parts with similar routings in a *continuous flow*

SEMI -CELL

Parts with dissimilar cycle times requiring a variety of machine sequences



Machine Cell

Cell provides machining with minimal handling time...

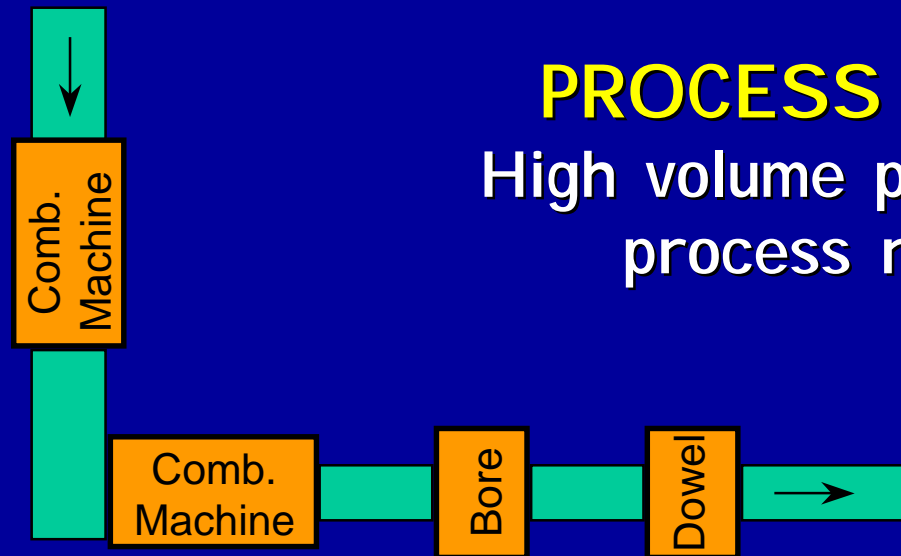


Machine Cell

Portability of machines provides flexible sequencing...



Organization Types

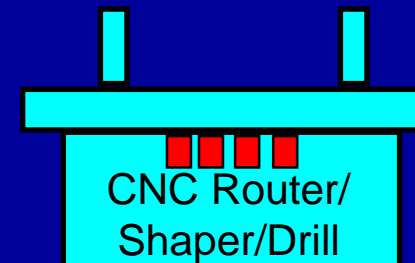


PROCESS FLOW LINE

High volume parts with similar process requirements

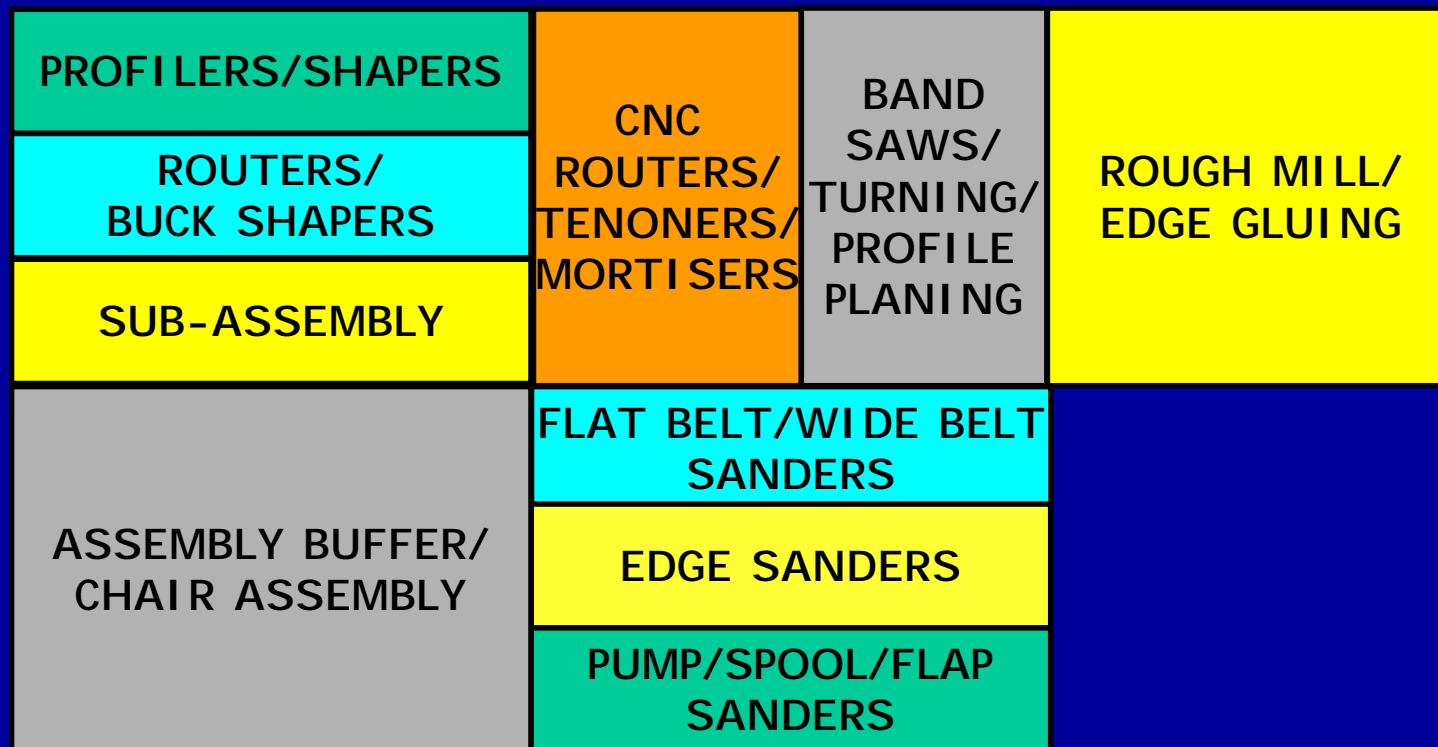
SUPER MACHINE

Small lot sizes with complex process requirements



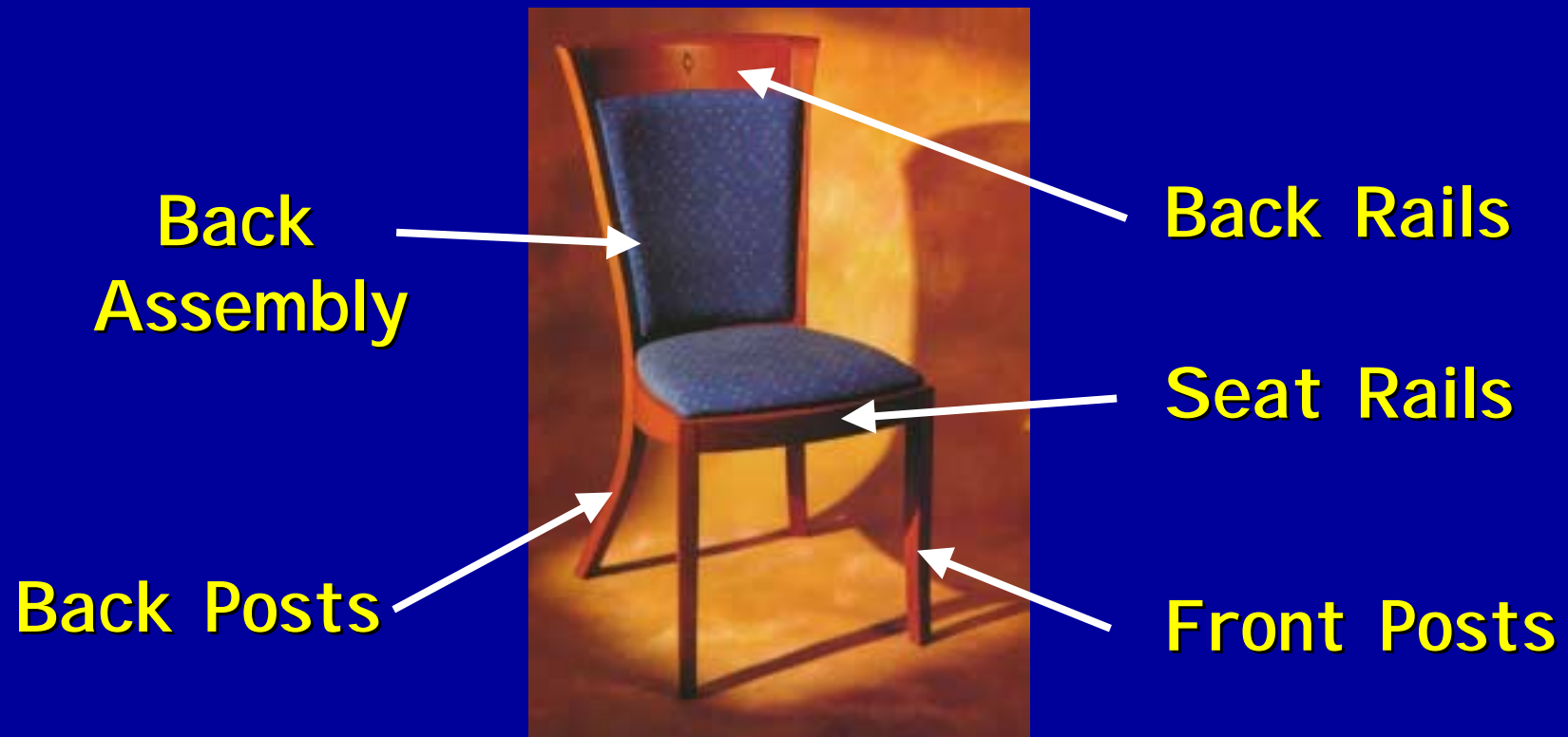
An Example of Product Focus

Many plants have organized parts machining operations by process...



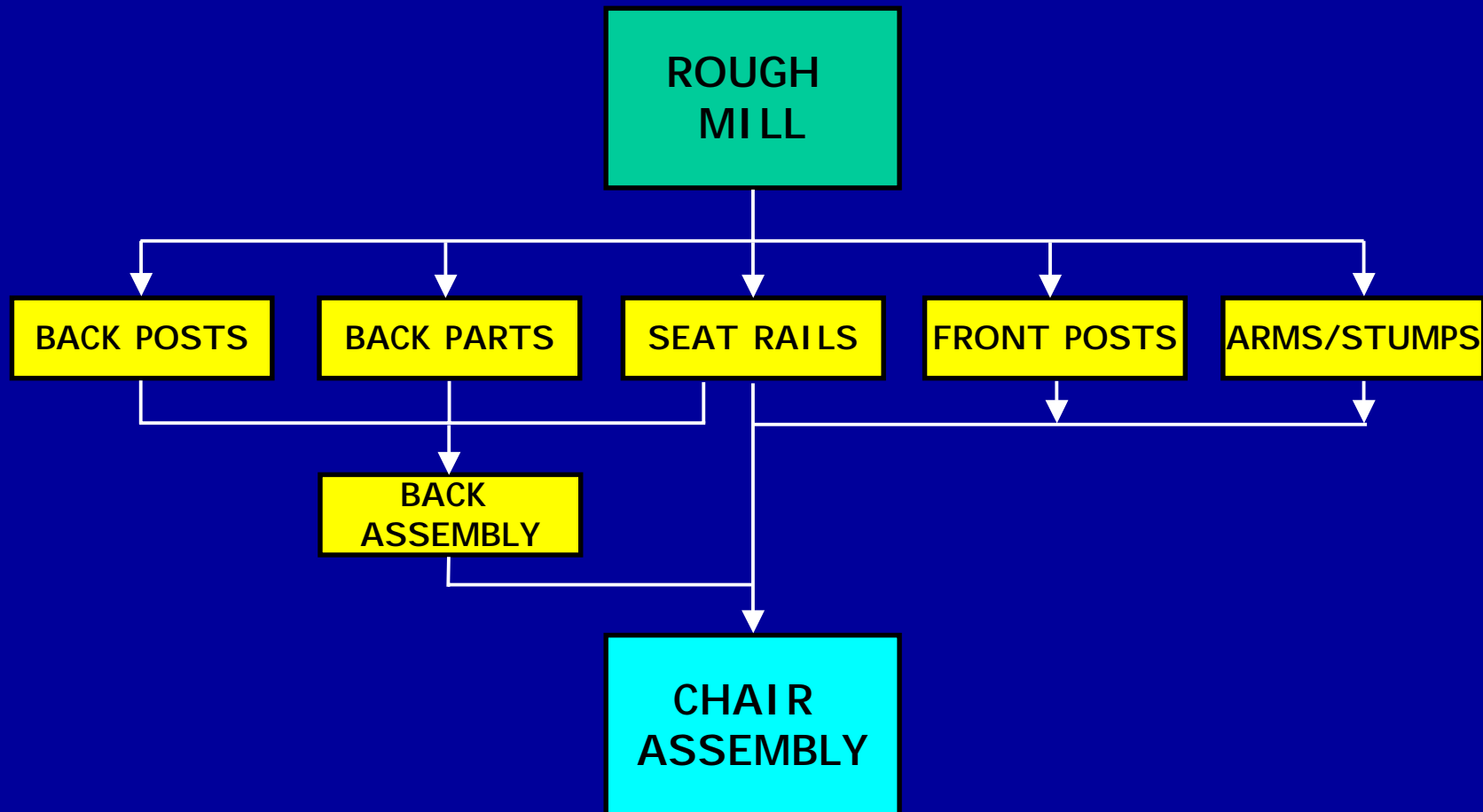
Organizing By Product

Products often exhibit part family standardization...



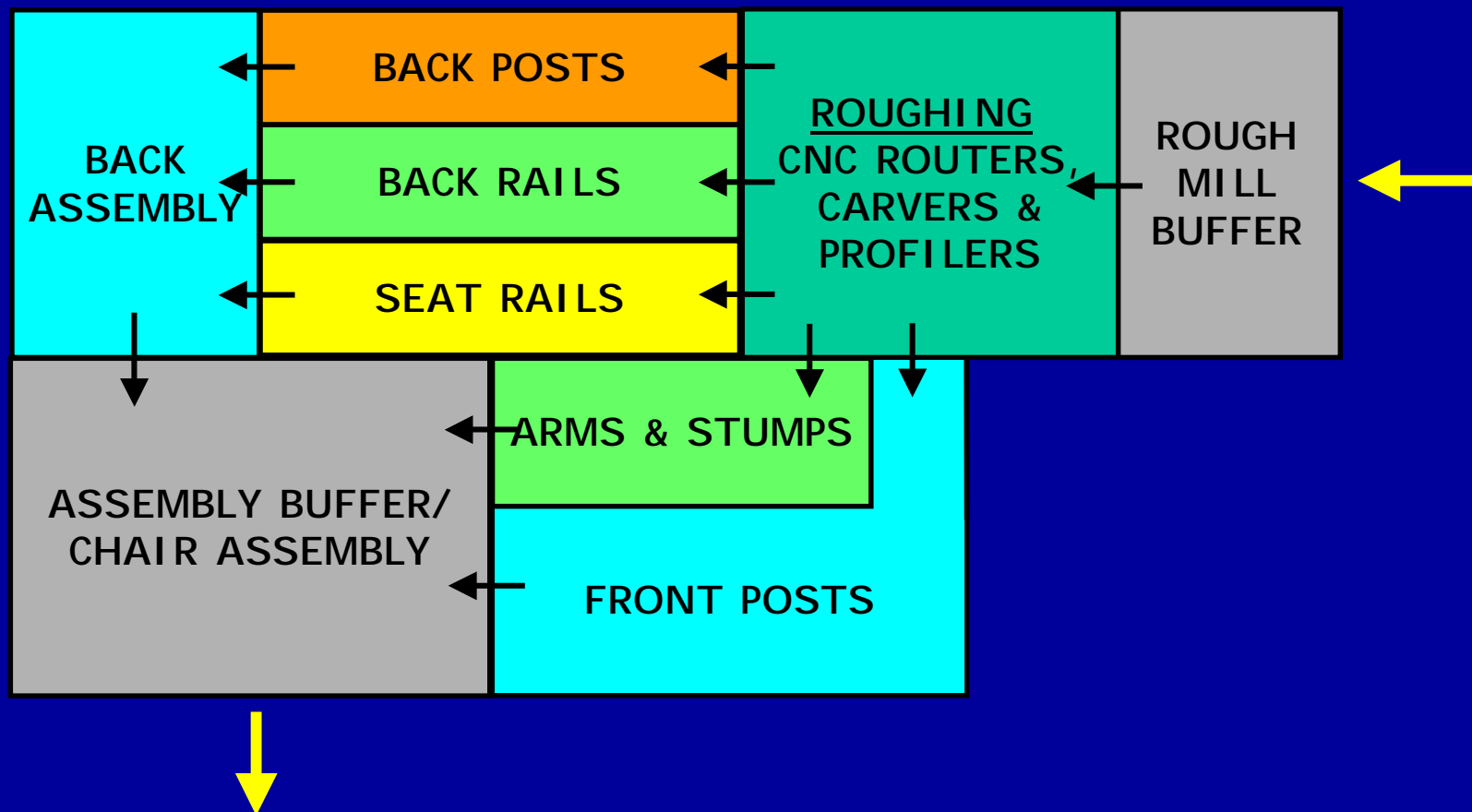
Product-Focused Layouts

Efficiency can be gained by organizing this plant by product or by component type...



Product-Focused Layout

Reorganizing by part family reduces handling, increases teamwork, and reduces complexity...

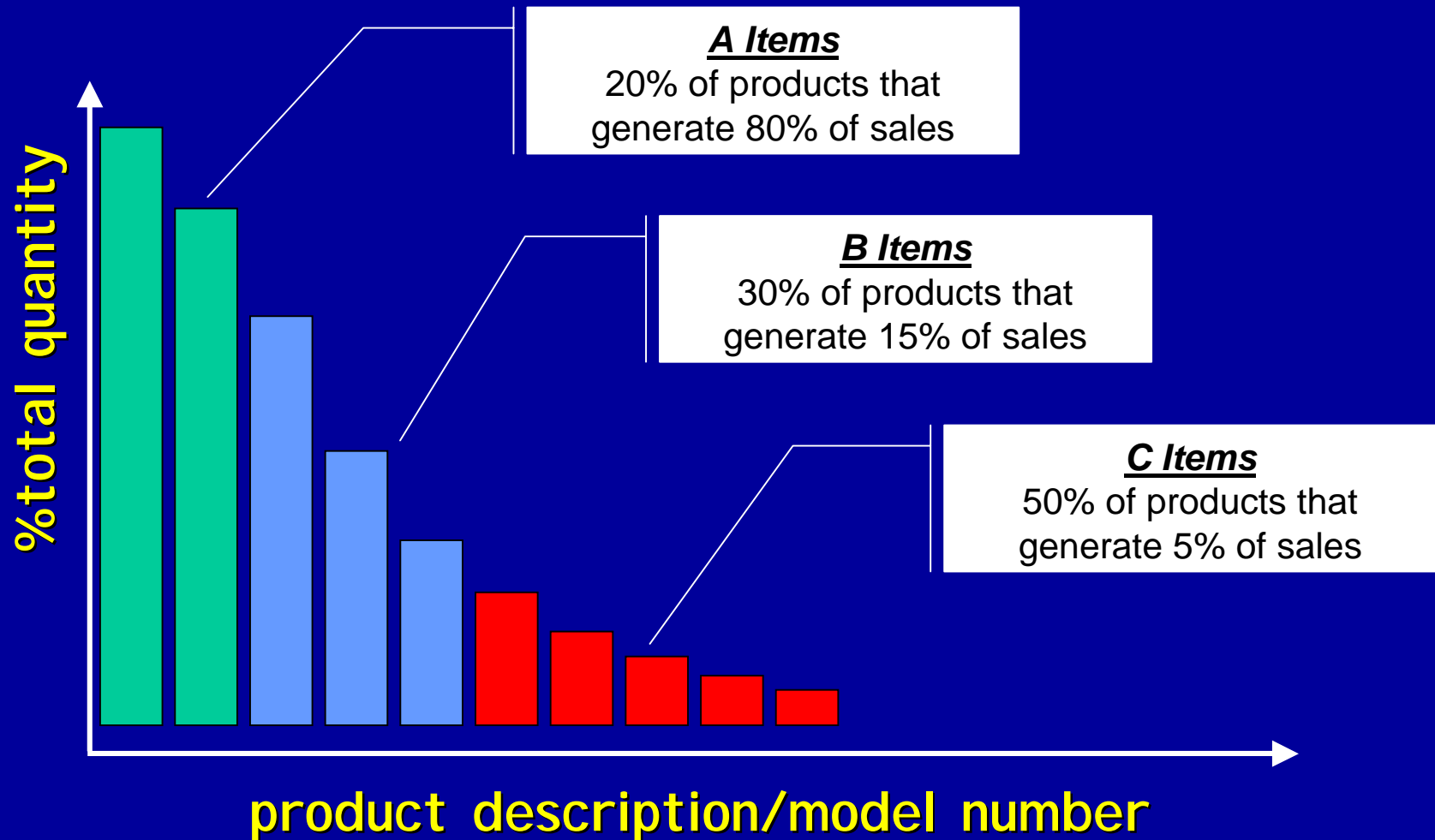


Re-Layout Benefits

- ☑ 33% increase in capacity
- ☑ 50% reduction in throughput time
- ☑ 20% reduction in labor cost

Pareto's Law

Remember 80/20...



Material Handling Alternatives

Consider these principles...

- Minimize work.
- Consider human limitations.
- Minimize safety hazards.
- Use space efficiently.
- Integrate with the process.
- Be environmentally friendly.

Material Handling Alternatives

And remember...

- Handling adds cost not value.
- The best handling system is no handling at all.

Factory Carts



Investment	Low
Operating Cost	High
Space Utilization	Moderate
Stackability	None
Flexibility	High

Moving a variety of materials
on variable flow paths

Pallets



Investment
Operating Cost
Space Utilization
Stackability
Flexibility

Low
High
Moderate
High
Moderate

Moving easily-stacked materials
on variable flow paths

Roller Conveyors



Investment
Operating Cost
Space Utilization
Stackability
Flexibility

Moderate
High
Above Average
Poor
Moderate

Moving easily-stacked materials
on relatively fixed flow paths

Fork Lifts & Racks



Investment
Operating Cost
Space Utilization
Stackability
Flexibility

High
High
Above Average
Excellent
Moderate

Moving easily-stacked materials +
Using building height

Fork Lifts & Racks



High Rise
Cantilever Rack



Narrow Aisleway

Order Picking
Truck





A Case Study

A Case Study

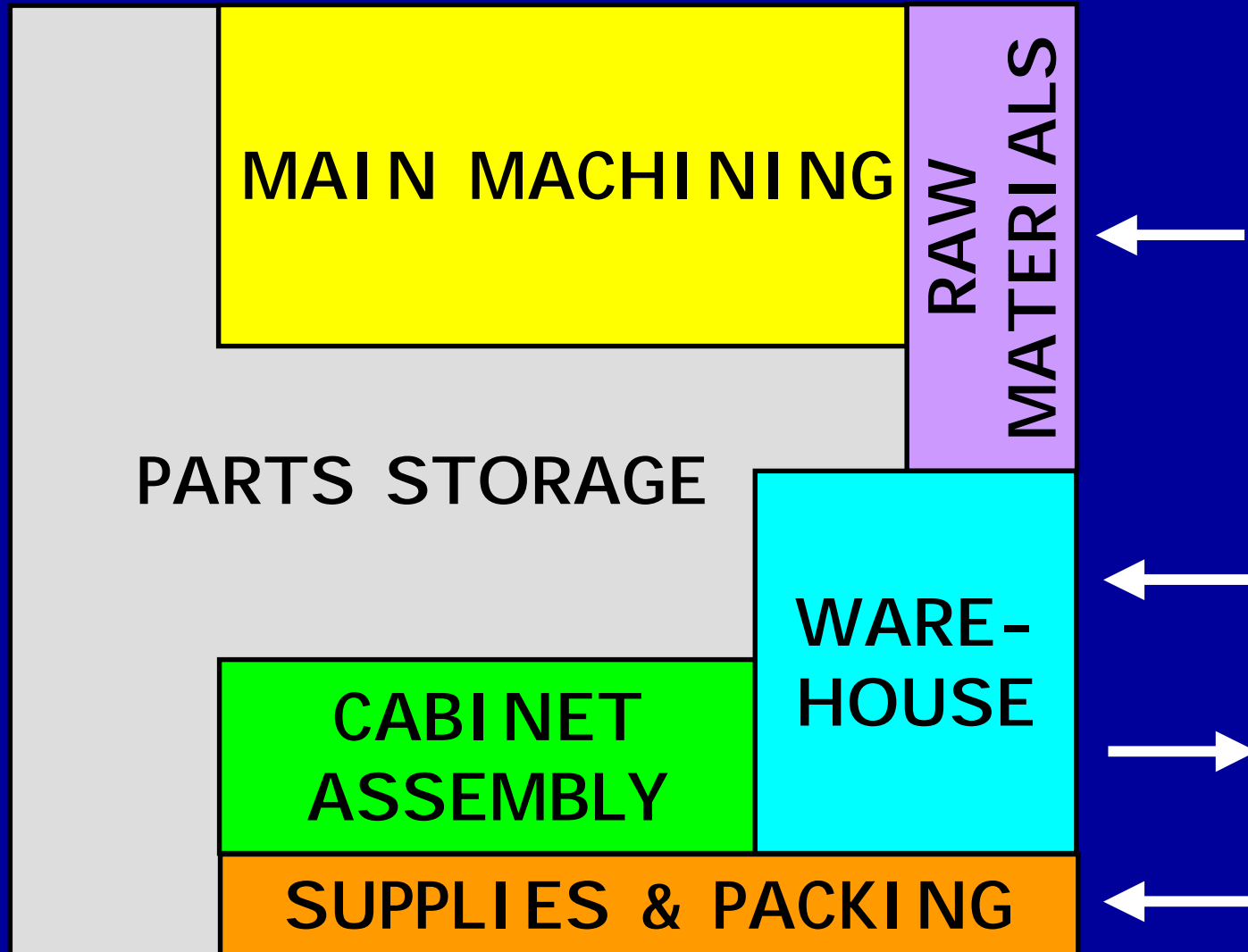
Let's look at a kitchen cabinet producer that has revamped its entire process to improve its ability to serve its customers.

The original plant (graphic 1) was equipped with high volume machinery (graphics 2 and 3) that required the storage of thousands of parts ahead of the assembly line.

Their ability to expand their product line was restrained by the lack of space to store these unsold parts.

Original Plant

1.



2.



**High-Volume
Panel Saw**

3.



High-Volume
Edge Banders

Initial Expansion

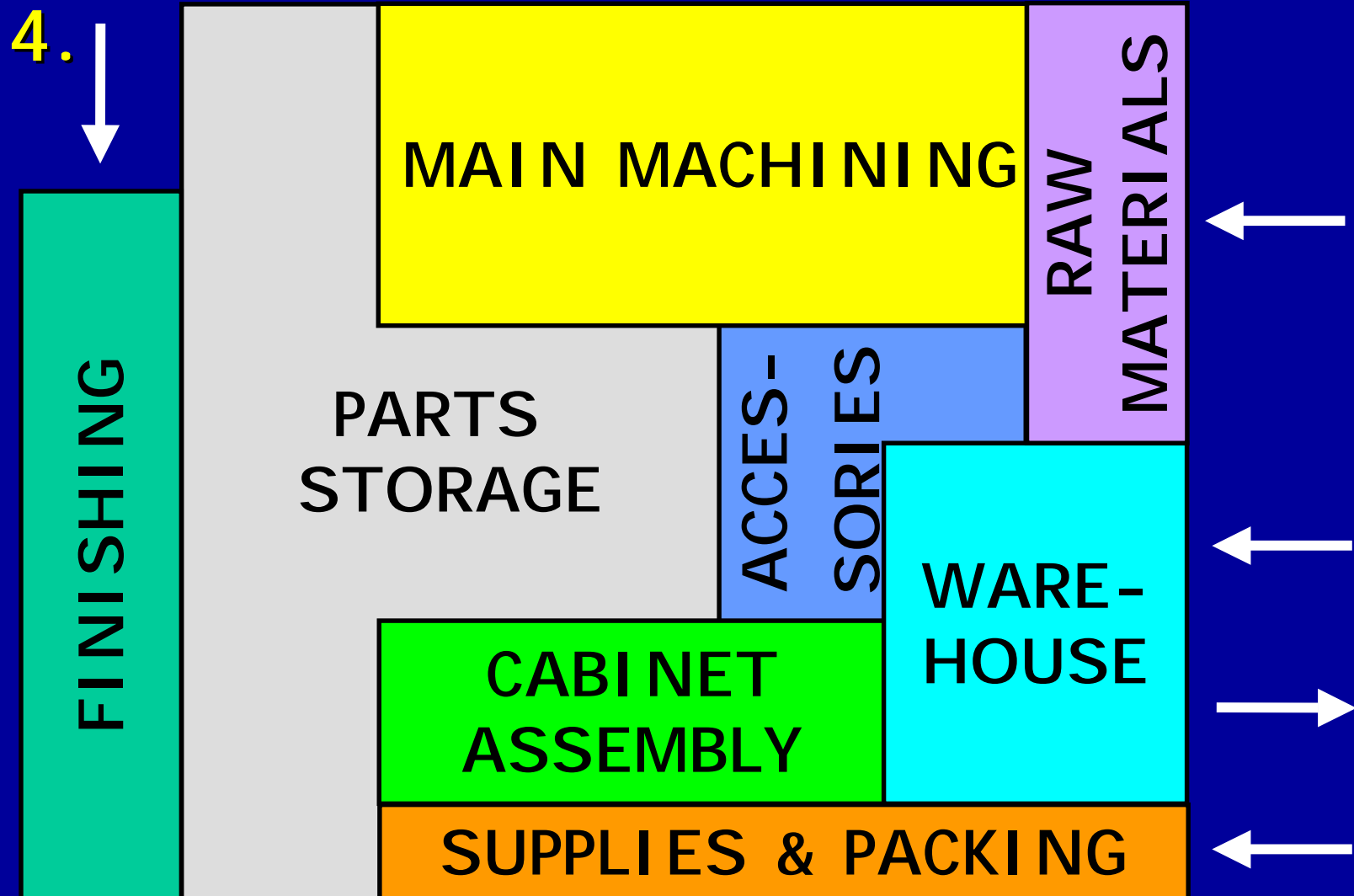
Customers demanded a wider variety of products. In response the company added wood doors/drawer fronts and accessories such as mouldings, shelving, and wine racks.

Graphic 4 shows additions of:

- A small finishing room to stain and lacquer wood doors and other wood components
- A small accessories department

Cabinet parts continued to be machined on the high volume machinery.

Initial Expansion/Re-Layout



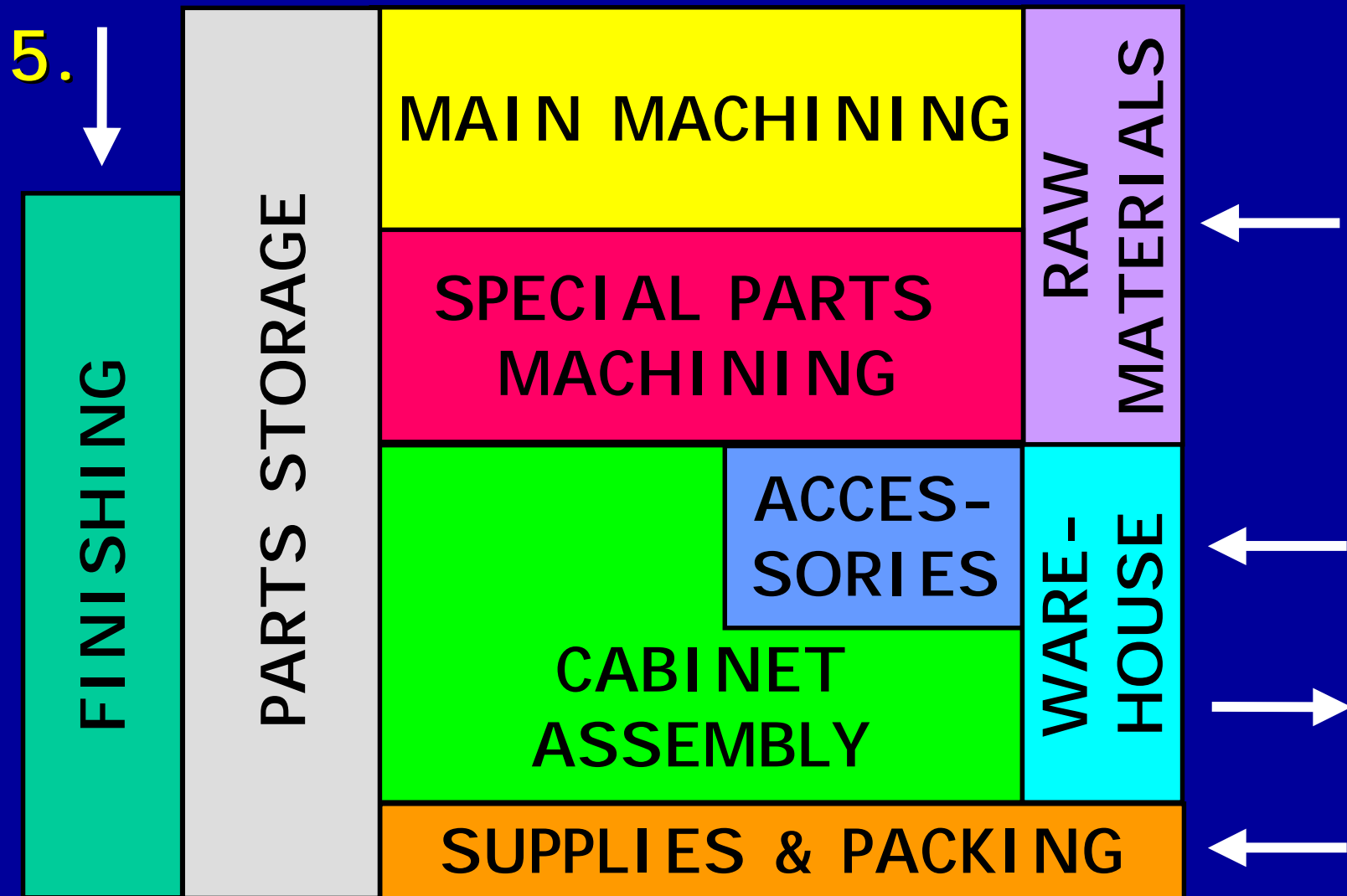
Second Re-Layout

The market continued demanding more cabinet configurations and cabinet colors. The company decided to convert space used for parts storage to production by *making parts to order*.

Graphic 5 shows the necessary layout changes.

Graphics 6, 7, and 8 show examples of fast set-up machinery that enabled manufacturing lot sizes of one. These machines were linked to the company's computer system to provide real time information to the operators.

Second Re-Layout



6.

Information
Interface

Single Beam
Panel Saw



7.

Return
Conveyor

Single Sided
Edge Bander



CNC Drill

8.

Optimat BP 12

Information
Interface



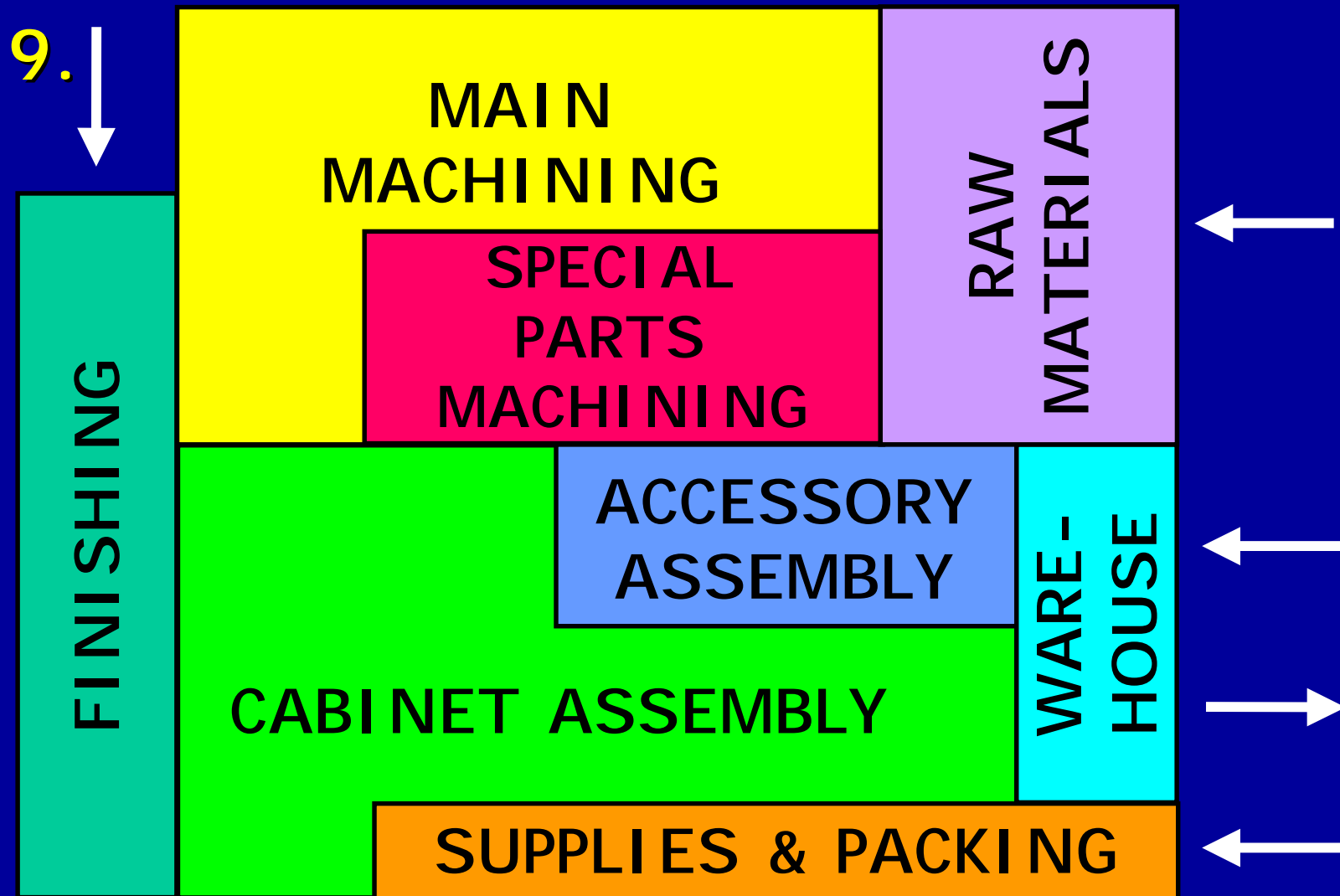
Final Re-Layout

The final step will be the installation of a *highly flexible strip processing line* that will enable just-in-time production of cabinet parts. This line will eliminate the GREY parts storage areas shown in graphics 1, 4, and 5.

The space released from parts storage will also be redeployed for expanded cabinet assembly.

Graphic 9 shows these changes.

Final Re-Layout



Re-Layout Benefits

- ☑ **Expanded Product Offering** – The original product line of 2,270 SKUs was expanded to over 1.5 million.

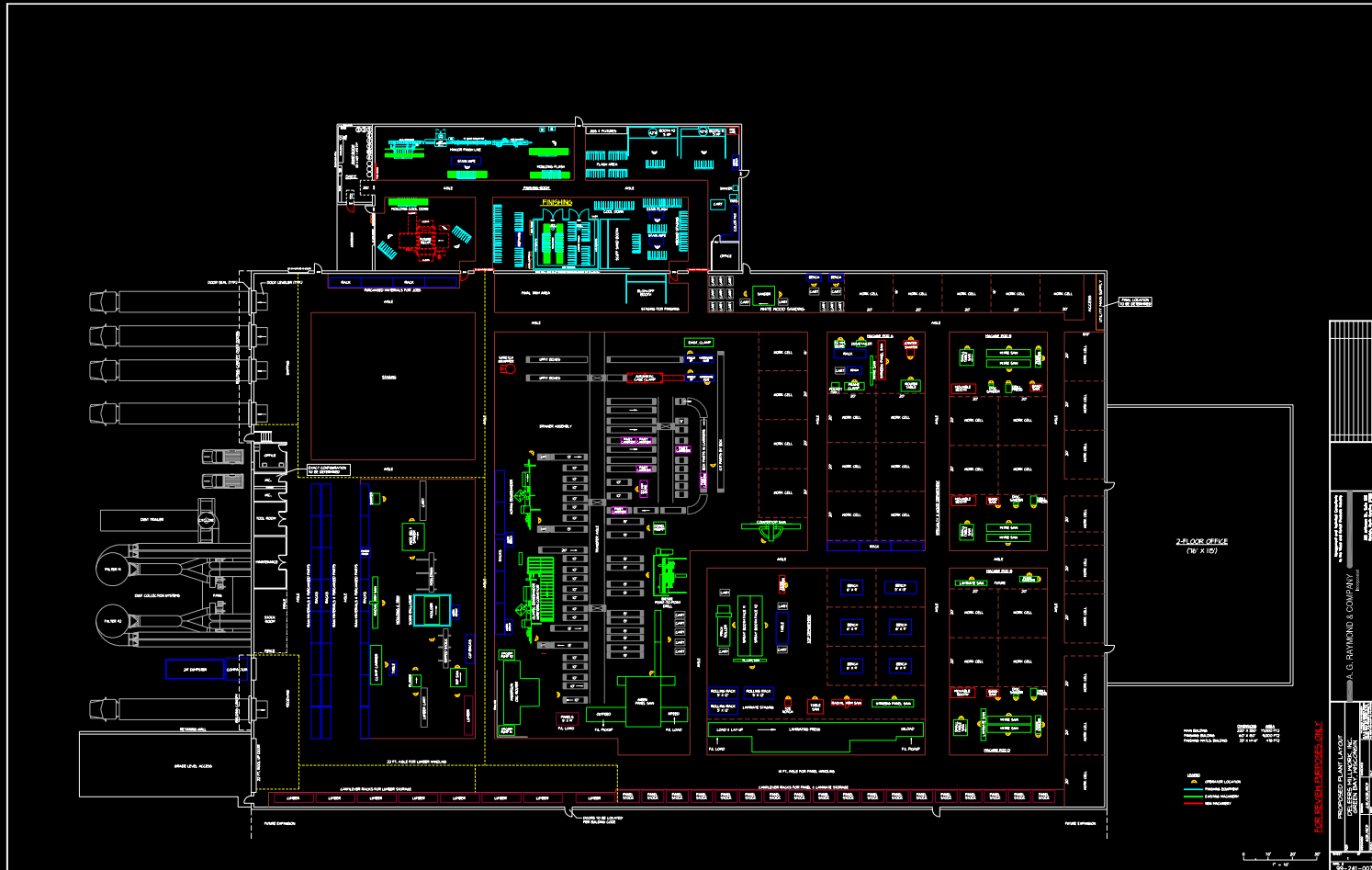
- ☑ **Faster Delivery** – Time from order to delivery is now averaging three weeks.

- ☑ **Higher Productivity**
 - > \$220,000+ per man

 - > \$250+ per square foot

The End Result

Good analysis and planning result in a great layout...



For more information on improving your plant layout contact...

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