# How to Plan Your Next Supply Chain Facility

with
**Lee Hales**
President, Richard Muther & Associates

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# Supply Chain Management Series

# Strategic Planning of Supply Chain Facilities

August 13-16, 2013 | Georgia Tech Campus (Atlanta, GA)

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# How to Plan Your Next Supply Chain Facility

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**August, 2013**

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# 4-Day Working Conference on Strategic Planning of Supply Chain Facilities

| Session & Time | Day 1 | Day 2 | Day 3 | Day 4 |
|---|---|---|---|---|
| A 8:00 | Fundamentals of Strategic Planning | Systematic Handling Analysis (SHA) | Master Site Planning | Team Presentations |
| B 9:15 | Supply Chain Network Analysis | Impact of Automation on Supply Chain Facilities | Site Planning Methods | Evaluation of Alternative Plans |
| 10:30 | | Break | | |
| C 10:45 | Site Selection & Location | Systematic Planning of Industrial Facilities (SPIF) | Case Exercise: Planning a New Facility | Guided application: DC planning; Off-shore planning |
| 12:00 | | Lunch | | |
| D 1:00 | Basics of Facilities Planning | Tie-Ins: Communications, Utilities & Building Design | Case Exercise Continues | Case Studies: Strategic Planning in Action |
| 2:15 | Break | | | |
| E 2:30 | Systematic Layout Planning (SLP) | Estimating Capacity & Space Requirements | | Organizing & Managing for Strategic Facilities Planning |
| 3:45 | Break | | | Adjourn 3:30 |
| F 4:00 | Facility Layouts & Flow Patterns | Case Exercises in Long-Range Space Projections | | |
| 5:00 | | | | |

# Today's Topics (using pages from 4-day workshop)

1. Plan top-down; from outside-in: Network to location; surroundings to plans.
2. Different approaches to network planning.
3. Long-range space estimating.
4. Master site planning principles and practices.
   - Site-saturation method
   - Dominant considerations
5. Putting it all together:

- Systematic Planning of Industrial Facilities (SPIF)

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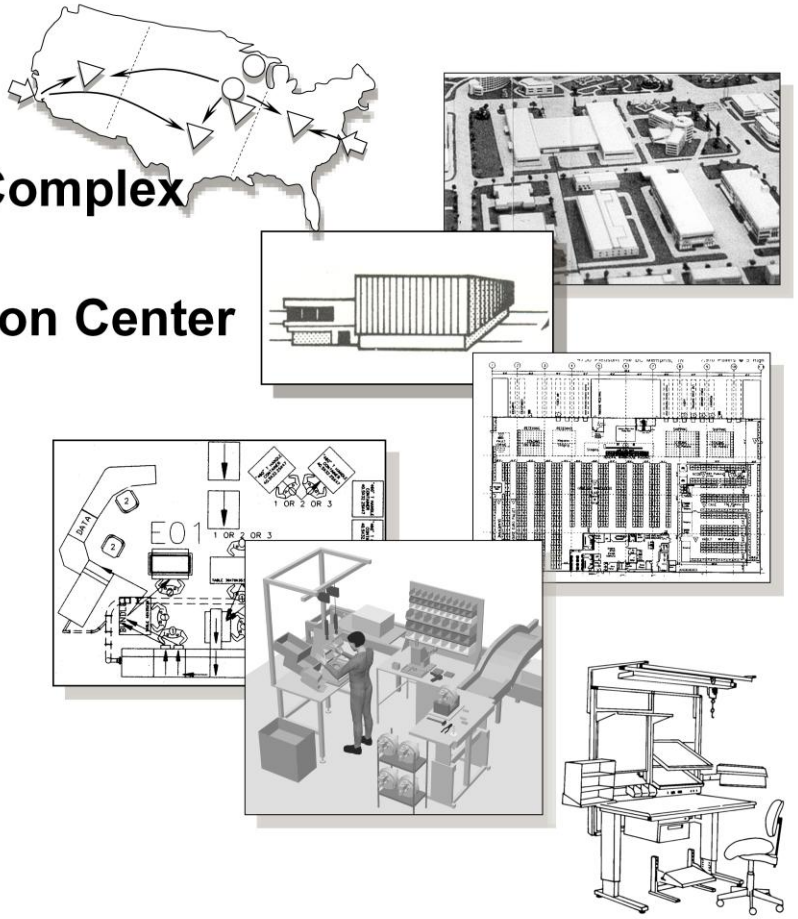
**Main Points**

1. Plans are made at many levels, classified primarily by size and importance of the thing(s) being planned.
2. The strategic planner is most frequently involved in levels 9, 10 and 11.
3. The higher the level of planning, the greater the opportunity to make a contribution to profits (or a serious mistake).
4. The significance of this levels of planning concept is multiple: each facility falls within a larger "facility" in system-and-subsystem sequence; each plan falls within a larger "plan"; and each planning project itself breaks down into sub-projects – facilities within facilities, plans within plans, projects within projects.

# Levels of Physical Planning

11. **Network**
10. **Site/Multi-Building Complex**
9. **Factory or Distribution Center**
8. **Department or Zone**
7. **Work Area**
6. **Workstation**
5. **Machine/Equipment**

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**Notes**

**Main Points**

1. Most networks are planned incrementally, one location at a time. The "next location" is often fairly obvious in terms of a region or even community
2. Within an industry, networks often evolve into similar forms– presumably because their economics are similar. The more specialized the industry, the more likely this will be true.
3. When the choice is between two or three network designs and will be determined by a handful of variable costs, one can construct annualized cost estimates for each. This type of comparative costing is made easier with industry reports and databases on operating costs.
4. Static, hand-built cost comparisons are impractical when considering more than a handful of alternatives or many interacting costs.
5. Network modeling uses mathematics and specialized software to evaluate many alternatives and interacting costs.
6. But network modeling requires expensive tools and specialized staff or outside consultants. This de-coupling from line management often results in rework and misuse.
7. Systematic Network Planning helps to assure faster and better results through sound planning and management of modeling projects.

# Typical Approaches to Network Planning

- The Obvious Locations Approach
- Go Where the Industry Goes
- Comparative Costing
- The Network Modeling Approach
- The Systematic Methodology Approach (SNP)

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**Notes**

# Network Planning: One-day delivery

**Main Points**

1. This company has two DCs co-located with production plants in Dover, DE and Des Moines, IA.
2. For competitive reasons, they need next-day delivery to customers and must add warehouses.
3. Working only from your knowledge, add four warehouse locations to Dover and Des Moines that can deliver to most customers within one day's drive. List your locations below:

_____

_____

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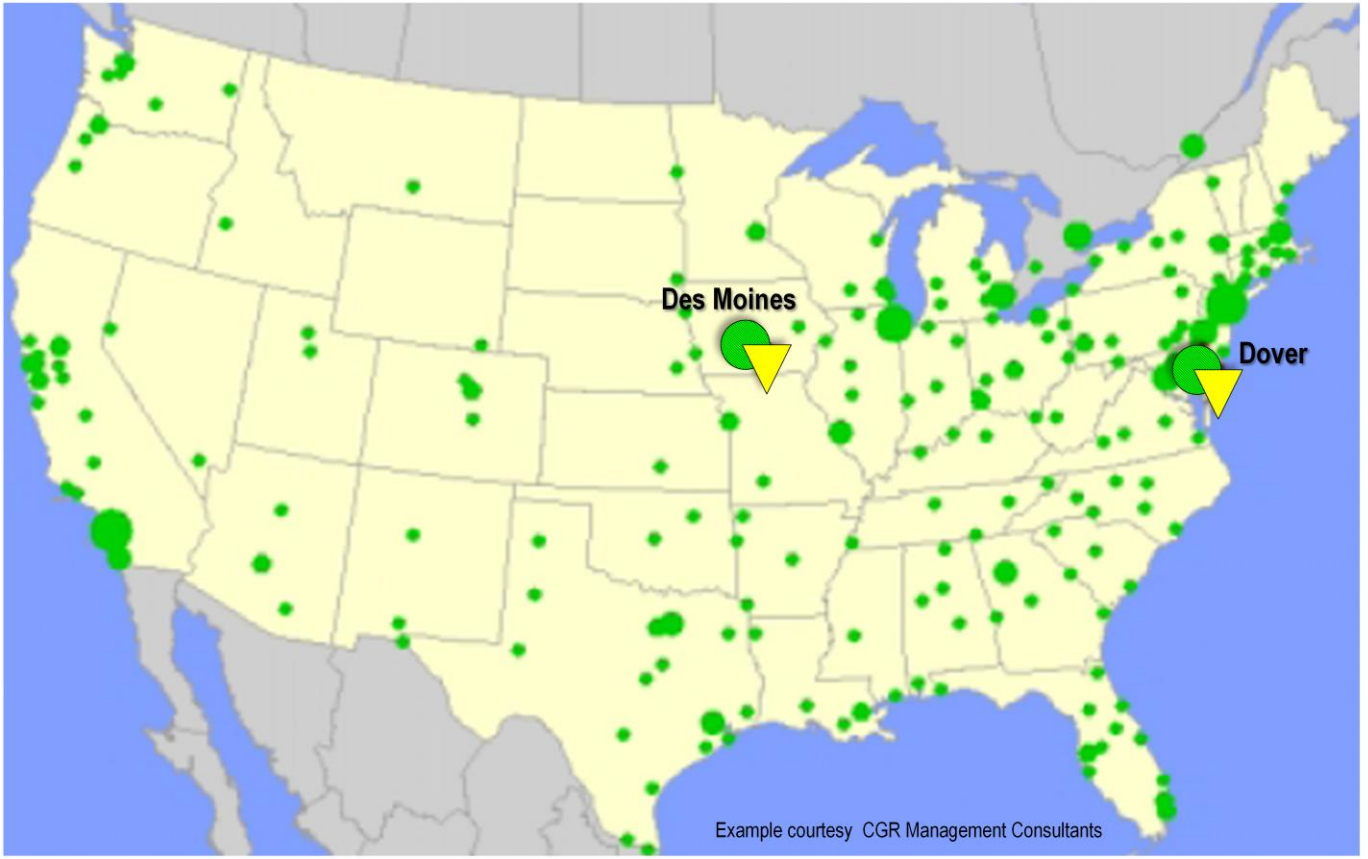


Working only from your knowledge, add four warehouse locations to Dover and Des Moines that can deliver to most customer locations within one day's drive.

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**Notes**

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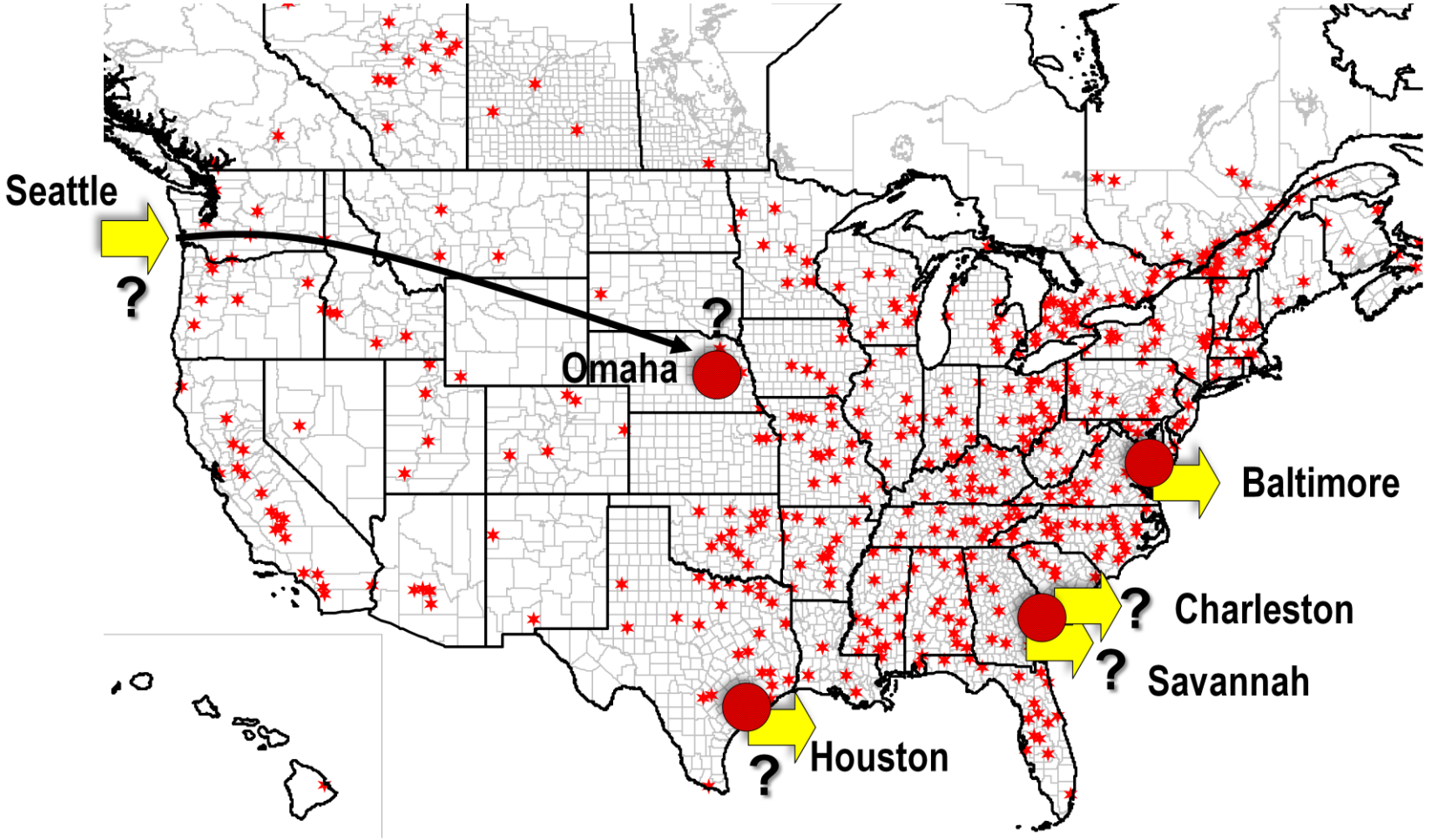
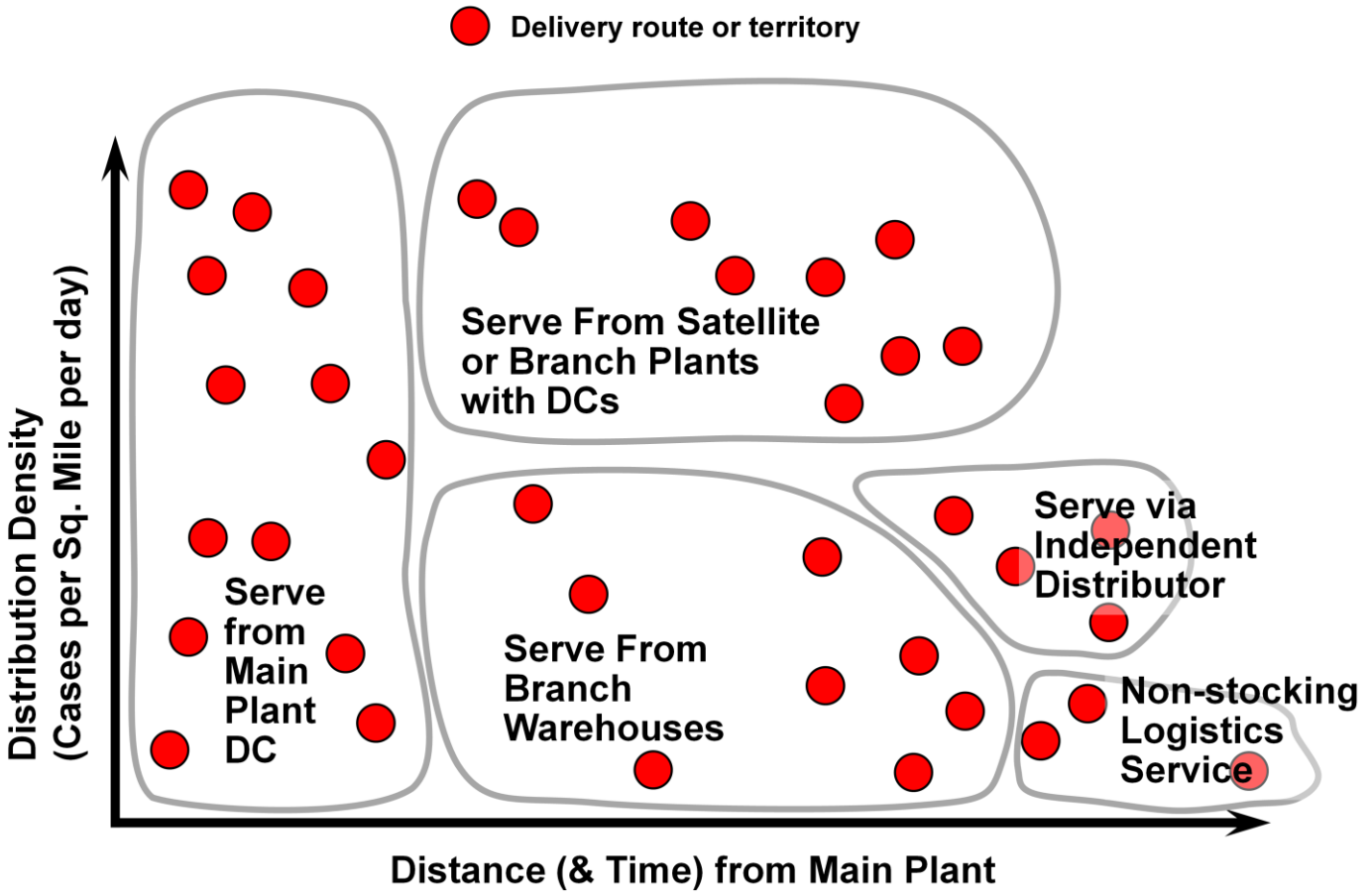
# Farm Machinery Inc.
# Dealer Map



**Main Points**

1. In the chart shown here, distribution density (vertical axis) refers to demand rate or volume per period per square mile or kilometer. This is a measure of "flow intensity" from the producing plant to a delivery route or territory, or even to specific customer locations.
2. Generally, demand locations that are close to a large plant should be served from it, or from a DC on its site, regardless of distribution density – low or high.
3. When distribution density is low, and the distance from the plant is great, a branch warehouse serving these routes or territories will improve service and reduce transport costs by its proximity.
4. If distribution density is high and distance is great, our transportation costs will typically become unacceptably high. Here the only solution is to put a branch plant closer to the demand, quite often with its own attached distribution center and perhaps even branch warehouses.
5. Note that the boundaries of the three warehouse types change in response to changes in demand and transport costs.

# Soft Drink Company: Theoretical Solution

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**Notes**

**Main Points**

1. From the classical theory of network optimization, every "problem" is represented by nodes (locations) and arcs (transportation lanes or flows).
2. Modeling is done with specialized software, ranging, from simple and inexpensive to complex and costly.
3. Most modeling software uses the CPLEX algorithm for mixed-integer linear programming. This algorithm optimizes – meaning it seeks to maximize or minimize an objective function subject to constraints.
4. The objective function is typically defined to minimize costs of interest, or to maximize profits. Most modeling software has a three-part structure:
   a. User interface to enter and view data and results.
   b. Mid-layer where mathematical equations are formulated.
   c. Optimization engine which solves the problem as formulated.
5. Modeling software does not typically consider intangible factors or consequences of network planning decisions. Factors such as risk or ease of implementation, or flexibility must be addressed by a larger and more comprehensive and systematic planning procedure.

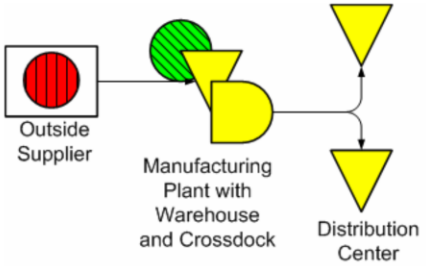
# Network Modeling & Optimization

$$\underset{\text{Cost}}{\text{Min}} \sum_i \sum_j c_{ij} x_{ij}$$

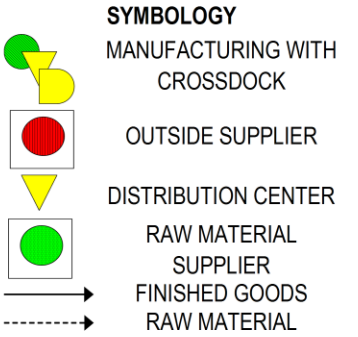
$$\text{st} \quad \sum_i x_{ij} - \sum_k x_{jk} = b_j \; \forall j \in N$$

HOW TO READ THIS FORMULA:

- Minimize flow (x) cost (c)
- between all pairs ($\sum\sum$)
- of network locations (i's and j's),
- subject to (st)
- the conservation constraint that
- all flows into any location ($X_{ik}$) must be accounted for,
- either as outflows ($X_{jk}$)
- or as quantities remaining ($b_j$)
- at each ($\forall$) location,
- where j is a type of ($\in$) number N,
- either integer or real – to require only whole locations or to permit a fractional result.




NODES = Locations
ARCS = Transportation Lanes

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**Notes**

**Main Points**

1. Some networks are simple and straightforward to configure. They require only one or a handful of locations, the selection of which is fairly clear and often obvious.
2. At the other extreme are networks comprising dozens to hundreds of warehouses that can be placed in many possible locations.
3. Clearly the techniques used to plan simple and complex networks will be different.

# Typical Networks & Strategies

| Type of business | Number of U.S. DCs & Warehouses | Stocking levels to point of consumption | Where located | Strategic considerations |
|---|---|---|---|---|
| Automobile manufacture (purchased parts) | | | | |
| Expensive surgical instruments | | | | |
| Major airline (service parts) | | | | |
| Imported apparel (sell to retail trade) | | | | |
| Specialty retailer | | | | |
| Automotive service parts (retail) | | | | |
| Soft drinks | | | | |

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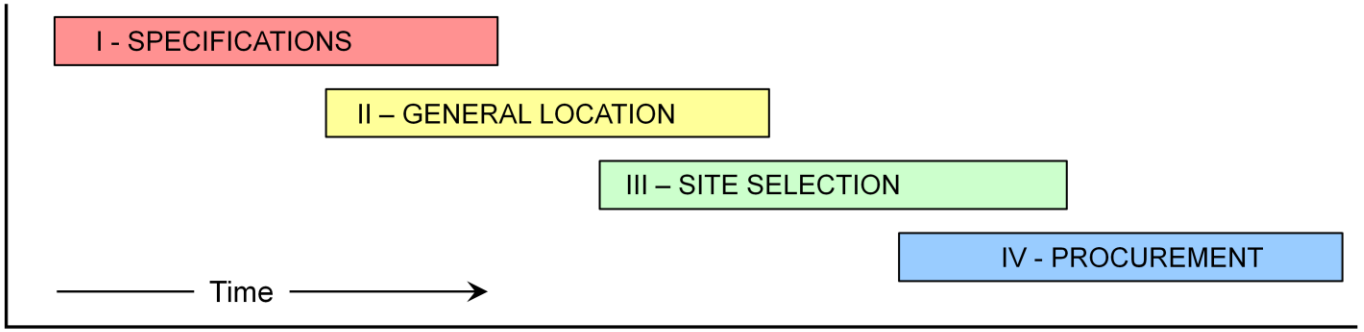
**Notes**

**Main Points**

1. Location projects break down into the four phases shown here.
2. The four phases should overlap. Finding out what differences exist among communities may lead to some adjustments in specifications. For this reason, cursory reviews of communities or regions should begin before the final specifications are written.
3. Similarly, there is no point in considering a community that contains no suitable sites.
4. Phases II and III both involve search activity. Both follow common procedures to arrive at selected locations.
5. Location projects typically require two groups. A top management group sets objectives, reviews progress and makes or approves final selection. A middle management group writes the specifications, gathers information and makes recommendations.

# The Phases of Site Location & Selection




Phase I:

Establish what is wanted: Proximities to customers & suppliers, capacities short- and long-range, features and surroundings…

Phase II:

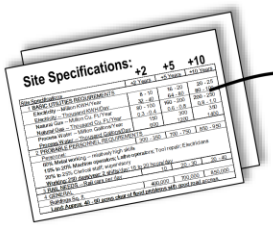
Select the general region or community. Compare costs, intangible features and characteristics, and availability of suitable sites.

Phase III:

Analyze and select the specific site. Compare costs and suitability for intended layout and operations.

Phase IV:

Procure the site through negotiations, lease or purchase.





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**Notes**

**Main Points**

1. The nine steps or procedures listed here are repeated – once to choose the general location, and again to evaluate and select a final site within the chosen community or region.
2. Note that site visits are in the middle of the sequence.
3. Be sure to decide in advance if you are visiting on a confidential basis, without identifying your company, or if you can be public about your interests.
4. Going public may expose your senior executives and organization to questions, sales pitches, and explanations that they are not yet ready to handle.

# Location Planning Procedures

repeated for General Location & Site Selection

1. Transportation studies
2. Review of published information and data
3. Preliminary screening
4. Establish local contacts
5. Field visits
6. Economic analysis
7. Intangible considerations
8. Negotiations
9. Final evaluation & selection

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**Notes**

# Typical questions answered by site master planning

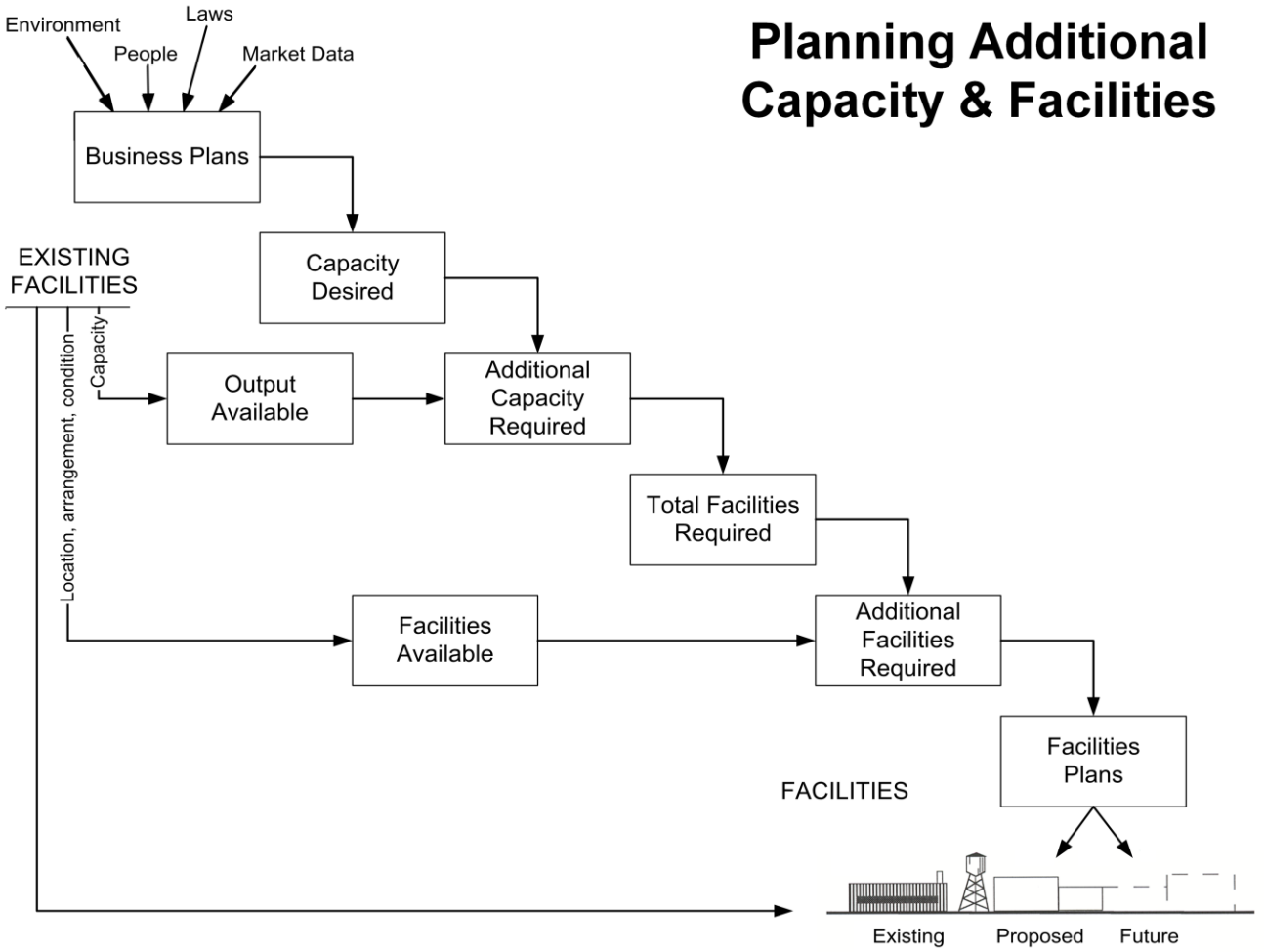
1. How much business can we support from our existing land and buildings?
2. How much space and land do we need to support potential long-range growth?
3. What is the value of adjacent or nearby facilities that could be purchased or leased?
4. How much capacity do we gain by taking something off site (or more of something already off site)? What should stay? What should move?
5. Where is the best place to introduce a new product or activity?
6. What is the best use of each major building or area?
7. To what degree could we improve material, vehicle and personnel flow?
8. How do we best honor important relationships and considerations other than flow: safety, appearance, convenience, organizational interaction…
9. How would a greenfield relocation look compare to staying put?
10. What is the transition plan or sequence to get from where we are to where we want to be in 5 years?

# Planning Additional Capacity & Facilities

**Main Points**

The general procedure for planning capacity requirements consists of the following steps or outputs:

- **Business Plans.** Management's overall plans for the business.
- **Capacity Desired.** The output or production per period of time needed or desired by management.
- **Output Available.** The maximum production per period available from existing facilities.
- **Additional Capacity.** What additional quantities of what products are required.
- **Total Facilities Required.** The land, buildings, equipment and machinery required to satisfy the output requirements.
- **Facilities Available.** The total space, machinery and equipment available, in amount, kind, condition and configuration.
- **Additional Facilities Required**. The space, machinery, and equipment required to provide the additional capacity required.
- **Facilities Plans.** The proposed or intended location, arrangement,, specifications and costs of facilities required.

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**Notes**

## Main Points

1. The Space Requirements Converting form summarizes current space, adjustments required, and future estimates.
2. The "Plan-For" columns (g and k) can be used to record the space that will be provided in the selected plan, or in a particular alternative plan.
3. When used in this way, the Plan-For columns are filled after a plan is developed, by measuring the areas it provides.
4. When the plan does not provide sufficient total space, this form and procedure forces the planners to decide which areas will be cut and by how much to fit within the total space available.

### SPACE REQUIREMENTS -- CONVERTING

Plant *C.F. Company* Project *10-year plan*
By *JDW* With *KH*
Date *1/20* Sheet *1* of *1*

*Totals rounded to nearest module*
Basis (year, period, quantity) of *# of 400 sq.m. modules* Columns e, f, g *+5 years* Columns h, j, k *+10 years*

| | a Activity-- Area or Dept. | b Area Now Occupied Plant | Leased Whse | Total | c + or - Adjstmt. ( Modules ) | d Should Have Now ( Modules ) | e Increase Decrease ( Modules ) | f Req'd Area Determined ( Modules ) | g Plan-For Area ( Modules ) | h Increase Decrease ( Modules ) | j Req'd Area Determined ( Modules ) | k Plan-For Area ( Modules ) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Receiving | 0.5 | 1 | 1.5 | 0 | 1.5 | 0 | 1.5 | | 0 | 1.5 | |
| 2 | Raw Material | 1.5 | 0 | 1.5 | -0.5 | 1 | 0.5 | 1.5 | | 0 | 1.5 | |
| 3 | Pistol Manufacturing | 3 | 0 | 3 | -3 | 0 | 0 | 0 | | 0 | 0 | |
| 4 | Pistol Repair | 2 | 0 | 2 | 0 | 2 | 0 | 2 | | 2 | 4 | |
| 5 | Connector Manufacturing | 6 | 0 | 6 | 0 | 6 | 2 | 8 | | 0 | 8 (b) | |
| 6 | Fastener Finished Goods | 1.5 | 6 | 7.5 | 2.750 | 10.3 (a) | 4.6 | 15 (a) | | 7 | 22 (a) | |
| 7 | Connector Finished Goods | 1.5 | 2 | 3.5 | 0.667 | 4.2 (a) | 1.4 | 5.6 (a) | | 3 | 8.6 (a) | |
| 8 | Order Staging & Shipping | 1.5 | 1 | 2.5 | 0 | 2.5 | 0 | 2.5 | | 1 | 3.5 | |
| 9 | Test Lab | 0.5 | 0 | 0.5 | 0 | 0.5 | 0 | 0.5 | | 0 | 0.5 | |
| 10 | Quality Assurance | 0.25 | 0.25 | 0.50 | 0 | 0.5 | 0 | 0.5 | | 0 | 0.5 | |
| 11 | Maintenance & Utilities | 0.75 | 0.25 | 1 | 0 | 1 | 0 | 1 | | 0 | 1 | |
| 12 & 13 | Offices, Rest Rms, Lunch Rm. | 1 | 0.25 | 1.25 | 0 | 1.25 | 0.25 | 1.5 | | 0 | 1.5 | |
| 14 | Main Office (Admin & Engr.) | 2 | 0 | 2 | 0 | 2 | 0 | 2 | | 0 | 2 | |
| 15 | Order Picking & Packing | 0 | 2 | 2 | 0 | 2 | 0 | 2 | | 1 | 3 | |
| | Vacant Underroof | 6 | 0 | 6 | -6 | 0 | 0 | 0 | | 0 | 0 | |
| | **Total Underroof (U-Space)** | **28** | **13** | **41** | **-6** | **35** | **9** | **43** | | **14** | **57** | |
| 16 | Drives and Roadways | 20 | 4 | 24 | 0 | 24 | 2 | 26 | | 8 | 34 | |
| 17 | Plant/DC Parking | 7 | 2 | 9 | -2 | 7.3 | 0.7 | 7.9 | | 2.3 | 10.2 | |
| 18 | Truck & Trailer Parking | 2 | 6 | 8 | -6 | 2.2 (c) | 0.1 | 2.4 (c) | | 0.5 | 2.8 (c) | |
| 19 | Main Office Parking | 2 | 0 | 2 | -0.5 | 1.5 | 0 | 1.5 | | 0 | 1.5 | |
| | **Total (Y-Space)** | **31** | **12** | **43** | **-8** | **35** | **3** | **38** | | **11** | **49** | |
| | **Vacant, Set Back, Unusable** | **216** | **0** | **216** | **-11** | **205** | **-12** | **194** | | **-25** | **169** | |
| | **TOTALS** | **275** | **25** | **300** | **-25** | **275** | **0** | **275** | **275** | **0** | **275** | **275** |

NOTES: (a) *FG requirements at 3 pallets high (= plant clearance). If stored 4-high, then reduce required area by 25%.*
(b) *Assumes replacement activity if connectors are outsourced.* (c) *Parking per County code.*

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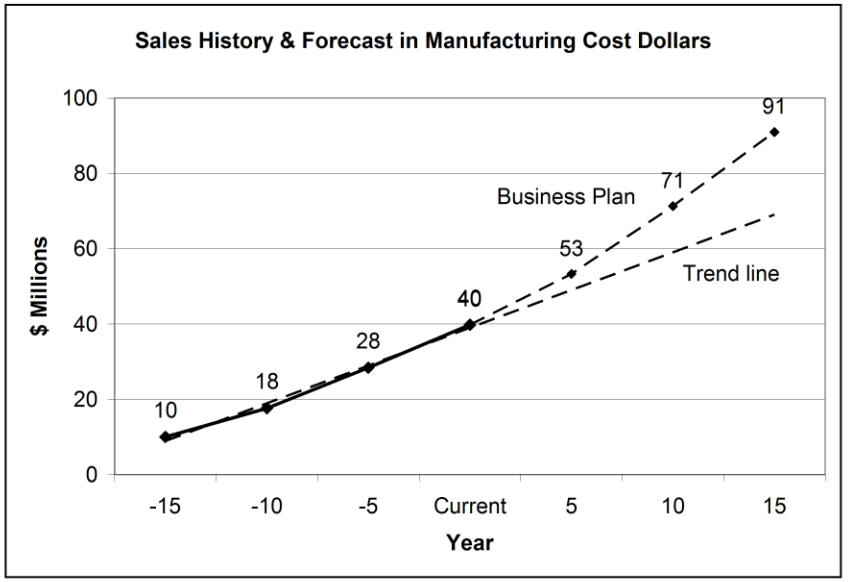
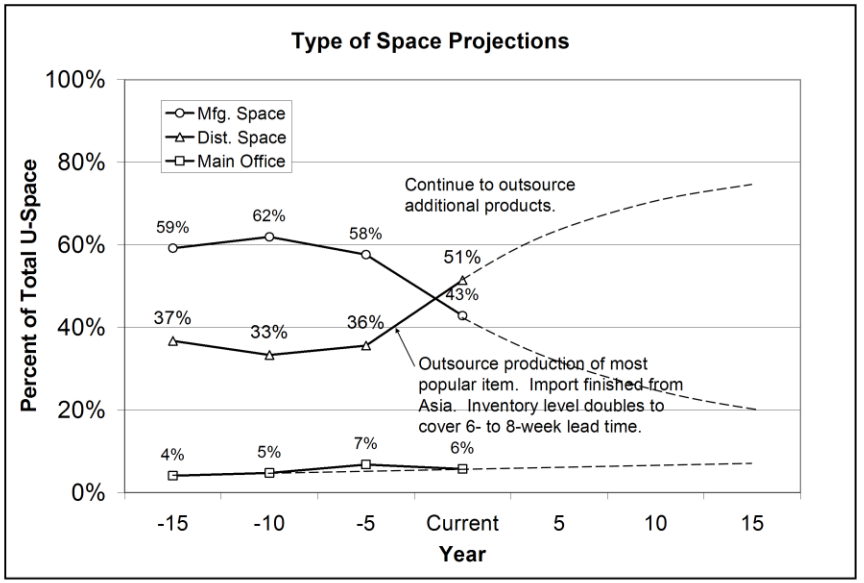
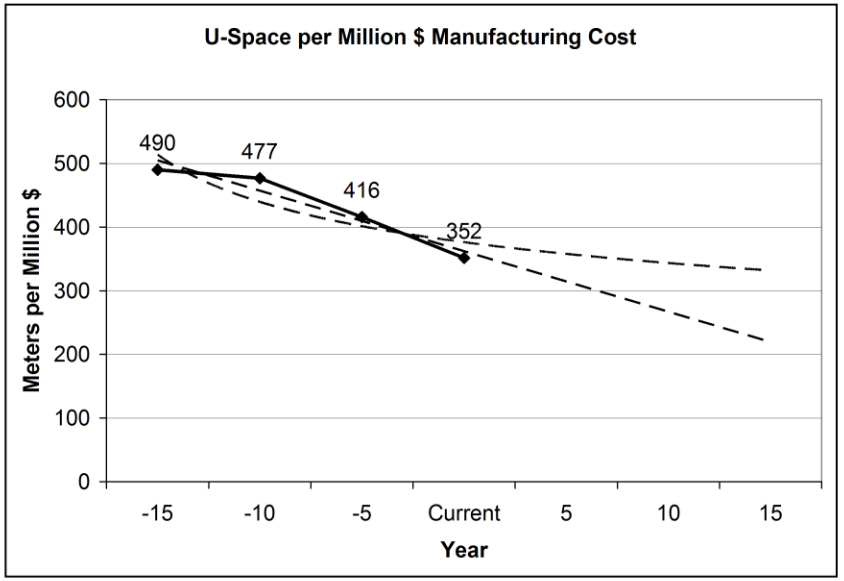
## Notes

# Construction Fastener Co. -- Ratio-Trend & Projection




Exercise:

1. To support the business plan, how much Underroof space will the company need in 10 years?

2. If recent outsourcing trends continue, how much distribution space will the company need?

# 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?

2. In Year 15?

**Main Points**

1. SPIF uses percentages of total when projecting long-range, underroof, class-of-space requirements. It uses index numbers and land-to-building ratios to project land and outdoor yard requirements.
2. The underroof space provides the base (1 or 100). Thus, the land-to-building ratio indicates how much land is in use or required to support each unit of building space.
3. SPIF codes open, occupied land as "Y-land" (for yard) and land underroof as "U-land." Land that is vacant, not available for use is coded "V"; not useable land is coded "X" – unless included in "Y". Total site then becomes U + Y + V + X.
4. Land-to-building ratios are helpful in site acquisition and long-range planning. Ratios vary by industry, type of facility, and by region.
5. Minimum ratios are often dictated by local zoning code.
6. As with underroof estimates, be sure to adjust yard space for tight or loose conditions before establishing a planning index.

**Exercise:**

If total land available is _____ its full density (total saturation) use should be allocated as in column f.

# Allocation of Land Use by Land-to-Building Ratio and Classification of Land Use

Land Total = Open land (Y or yard land) plus built-upon land (U or under-roof land)

| Classification of Open Land | Ratio of Class to Under-roof land (U) | | | | |
|---|---|---|---|---|---|
| (a) (Y land) | (b) Hi | (c) Av | (d) Lo | Plan (e) for* | (f) |
| Parking | 0.8 | 0.7 | 0.6 | 0.75 | |
| Roads, Streets, Set-Back | 1.3 | 0.8 | 0.6 | 0.75 | |
| Yard Storage | 3.2 | 2.2 | 1.5 | 2.0 | |
| Outside Services (pond, transformer, filter bed, etc.) | 0.8 | 0.6 | 0.3 | 0.5 | |
| Miscellaneous Losses (rail curves, lost "corners", fencing, walls, restrictive easements, etc.) | 0.9 | 0.5 | 0.3 | 0.5 | |
| Unused -- unoccupied | | | | | |
| | | | Total | 4.5 | |
| | Land under-roof | | | | |
| | Total Real Estate | | | | |

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**Notes**

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# Ways to Increase Capacity Without New Construction

**Main Point**

1. New construction is not the only way to increase plant capacity. The most common tactics are listed here.
2. When capacity and space required exceed that which is or can be made available, management must decide how the shortage will be resolved.
3. The facilities planner may be called upon to estimate the impact of each tactic.

1. Increase working hours.
2. Improve methods, processes, equipment.
3. Redesign products; simplify product line or components.
4. Readjust inventory policy, change distribution plan.
5. Overhaul production planning and control to get more output.
6. Initiate housekeeping campaign and scrap removal.
7. Rearrange layout for better space utilization.
8. Go up or overhead: mechanical handling; stacking; mezzanine
9. Lease nearby and move storage, offices or customer service.
10. Buy rather than make; sub-contract certain items/components.
11. Sell existing building rather than expand; move to larger one.
12. Decentralize into several available buildings in other communities.
13. Buy out or merge with another company and integrate the work of both.

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**Notes**

# Procedure for Full Site Saturation (Or Full-Occupancy) Method of Site Planning

## Main Points

1. To establish the long-range space allocations and capacity for a site or total facility, the approach known as full site saturation (or total saturation) is most effective. This is a site planning technique that arranges facilities by major functions or classes of space, as if the site were fully occupied. (See RMA 2360-1 for explanations of each step.)
2. With an effective master plan or saturated site plan, the main pattern of roads and rail lines, primary distribution of utilities and drainage, the arrangement of basic functions, and the alignment of future structures can all be established early. Properly done, this maximizes the value of the site and initial construction, and avoids problems or limitations later on.
3. Step 8, the actual site planning should result in several alternatives by applying relevant site planning concepts and principles. (See RMA F-2353, F-2366 and 2100).
4. The Site Saturation procedure bypasses sales forecasting by simply assuming full use of the site. It does not establish in what year full occupancy will occur.
5. By planning around classes of space, Site Saturation avoids becoming too specific, which is exactly what is not wanted in long-range planning.
6. This procedure can be applied to almost any size of site or kind of facility.

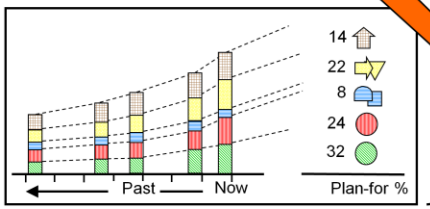
1.

Classification of Space Underroof

Green - Fabricate (plate & sheet)
- Machine, Bend, Trim
- Clean, Plate, Heat Treat

Red - Subassembly, Assembly
- Repair

2. & 3.




U-Land

4.

Classes of Land Use

U - Purple — Underroof land occupied by bldgs.

G - Green — Unoccupied land uses, setbacks, grass, forest, beautification, fencing.

5. & 6.

| | Class | Historical Range Hi | Lo | Avg. | Plan-for Index | |
|---|---|---|---|---|---|---|
| U | Underroof land | 1.0 | 1.0 | 1.0 | 1.0 | |
| G | Grass, setback | 0.6 | 0.2 | 0.4 | 0.4 | 3.5 |
| R | Roads & rail | 0.9 | 0.3 | 0.6 | 0.5 | |
| ▽ | Yard Storage | 1.8 | 0.8 | 1.0 | 1.2 | |
| P | Car parking | 0.9 | 0.5 | 0.7 | 0.7 | |
| S | Services / Utilities | 1.0 | 0.3 | 0.4 | 0.5 | |
| V | Vacant and not usable | 0.5 | 0.1 | 0.3 | 0.2 | |

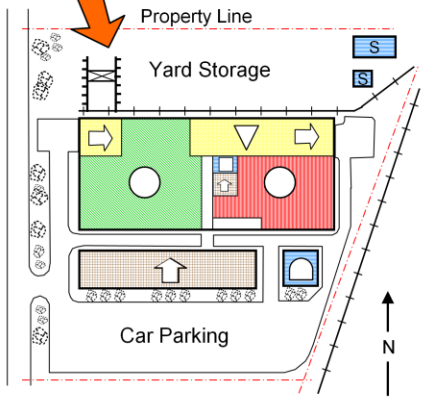
Y-Land

7.

Space Required for Full Saturation (450,000 sq. mtrs.)

| U-Land (sq. m.) | | | Y-Land (sq. m.) | | |
|---|---|---|---|---|---|
| | Fabricate & form | 32,000 | G | Grass, etc. | 40,000 |
| | Assembly & pack | 24,000 | R | Roads & rail | 50,000 |
| | Storage & handle | 22,000 | ▽ | Yard storage | 120,000 |
| | Service & test | 8,000 | P | Car parking | 70,000 |
| | Office & labs | 14,000 | S | Service / Utilities | 50,000 |
| | | | V | Vacant / Not usable | 20,000 |
| | Total U-Land | 100,000 | | Total Y-Land | 350,000 |

8.




Long-Range Site Plan at full site saturation

RICHARD MUTHER & ASSOCIATES - 2360-2-ppt FROM THE BOOK: SYSTEMATIC PLANNING OF INDUSTRIAL FACILIITES, BY R. MUTHER & L. HALES

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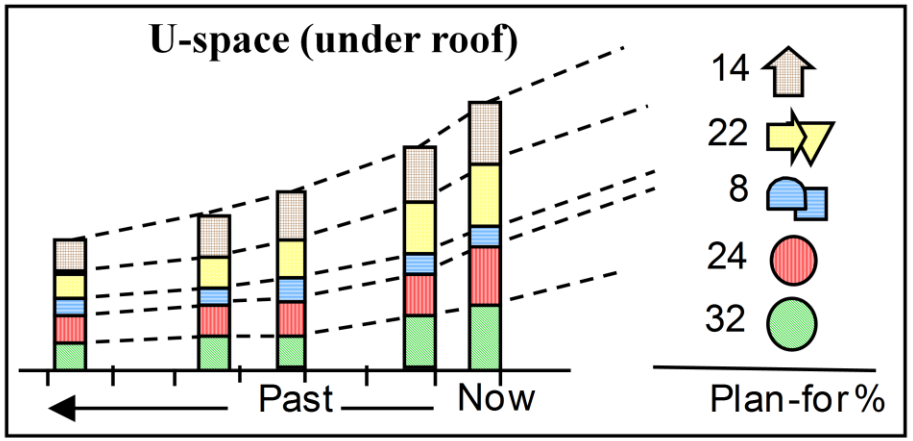
## Notes

**Main Points**

1. When making estimates for 5, 10 or more years into the future, methods that rely on estimates for specific equipment or activity-areas are of questionable validity.
2. Changes in products, processes, and organizational structures tend to invalidate estimates for precisely-defined activity areas. For this reason, the Calculation, Conversion, and Rough Layout methods tend to be of less value for long-range projections.
3. However, by combining similar areas or departments into several classes of space, the aggregate space in each class can be estimated, long-term, using Ratio Trend and Projection.
4. Projecting the percentages of under-roof space by class of occupancy is not difficult so long as we realize that long-range projections need not be precise.
5. Whenever the basic character of a business changes, the percentages change. Percentages also reflect improvements in operations.
6. Historical records of space by class are often difficult to obtain. Old photographs, memories of senior and retired employees, old drawings, and insurance records may be useful.
7. Yard space can be estimated in ratios or index numbers of total space underroof.

# Space ratios and indexes by type or class of space




**Y-space (yard)**

| | Class | Historical Range Hi | Lo | Avg. | Plan-for Index | |
|---|---|---|---|---|---|---|
| U | Underroof land | 1.0 | 1.0 | 1.0 | 1.0 | |
| G | Grass, setback | 0.6 | 0.2 | 0.4 | 0.4 | 3.5 |
| R | Roads & rail | 0.9 | 0.3 | 0.6 | 0.5 | |
| ▽ | Yard Storage | 1.8 | 0.8 | 1.0 | 1.2 | |
| P | Car parking | 0.9 | 0.5 | 0.7 | 0.7 | |
| S | Services / Utilities | 1.0 | 0.3 | 0.4 | 0.5 | |
| V | Vacant and not usable | 0.5 | 0.1 | 0.3 | 0.2 | |

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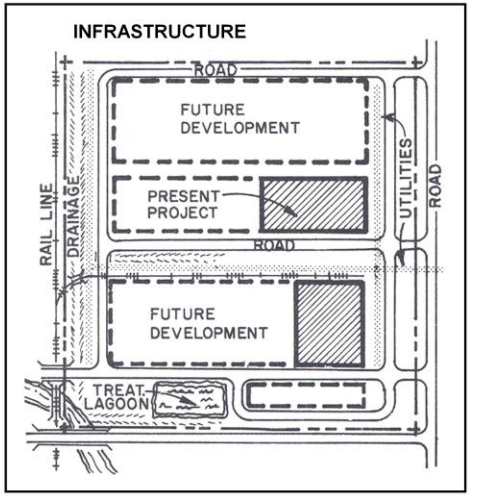
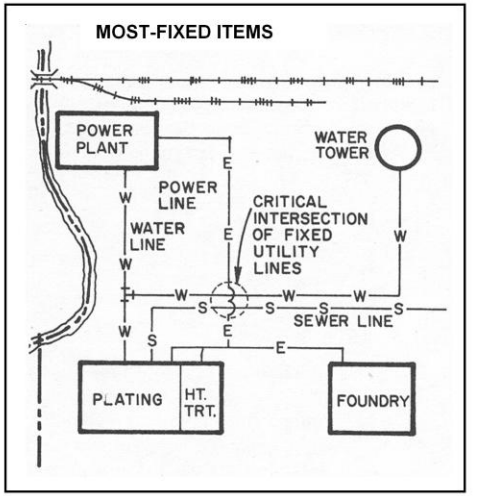
**Notes**

**Main Point**

1. Site plans are typically developed around one or a combination of the approaches shown here.
2. The Infrastructure Approach starts with the layout of roads, main utilities, drainage, and rail. These define spaces available for buildings, yard activity, and parking.
3. The Most-Fixed Items Approach places any highly fixed facilities or "monuments" so that they will not have to be disturbed in a major way, tie-in in other features around these most-fixed items.
4. The Material Flow Approach strives to follow the basic sequence of material processing, using one of several basic flow patterns: straight thru; U-shape; L-shape, spine, or external.
5. The Growth Plan Approach concentrates on providing for future expansion of buildings and spaces, using Zone, Block, or Duplicate plans, or a combination of these three.
6. In "No Growth" situations, the site is filled at the outset, orienting to the site' external dominant considerations.
7. "No Plan" is the "worry about it later" approach. This more or less leaves everything to happenstance, or short-range considerations.

# Typical Physical Site-Planning Approaches or Arrangements



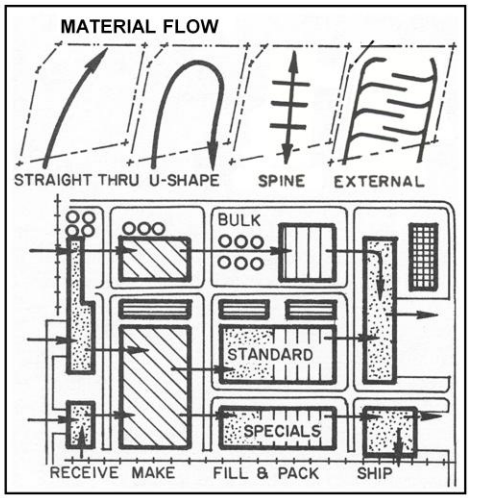



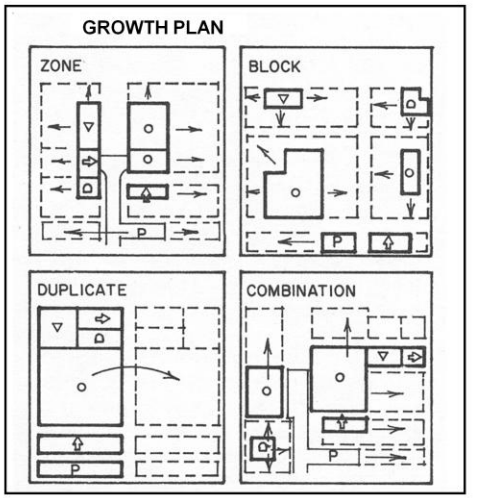

**No Growth**

Fill the site with the initial construction and fit it thereon with room for access, storage, parking & circulation.

**No Plan**

Place first building where it seems best; then add others later on, placing each as it seems best at that time.

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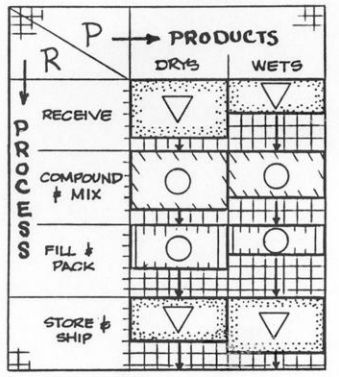
**Notes**

# Concept Planning

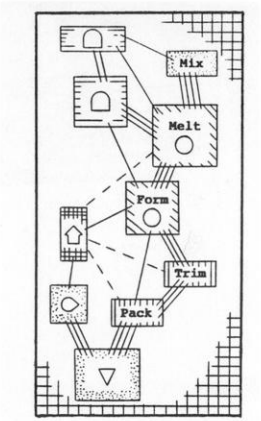
**Main Points**

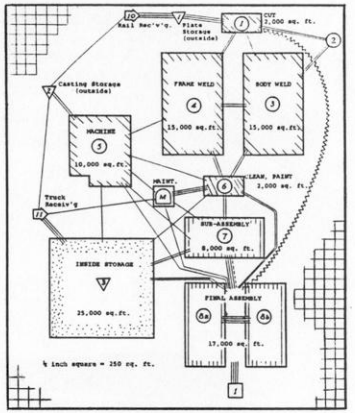
Three examples of adjustment from flow diagram or space relationship diagram to concept plan for a layout. Left to right:

- Pharmaceuticals, with space arranged by cross-orientation. This approach divides products by their primary characteristics or requirements; divides the process by its primary features or requirements; cross-orients the two; and lays that cross-orientation onto/into the space available, fitting in support activities as appropriate.
- Glass containers, with conceptual plan modified for energy consumption. Similar examples are found in food and pharmaceutical plants with environmental-control zones.
- Off-highway, heavy-duty vehicles adjusted from the space relationship diagram. This approach attempts to honor flow and other-than flow relationships. Typically the diagram is adjusted to keep like kinds of space together since this tends to minimize construction costs, and to accommodate dominant considerations of the site.



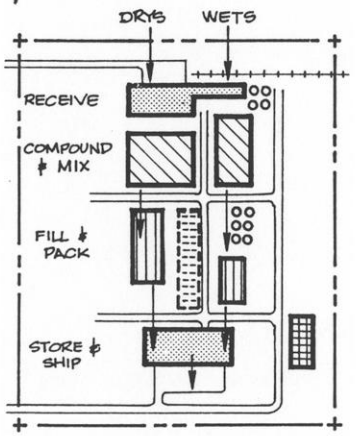

Spaced flow diagram

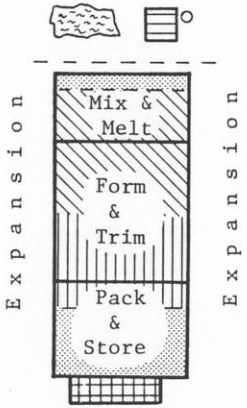


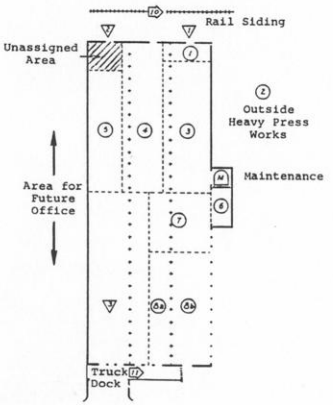
Space Rel. diagram

Concept plan




Concept plan





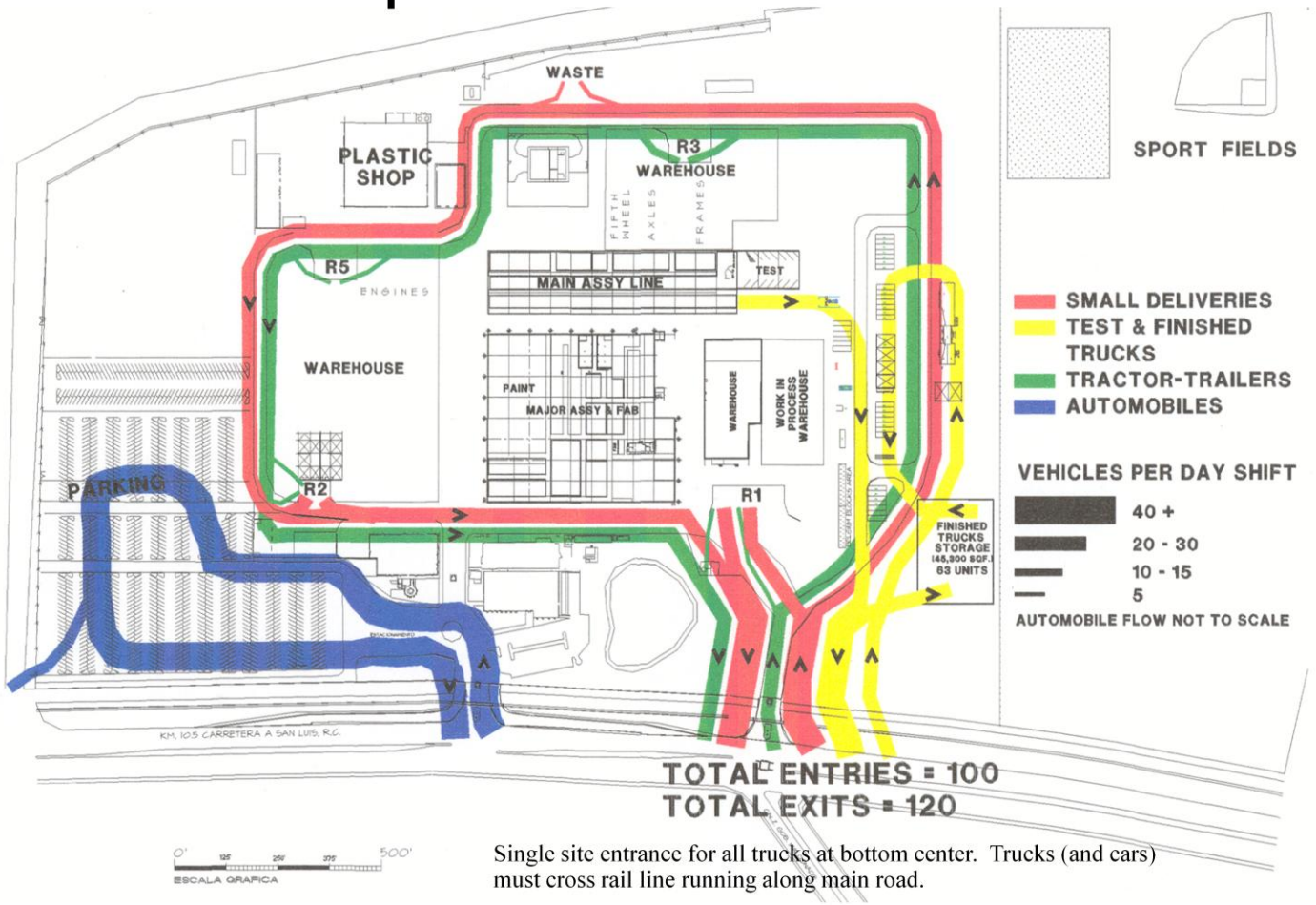



**Notes**

# Traffic flow & separation

**Main Points**

1. When planning an industrial site and its flow patterns, be sure to recognize and quantify the different kinds of traffic involved.
2. It is valuable to know and to visualize the rate of entrances and exits at gates and security checkpoints. This helps to understand likely bottlenecks and traffic back-ups at various times of day.
3. Usually, it is important to separate tractor-trailer traffic from personal automobiles and parking.
4. One way vs. two-way flow may be a choice and needs consideration.
5. Vehicle manufacturing plants such as the one shown here may have test tracks and associated traffic flows.
6. Note that forklift traffic and other types of production material flows are not shown here. These "internal" moves will be in addition to and possibly in conflict with the "external" vehicle moves pictured here.




Single site entrance for all trucks at bottom center. Trucks (and cars) must cross rail line running along main road.

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**Notes**

# Dominant Planning Considerations

**Main Points**

1. Every facility has certain important features or conditions that must be reckoned with in making plans for that facility. These are termed "dominant considerations."
2. Dominant considerations primarily involve three variables:
   - External & Internal
   - Physical & Non-Physical
   - Existing & Future
3. "Dominant Considerations" also refers to a planning method or approach for long-range. master site planning. Under this approach, considerations are rated as to their importance over the service life of the facility. Plans are developed to specifically address or cope with each consideration.

**Examples:**

EXTERNAL:

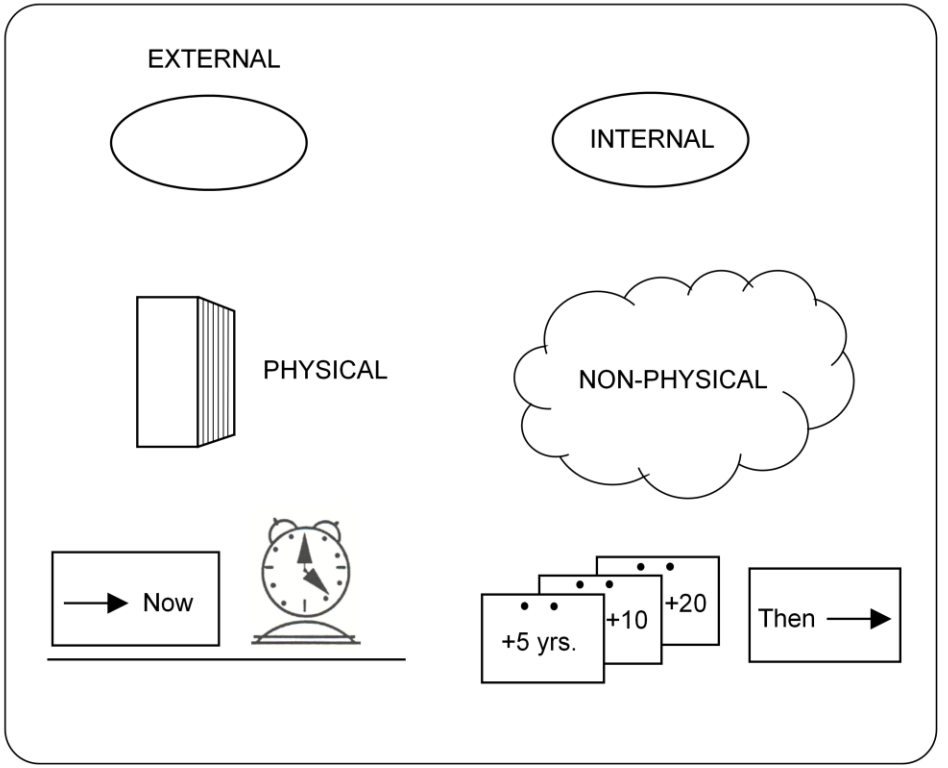
INTERNAL:

PHYSICAL:

NON-PHYSICAL:

EXISTING:

FUTURE:

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**Notes**

# Dominant Considerations

## DOMINANT CONSIDERATIONS

(Identification & Dominance Rating)

Plant: Clorox A& M Mfg. | Project: Spring Hill Master Site Plan
By: LH | With: --
Date: 10/7/2008 16:32 | Page: 1 Of: 1

| | | | EXISTING (Mark "X" if beyond control of company/plant; Dominance rating) | | | FUTURE (through year 2013) (Mark "X" if beyond control of company/plant; Dominance rating) | | |
|---|---|---|---|---|---|---|---|---|
| EXTERNAL | PHYSICAL | 1 | Site is surrounded by developed property, except for vacant tract at SW corner. | I | X | 20 undeveloped acres still available but slopes away from upper warehouse site. Looks like watershed area. | I | X |
| | | 2 | City street separates East Drop Lot and Rail Storage from Plant. | I | X | No change. | I | X |
| | | 3 | No street access from West. | E | X | No change. | E | X |
| | | 4 | Veterinary clinic parking lot to West is slightly on our property. | O | | Same. | O | |
| | | 5 | Vacant tract at SW corner will have no road access for trucks and probably not for cars. | A | X | | | |
| | | 6 | Trucking service for glass plant on corner of 207th & Lincoln. Ideal truck staging area. | I | X | Since trucker serves glass plant, unlikely to relocate. Has wanted a high price in the past. | I | X |
| | | 7 | Sandell Bldg available for lease. (Perhaps for purchase?). | I | | Sandell site is more likely available than glass plant trucking service. Too small for storage. Could be truck staging. | I | |
| | | 8 | 207th and Lincoln streets not designed for heavy truck traffic. Intersection breaking up. | O | X | May need to contribute to re-building of intersection. | O | X |
| | | 9 | Curb radii to tight for trucks: intersection and drop lot entrances. | O | | Plan for increases to reduce erosion and damage. | O | |
| | NON PHYS | 1 | Railroad will provide only one switch per day and 6 per 7-day week. | O | X | No change. | O | X |
| | | 2 | Residential area to East. Concern over noise and night lighting by Planning Commission. | O | X | May become more of a problem with residential expansion and increased production. | I | X |
| | | 3 | | | | | | |
| | | 4 | | | | | | |
| | | 5 | | | | | | |
| INTERNAL | PHYSICAL | 1 | Practical capacity of current rail storage is 34 cars x 110 tons | E | | Space for 4th siding but expensive to replace retaining wall along west side plus interference with culvert & drain. | E | |
| | | 2 | Stormwater retention between street and rail prevents East drop lot expansion to South. | I | | No change. | I | |
| | | 3 | Stormwater retention west of upper warehouse is sized for expansion of warehouse. | O | | Must retain retention area. Cannot use for drop lot. | O | |
| | | 4 | New concrete drainage trench will need to be replaced if warehouse is expanded to West. | O | | No change. | O | |
| | | 5 | Upper warehouse can be expanded one more bay to the west: 25,000 sq. ft. | I | | Very costly expansion in $ per sq. ft., especially when including drainage relocation. | I | |
| | | 6 | Main plant cannot be expanded. | A | | Can add silos but not building. | A | |
| | | 7 | 8% incline between plant and upper west warehouse. Fire lane & turnaround. Buried fire lines. | I | X | No change. | I | X |
| | | 8 | Doorways between plant and 2004 (lower west) warehouse too narrow for 2-pallet trucks. | I | | Could add additional doorway/passageway for 2-way, 2-pallet operation. | I | |
| | | 9 | No tractor-trailer turnaround on upper tract. | I | | Add turnaround when expanding west drop lot. | I | |
| | | 10 | Only 12 docks in upper west warehouse; space for 16 more. | I | | Plan to build out docks on the south wall of the upper west warehouse. | I | |
| | | 11 | Some products run too fast to be carried up the hill. Store in lower warehouse. | E | | No change unless move to off-site warehouse. | E | |
| | | 12 | Front of building (office, lunchroom, lockers/restroom) not easily expanded. Lose parking. | I | | Lunchroom may need to be larger with growth. Need space for all-employee meetings. | I | |
| | | 13 | Only one ramp at lower building. No ramp for warehouse. | O | | Add ramp when additional docks are installed. | O | |
| | | 14 | Process area (mix, add) cannot keep up when all packaging lines are running. | A | | Add mixer, add minors addition unit to support growth. Logical space is to west in palletizer bay. Keep clear. | A | |
| | | 15 | No dock in SE corner. Supersacks of additive must be moved from North end. | I | | Consider bulk delivery of speckels and borax before adding dock. Add if bulk not practical. | I | |
| | | 16 | North roadway narrow with tight radius. Trucks use for staging. Issue with fire marshall. | O | | No change. | O | |
| | | | Tunnel to warehouse cannot be blocked by conveying equip. Fire truck passage. | A | | No change. | | |
| | NON PHYSICAL | 1 | Main site is platted as two tracts. City could require setback on both sides in future. | U | X | No change. No issue. No need to construct close to boundary line. | U | X |
| | | 2 | About 10% of upper west warehouse holds imported product. Can surge to more. | O | | May be able to reduce or eliminate distribution of imports. | O | |
| | | 3 | Desire to improve teamwork in production; keep like operations together and compact. | I | | Keep all packaging lines together and parallel. | I | |
| | | 4 | Must maintain drive-through doors in tunnel for fire trucks. | A | X | Any conveyance must be above fire truck height or in ground. | A | X |
| | | 5 | Warehouse must store imported product. (Crystals) Space loss when crowded. | I | | Try to have other DC fill these orders or move to off-site. | I | |
| | | 6 | Potential exposure to remedial warehouse parking when getting permit for new docks. | O | X | Always present. Depends upon relationships with officials and zoning board. | O | X |
| | | 7 | Multiple, uncontrolled points of entry to the site. | I | | Consider remote controlled gates, or keypad gates and cameras. No room for guardhouse at any entrance. | I | |
| | | 8 | | | | | | |
| | | 9 | | | | | | |

Reference Notes:

a
b
c
d
e
f
g
h

Instructions:

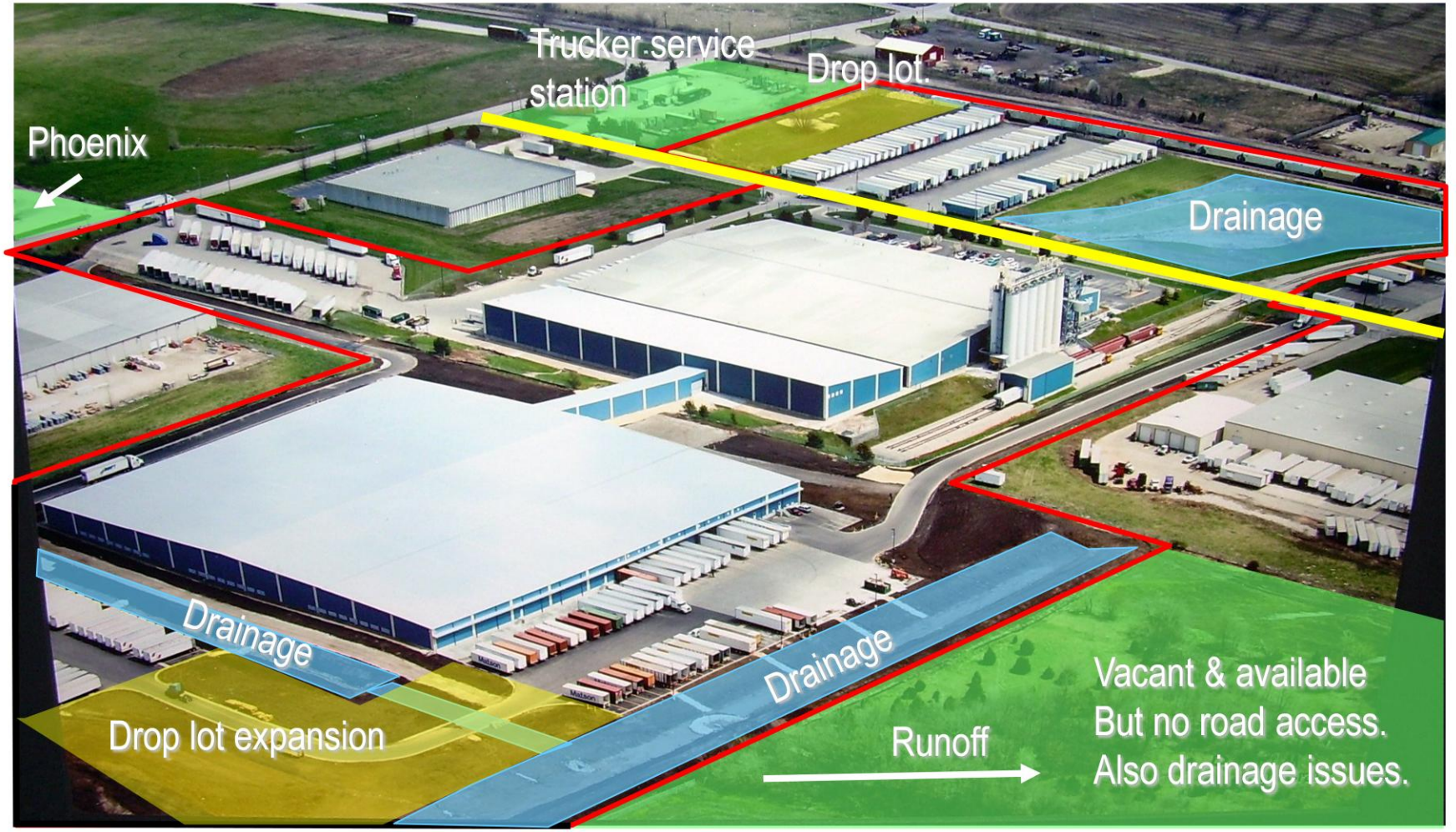
1. Determine what major considerations affect the existing facilities and future facilities plans.
2. Record these in the appropriate section.
3. Rate each consideration for its relative effect or influence on the project's facilities planning.
4. Mark "X" where consideration is beyond the control of the company/plant.

Dominance Rating -

Effect on Facilities Planning

A - Abnormally High
E - Especially Important
I - Important
O - Ordinary
U - Unimportant

# Site surroundings & Planning Considerations




The site is over-built. Vacant ground left is only good for drop lot expansion.

Adjacent vacant tract to south is undesirable.

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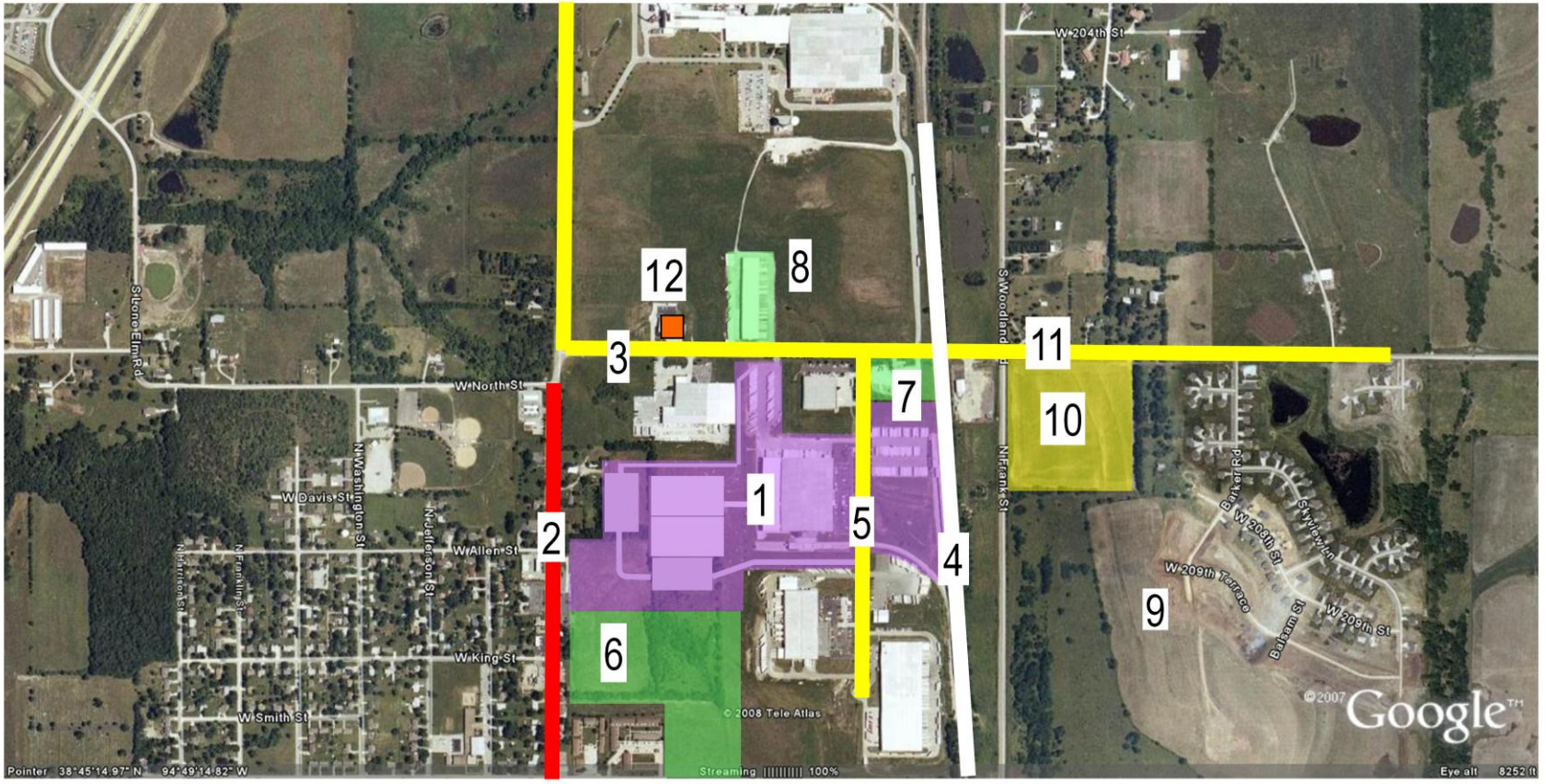
# Site surroundings & Planning Considerations




1. Irregular, surrounded property.
2. Commercial street; no access permitted.
3. Shady Lane not designed for heavy truck traffic.
4. Main line of N-S.
5. Smith Ave. splits property; too narrow; in poor repair.
6. Tract available but no road access.
7. Truck service station; ideal truck staging.
8. Phoenix Bldg. formerly leased; still available.
9. Encroaching single family potential issue.
10. Zoned R-2. More residents and traffic.
11. Shady Lane will be residents' access to town & Interstate Highway.
12. Fire station and fire marshal.

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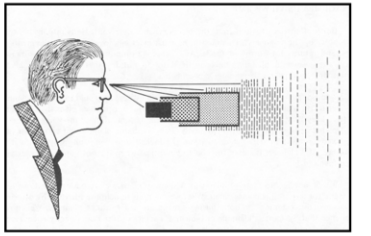
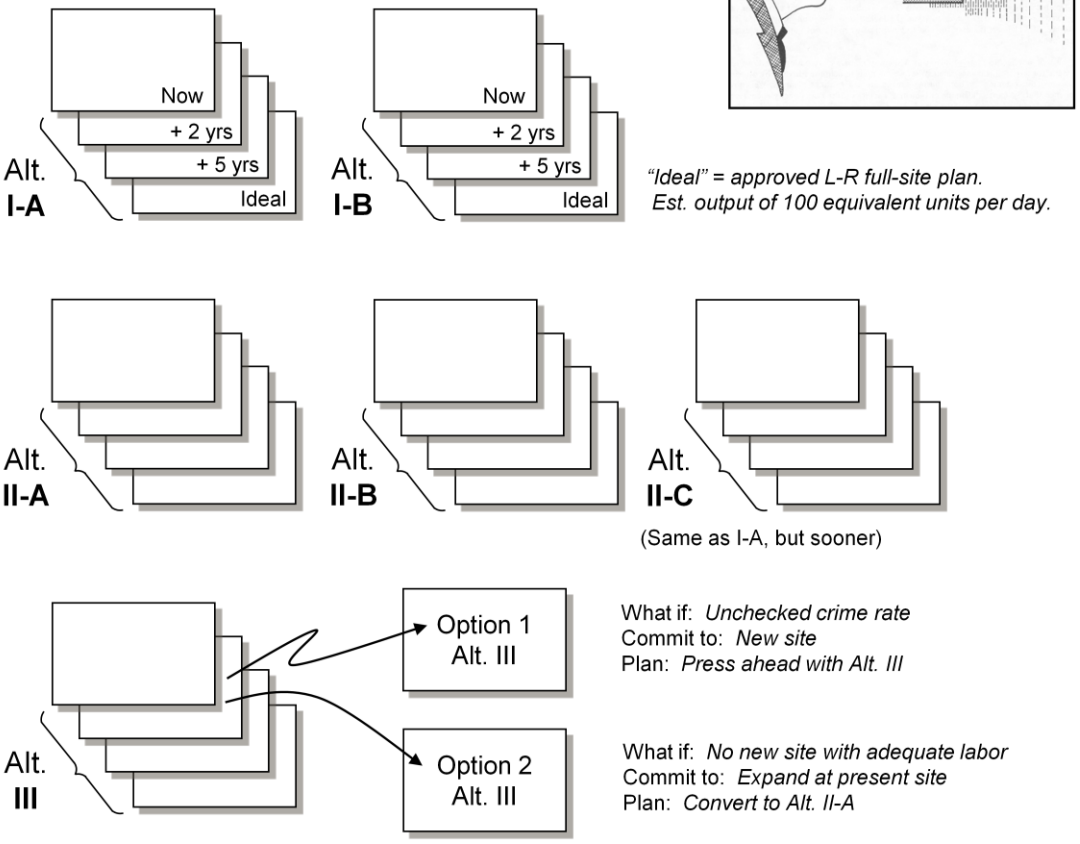
**Main Points**

1. Buildings are typically planned on a 3- to 5-year horizon, yet they should be good for 30 to 50 years or more.
2. Many planners and managers consider long-range planning an idle exercise since they cannot get information on future products, quantities, processes, supporting services and operating times.
3. By constructing a set of scenarios based on "what might be," the planner can explore "probable likelihoods" and develop conceptual alternatives for each.
4. These alternatives will often be courses of action, ready for subsequent planning, rather than finite plans and designs.
5. Through periodic or annual review, planners and their managers monitor which scenario and alternative should be used as the basis for the current or next short-term plan.

# Flexible, Premeditated Foresight in Action



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**Notes**

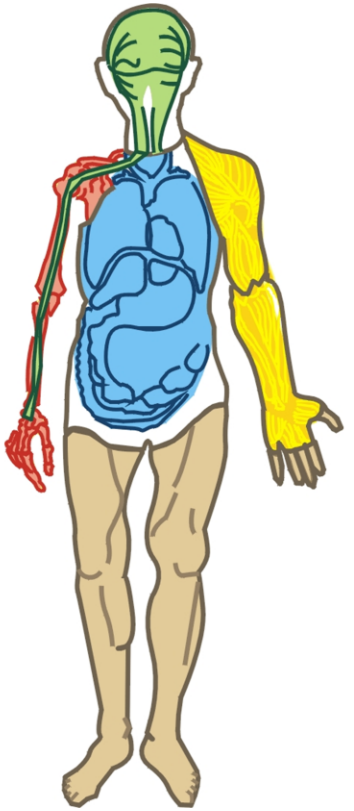
# Summary of Site Planning Principles

1. Group similar activities or functions together.
2. Develop a basic plan of growth for the site.
3. Establish a basic pattern(s) of material flow and/or product-process (or other primary) relationships.
4. Orient or align the proposed facilities with the property lines or existing dominant features.
5. Take advantage of the natural features of the site.
6. Develop a basic infrastructure for the site.
7. Establish a pattern of internal transport and/or circulation.
8. Establish a pattern and dedicated corridors for primary distribution of facilities.
9. Keep the planned facilities flexible.
10. Plan facilities for ease of expansion.
11. Plan for implementation of plans and the site's development.
12. Protect the resale value of the property(ies).
13. Stay incompliance with all regulations.
14. Conserve energy through orientation, alignment, short distances, and minimum openings.
15. Provide for appearance, beautification, company image, and natural environment.
16. Provide for safety and convenience of employees.
17. Aid security considerations – fire, theft, espionage.
18. Avoid overcrowding the site. Keep some uncommitted space.

**Main Points**

1. Industrial facilities planning involves five interacting components:
   - *Layout* (or arrangement)
   - *Materials handling* (or transport)
   - *Communications* (and procedures)
   - *Utilities* (and auxiliaries)
   - *Buildings* (and structures)
2. The planning of these components – individually and jointly – allows the facilities to work together as a purposeful system.
   - Skeleton or system of bones likened to *Layout* or system of related areas.
   - Muscular system likened to *Materials handling* methods.
   - Nerve system likened to *Communications* and controls.
   - Respiratory, circulatory, digestive systems to *Utilities* and auxiliaries.
   - Flesh and skin likened to *Building* walls, roofs, and floor.
3. While all five components must be provided, the planner places a different importance on different components as called for by different situations.

# Anatomy of an Industrial Plant



Skeleton

(Layout)

Muscular System

(Material Handling)

Nerve System (Communications

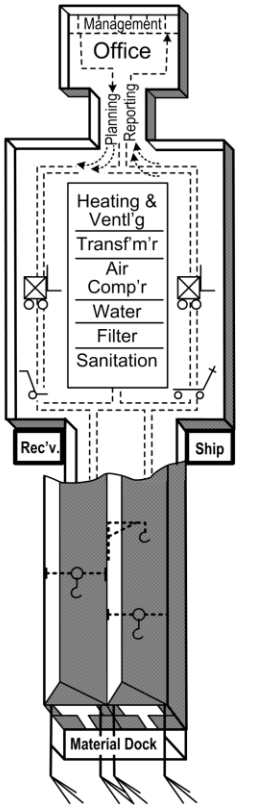
and Controls)

Respiratory, Circulatory, Digestive Systems

(Utilities and Auxiliaries)

Flesh and Skin

(Building Shell)

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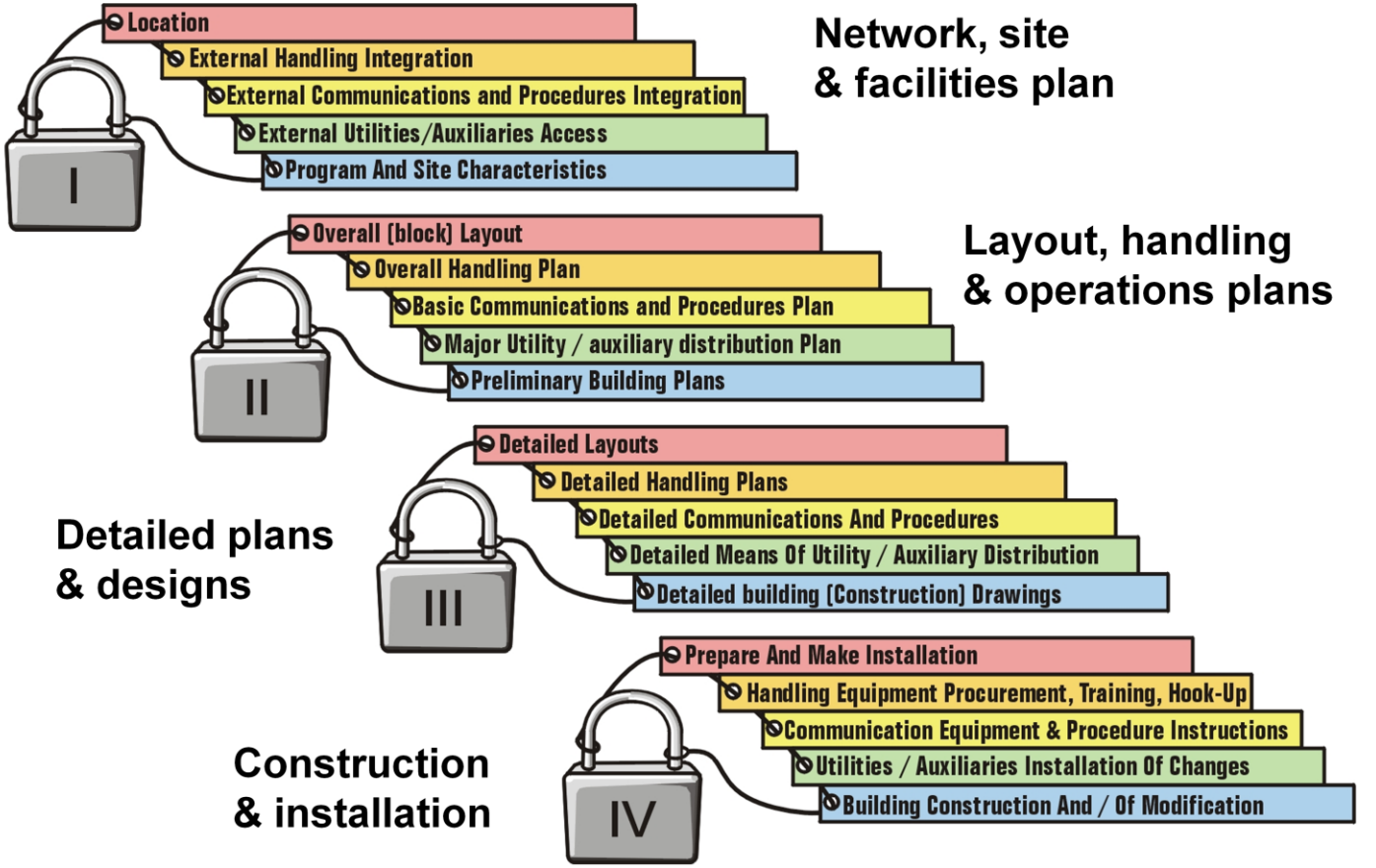
**Notes**

**Main Points**

1. For best results, facilities planning should progress in overlapping phases and sub-phases, from the overall to the detail, from the macro to the micro.
2. Each component is a distinct planning discipline in itself, with its own nomenclature or jargon. As a result, the terms describing the various phases are different for each component.
3. Just as the components of the human anatomy are present in every local part our bodies, the five components of an industrial facility are present at every level of planning – from the site or plant as a whole to the smallest department or workplace.
4. The plans of all five components are related to each other (locked together) at the conclusion of each phase. They are submitted at that time for approval and authority to proceed with the next phase.

# Lock together in each phase

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**Notes**

# The Process of Planning Facilities

Phase 0 -- Preplanning

A. Compile Basic Needs – (Company policy, business plans, and general goals) – and forecast non-physical requirements (What do we want?)

B. Evaluate Existing Facilities (What do we have now?)

C. Forecast Plan for Capacity Requirements – sizing, dimensioning, conceptual plans… (What do we need?)

D. Check for Feasibility (Is it economical to go after the need).

E. Develop a Project Plan – Breakdown of phases, steps, responsibilities, and schedule – (How will we plan to go after the need?)

Phase I -- Orientation

A. Converts the non-facility objectives and existing conditions to physical facility requirements.

B. Locate the site, the facility(ies) on the site, or the department in the plant, and identify its external opportunities and constraints.

Phase II – Overall Plan

A. Convert the physical requirements into overall plan of physical facilities – that is, plan the overall facility.

B. Establish a solution in principle.

Phase III – Detail Plans

A. Convert the physical requirements and physical constraints for subdivided areas or components of the overall plan into more detailed facilities.

B. Establish solutions in detail – details of major features.

Phase IV – Implementation

A. Convert the plans of physical facilities into a program of action; planning the "Do."

B. Plan the construction, renovation, and/or installation.

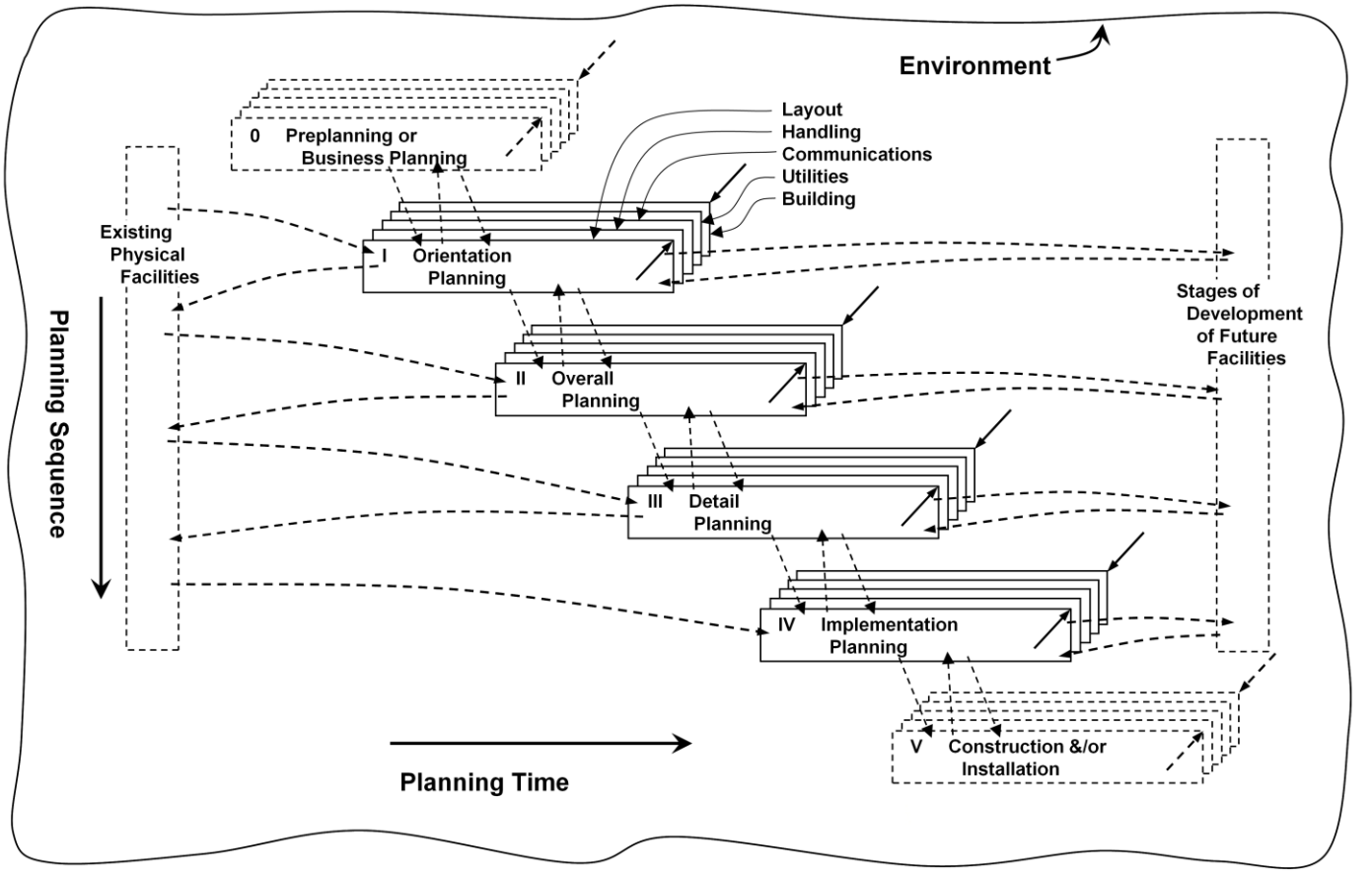
Phase V – Construction, Renovation and/or Installation.

Follow-up or carrying out of the planning.

**Main Points**

1. The extended framework of planning phases puts together the overlapping of phases, the interaction of five components, and the cross-influences of existing, needed, and future facilities.
2. The framework starts with the need and desire for an operating facility or its change. The planning phases represent how to get there.
3. The planning – if carried through to implementation – results in the planned-for facility in its physical setting. This physical locale, with its physical and non-physical influences on the facility, can jointly be termed the planning project's environment.
4. SPIF extends the four basic planning phases in three dimensions: diagonal (for all 5 components); vertical (for Phases 0 and V), and horizontal (for the influence of existing facilities and stages of future development.

# Variations to SPIF Framework of Phases

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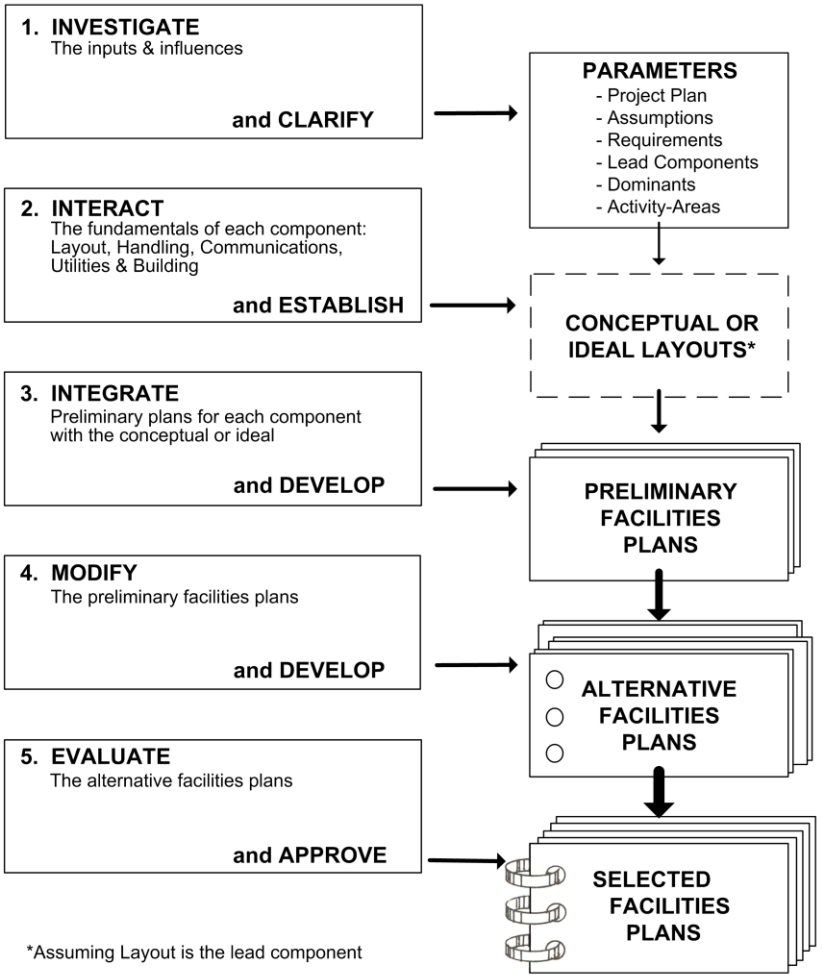
**Notes**

**Main Points**

1. For each component of the facility there is a step-by-step pattern of procedures. This pattern applies to Phase II and III, the strictly planning phases; that is, the phases framed by Orientation and Implementation.
2. Actually, there are five patterns of procedures, one for each component: Layout, Handling, Communications, Utilities, and Building.
3. But in facilities planning, these stand-alone patterns must be integrated. SPIF does this by structuring a combined, more simple-to-comprehend pattern consisting of five basic steps.
4. A condensed form of the SPIF planning pattern appears here. It sets forth the five main steps (of Phases II and III), indicating the progressive development and refinement that characterize any organized planning.

# The Condensed SPIF Planning Pattern

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**Notes**

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