By: Dan Wiegandt, AIA, LEED AP

Plant Optimization

Plant optimization is often a key goal of the manufacturing team when building a new facility or updating an existing facility.

This goal of plant optimization is driven by the need for process improvement which itself is driven by a variety of competing demands or needs. These needs include improved quality, reduced costs, increased capacity, sustainability, product changes, new products, flexibility, staff reduction, reduced space, improved equipment, automation decreased production time, as examples.

Process improvement and plant optimization are manufacturing goals for virtually all types of manufacturing in today's competitive global environment. The auto industry is often credited with many of the major improvements in plant optimization. Starting with Henry Ford's moving production line, standardized parts and tolerances to the Toyota Production system with its emphasis on lean manufacturing and "kaizen," the auto industry's contributions to plant optimization are significant. Other industries and experts have contributed to process improvement tools including six sigma and the theory of constraints. Regardless of the principles or systems employed for process improvement, plant optimization is a key part of the overall facilities solution.

Existing manufacturing plants are the most challenging to optimize. Many plants have evolved, expanded, or changed over time and no longer are as efficient as they once were. Working around existing production requirements, building or site limitations, and local restrictions may limit available options.

It is important to note that planning for manufacturing facilities requires specialized skills, experience and understanding of the process of manufacturing. Few "regular" architects, engineers, or facility planners have those skills, and it is important to engage Industrial Architects and Designers experienced in plant optimization.

Planning

Plant optimization planning requires input from key manufacturing personnel who understand existing and proposed processes. These personnel also know and understand where existing bottlenecks or limitations are in the process which is invaluable in plant optimization activities. However, this insight is only part of the answer. Manufacturing personnel insights are often limited by familiarity with their own plant and processes. This can result in "not being able to see the forest for the trees" or being caught in the "we've always done it that way" situations. Industrial Architects and Designers experienced in plant optimization know the right questions to ask to ensure that a variety of options are considered and evaluated.

An early step in process improvement planning is formally defining the process. Simple flow diagrams are a very effective tool to document processes. These diagrams must be critically evaluated to ensure they accurately represent the "actual or real" process and not just an

idealized version. Often graphically documenting the process flow reveals valuable insights to both the manufacturing team and the design team working on plant optimization. Experienced Industrial Architects and Designers will ask critical questions during this exercise to ensure this graphic documentation is expanded to include not just the primary manufacturing process but also other processes including warehousing and waste recycling process.

Flow diagrams can also be used to document individual processes, process steps or portions of processes. They can be used to identify the relationships and interdependencies between multiple steps to better understand the overall process needs of the plant. These relationships will also identify desirable adjacencies or the need for separation.

Flow diagrams are valuable tools to help document existing plant capacity issues. Individual process steps or machines and equipment can be documented for their capacity. This is an important first step in an overall plant capacity study. This can include historic capacity such as number of units per shift or units per hour. Individual machines are evaluated for their theoretical capacity based on the maximum speed or other equipment related data. Care should be taken when evaluating capacity issues to include all related considerations or impacts. These include: maintenance; switching products or tooling; cleaning; adjustments; calibration; testing; reloading consumables; etc.

Once capacity issues are documented, they can be studied or assessed further to determine if the constraints are related to process, equipment, location or procedures. Alternatives can be developed modifying the constraints or assumptions and simulated to determine the overall impact on the process. Often, existing process flows are unbalanced resulting in a bottleneck or constraint that when corrected results in significant improvement or optimization.

Plant Layout

Flow diagrams are critical to developing idealized plant and equipment layouts which form the basis of the plant layout. These early layouts can be used to help develop alternative layouts or configurations. The development of alternatives is an important step to ensure that an adequate number of options are considered. Developing optimum plant layouts in existing facilities can be very challenging. If existing operations must be maintained while the construction is ongoing, the plant layout must consider this requirement. The layout may also need to consider scheduling relationships associated with production, new equipment, process modifications, design, permitting, bidding and construction.

Alternatives can be explored and evaluated based on their impact on efficiency, material flow, personnel needs, adjacencies and requirements. Numerous methods can be used to formally evaluate alternatives. The use of Weighted Factors Analysis is often a useful tool to evaluate numerous alternatives where multiple issues need to be considered. In a Weighted Factors Analysis, each alternative is evaluated on a single issue and provided a numeric score. In this way, each alternative is compared with the others on a single issue in isolation indicating which is best, worst or equal. A second evaluation is conducted independently on the issues to rank them

by level of importance or weight. For example, if budget is more important than schedule it should have a higher level of importance or weight. The issues and weighting can be numerically scored independently. These two evaluations can even be conducted by different groups. Both the ratings and weighting factors can then be combined to provide a single weighted score for each alternative.

Requirements for each step of critical processes should be well documented. Critical requirements include such things as utilities, space requirements, clearances, environmental conditions, cleaning needs, security, safety, and staffing. While these requirements are important to the plant optimization process, they are also critical to determining the facility infrastructure and overall plant size, which directly relates to the facilities overall cost.

Flow diagrams, alternative layouts and requirements all form the basis for developing the plans for a well optimized plant. The plans for the well optimized plant should be systematically developed and evaluated at each level of development.

Sustainability

Sustainability or "Green Building" is an important consideration for manufacturing plants of not only environmentally concerned companies but cost oriented companies as well. Sustainability may not usually be seen as a function of plant optimization; however sustainability issues are often closely related to many plant optimization issues. A basic goal of plant optimization is to eliminate wasted efforts or resources. Wasted effort is essentially a form of wasted energy. Plant optimization should promote the efficient use of energy. Efficient use of energy helps minimize or reduce the impact of manufacturing on the environment.

Wasted resources are an inefficient use of resources. Plant optimization should improve the efficient use of resources. Resources such as water, packaging, raw or reject materials should be considered for recycling or reuse as part of a plant optimization.

Reduced energy use and efficient use of materials or resources helps limit environmental impacts and improve sustainability. In addition, the cost impacts of energy, materials and disposal of waste can be reduced resulting more cost effective manufacturing. Cost effective manufacturing is often the primary reason for plant optimization with a secondary environmental benefit.

Summary

Plant Optimization is a key component to improving the overall manufacturing process. Well designed and optimized manufacturing plants support the processes with appropriate infrastructure and layout. Less than optimum plants adversely impact the process flow by adding steps, time, energy or distance which adversely impacts efficiencies and ultimately adds cost. Manufacturing teams are often familiar with process improvement. Experienced Industrial Architects and Designers have the experience and insights to improve the manufacturing plants and infrastructure. Working together as a team, manufacturing personnel and design personnel can combine their considerable expertise to develop well optimized manufacturing facilities. These

facilities will support the processes and ongoing improvements to enhance quality and reduce cost. Optimization which improves efficiency can result in substantial environmental improvements as well.

About Dan Wiegandt, AIA, LEED AP:

As Manager of Engineering for The Austin Company, Mr. Wiegandt is responsible for overseeing all design and engineering work performed. His activities include providing overall management, quality assurance, and an ongoing "independent" critical appraisal of the total engineering efforts. His responsibility places a strong emphasis on the quality assurance, and cost-effective design. Mr. Wiegandt has 30 years of professional experience and 19 years with The Austin Company.

Mr. Wiegandt's experience has provided him with a thorough working knowledge of design and construction procedures from inception through engineering, estimating, scheduling, purchasing, and construction. He has demonstrated the ability to accomplish successful results for building programs, based on a unique combination of technical knowledge, practical judgment, and overall management skills. His experience provides a solid base for meaningful understanding of management, technical, and cost and schedule considerations that must be optimally addressed in order to achieve a successful project.

The Austin Company:

The Austin Company is a consulting, planning, architecture, engineering, and construction services company offering a comprehensive portfolio of services to a broad spectrum of industries nationwide. Austin offers its clients significant flexibility in the way its services are offered, delivering services under a single source design-build agreement or on an individual service basis designed around specific project requirements. The Austin Company is credited by the Design-Build Institute of America (DBIA) as being the originator of design-build in the United States over 100 years ago. Using The Austin Method®, the company's design-build approach, Austin provides its clients a single source for all facility planning, design and construction services, and assumes undivided responsibility for meeting project budget, schedule and quality. In addition to complete services for the built environment, Austin offers a host of value-added strategic planning services including site location, transportation/ distribution consulting, facility/process audits and related services. The Austin Company works as an extension of its clients' organizations, offering unparalleled experience in each of the markets and industries it serves.