

GLOBAL MANUFACTURING FACILITY DESIGN

By

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ABSTRACT

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This study identifies key technical issues to be addressed by overseas corporations that intend to establish a production facility in the US. Business issues like finance and marketing are not taken into consideration.

Five topics were considered. They are:

1. Building and Utility Requirements.
2. Processing Equipment and Tooling.
3. Raw Materials.
4. Transportation and distribution.
5. Regulations.

The outcome of this study is a web site that provides information or links to other pages where the issues are covered, thus facilitating the research process to the aforementioned corporations.

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Chapter 1

Research Problem and Objectives

1.1. Problem Statement

Producing a product in a foreign country poses challenges to organizations worldwide. Many international companies would like to manufacture products in the huge and responsive USA market, but don't know how or where to start. Coping with issues like cultural differences, environmental regulations, technological barriers, and different measurement systems, leads to formulating the following question: What are the issues to be addressed in order to successfully produce a product in a foreign country? Once the issues are identified, the next question follows: Where to go to find information on this issues and how to address them? Certainly, there is a lot of information out there. But it is really scattered.

For example, to successfully operate a manufacturing facility in the USA, complying with environmental, health, and safety laws is a requirement. Companies which do not comply receive costly fines, production restrictions, and slow growth and profitability.

1.2. Scope and Limitations

This study does not consider business issues, like marketing, finance, competitive analysis, etc. These issues are extensively covered by a wide variety of business and production operations books.

Technical and more specific issues represent the focus of this research –i.e. how and where to get raw material.

1.3. Research Objectives

- a. Identify a list of relevant technical topics to be taken into account by a foreign firm to successfully manufacture a product in the United States.
- b. Compile a list of useful web sites that address these topics.
- c. Build a comprehensive web site with links to the sources of information on the topics relevant to this study.

1.4. Significance of Study

This study is important because its outcome, a one-stop source with links to pages that offer useful information on the topics under study, represents a time saver for anybody seeking to manufacture a product in the United States.

Chapter 2 Literature Review

2.1. Manufacturing Facility Design Issues

The design of a facility is a process that is becoming more and more difficult with the globalization of the workplace. The process implies taking into account several variables that will determine whether the organization succeeds and stay in business or not. The facility design process can greatly affect costs, both fixed and variable. “It can even have a large impact on the overall profit of the company. For instance, depending on the product and type of production or service taking place, transportation costs alone can total as much as 25% of the product’s selling price. That is, one-fourth of the total revenue of a firm may be needed just to cover freight expenses of the raw materials coming in and the finished products going out” (Heizer & Render, 1995, p. 346).

The process turns out to be more complicated for foreign organizations, which must research the environment they are going to be doing business in, and of which they lack valuable information on some of its facets, like local environmental regulations and measurement systems used. This poses a special challenge for foreign engineers in charge of designing and setting up facilities outside of their usual borders.

When setting up a manufacturing facility in the US –or in any other country, three types of costs are to be minimized (Chase, 1985, p. 161): regional costs, distribution costs, and raw-material and supplies costs. *Regional costs* are those associated with a given locale and include land, construction, labor, and state and local expenses. *Distribution Costs* are those directly related to the shipping of supplies and products to

customers and other branches of the distribution network. *Raw-Material and Supplies* costs refer to the availability and costs of production inputs including energy and water, as well as the lead time to acquire these inputs. The authors omit a cost that is becoming more and more important: costs associated to environmental regulations and costly fines for non compliance with them. Not knowing these regulations is a luxury that organizations shall not allow themselves because of political and monetary costs.

Heizer & Render (1995, p. 345) establish the following considerations and factors that affect location decisions:

a. Country Decision

- Government rules, attitudes, stability, incentives.
- Cultural and economic issues.
- Location of markets.
- Labor availability, attitudes, and productivity costs.
- Availability of supplies, communications, energy.
- Exchange rate.

b. Region/Community Decisions

- Corporate desires.
- Attractiveness of region (culture, taxes, climate, etc.)
- Labor availability, costs, and attitudes towards unions.
- Cost and availability of utilities.
- Environmental regulations of state and town.
- Government incentives.

- Proximity to raw materials and customers.
- Land/construction costs.

c. Site Decision

- Site size and cost
- Air, rail, highway, waterway systems.
- Zoning restrictions.
- Nearness of services/suppliers needed.
- Environmental impact issues.

Covering all of these factors in one single study is a hard-to-accomplish task, based on the wealth of information, and conditions and regulations that change constantly. In this study, focus is given to the following technical issues:

- i. Building and Utility Requirements.
- ii. Processing Equipment and Tooling.
- iii. Raw Materials.
- iv. Transportation and Distribution.
- v. Regulations.

Chapter 3 Research Methods

3.1. Research Design

This study can be viewed as exploratory because it tends to be loosely structured with an objective of learning and where no hypotheses are tested (Emory, 1985, p. 60).

The step-by-step process followed to carry out this research is the one that corresponds to a fact gathering, which “differs from both basic and applied research in that the researcher’s task is one of gathering some predetermined data” (Kress, 1974, p. 13). The process is outlined in Figure 1, as follows:

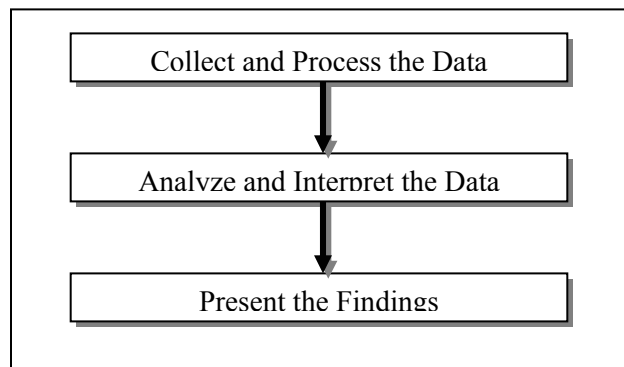


Fig 1. Fact Gathering Research Process (Adapted from Kress, 1974, p. 15)

3.2. Sources of Data

The information-gathering procedure that best fits the purpose of this research is *Searching for Data in Published Information* (Clover, 1979, p. 44). In this particular case, the major source of published information is the Internet and the primary tools used to

look up the information are search engines like Google (www.google.com) and AltaVista (www.altavista.com).

Libraries –public and educational, represent another source of published materials. They provided the books referred to in this research.

A wealth of the information provided here comes from government sources. Federal, state, and local governments want to attract new businesses to their respective area and offer information to facilitate the process of setting up facilities, and business in general, in the US.

3.3. Web Site Design and Setup

The internet site developed for this project is part of BlackBoard –a learning platform, which is part of the University of Wisconsin-Stout's learning technology services. “BlackBoard CourseInfo (Bb) is a course management tool. It provides an open, simple and compelling tool suite for instructors to build and manage a virtual classroom” (<http://www.lts.uwstout.edu/blackboard/blackboard.htm>). Basically, it allows students and instructors to interact through the internet. Students can access online resources and study material, submit papers and tests, and so on. Instructors can post tasks to be performed by the students, material for them to review and study, etc.

The material and information compiled during this research is part of the Facilities Design class at the university aforementioned. The web site is actively used by the students and serves as a guide that helps them through the decision making process that they undergo in this class.

As of yet, the information is not public domain and is only available to the students taking the class during a given semester. Access to the site can be requested by contacting Dr. Thomas Lacksonen, the class instructor, at lacksonent@uwstout.edu.

To access the web site, the students log on to BlackBoard (<http://www.lts.uwstout.edu/blackboard>) and go to a section called *Course Documents* where, as the name indicates, they will access the information relevant to the subject of this research.

All links are opened in a new browser window for two reasons: i) they are external links and are to be treated like that, and ii) to allow them to keep the BlackBoard page open, so they can easily come back at any.

The html code implemented to accomplish this follows:

```
<a href="www.webaddress.com" target="_blank">Text of the Link</a>
```

This piece of code would display [Text of the Link](#) on the browser and would take the user to the address *www.webaddress.com* once he/she clicks on it, in a new window.

Chapter 4 Global Manufacturing Facility Design Issues

4.1. Building and Utility Requirements

This section covers *Rent and Property Costs*, *Electricity*, *Water/Sewer Availability*, and *Telecommunications*.

Building and property costs may be a large percentage of the total facility cost. These costs may vary from country to country and from region to region; it is paramount to know them in order to determine the site for the facility. The web sites identified in this section will give current commercial building and property prices in western Wisconsin.

The utility requirements and availability are to be well known ahead of time. For instance, the electrical system available should have sufficient capacity to serve the loads required by the manufacturing plant, plus spare capacity to meet anticipated growth in the load of the system. “Specifications for utilities should be carefully developed because they can make up a significant portion of the variable operating cost of a manufacturing facility” (Sule, 1988, p. 361).

The availability of an adequate water supply is often important. Knowing whether the local public utility company can satisfy the water consumption needs of the future manufacturing plant is also a factor to be considered (Sule, 1988, p. 358).

- **Rent and Property Costs**

Typically, prices are in dollars per month and manufacturing space is 1/3 to 1/2 the price of office space.

Rent and Property Costs Links

<http://www.andalerealestate.com>

<http://www.tdre-online.com>

<http://www.americanedge.com>

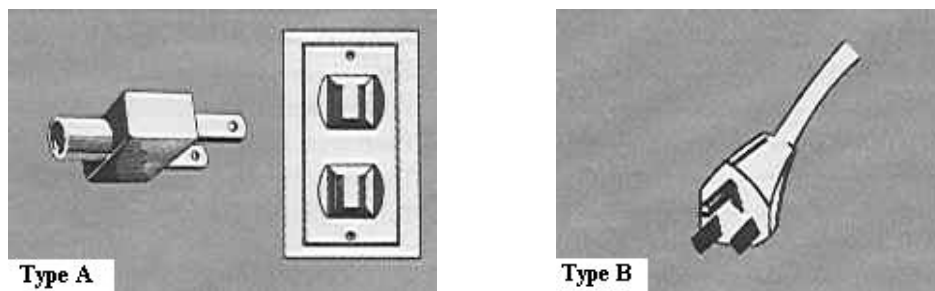
▪ Electricity

Availability: There is power available in existing buildings, industrial park sites, and land developed for buildings.

Reliability: Power is reliable except in the case of electrical storms or ice storms –over 99% reliability.

The U.S. electrical system offers 110/120 and 220/240 volts @ 60 hertz electric circuits.

Figure 2 shows the types of plugs used in the US for 110/120 volts outlets.



Flat blade attachment plug (2 prong)

Flat blade attachment plug (2 prong)

Figure 2. Types of plugs for 110/120 V outlets.

Source: <http://kropla.com/electric.htm>

Electricity prices are regulated by various government levels.

Electricity Links

<http://www.eia.doe.gov/price.html>

For information on energy -by price, fuel, sector, or by geography.

http://www.eia.doe.gov/cneaf/electricity/st_profiles/wisconsin/wi.html

To see an electricity profile of Wisconsin.

▪ **Water/Sewer Availability**

Water and sewer are utilities run by municipalities, cities and/or counties.

Existing buildings will all have water and sewer available. Industrial parks and other commercial land for sale usually have lines run to the property by the developer.

▪ **Telecommunications**

Telecommunications options available in the US include but are not limited to:

- 1) Conventional Telephony
- 2) Mobile Telephony
- 3) Internet
 - i) Dial-Up
 - ii) ISDN
 - iii) Cable
 - iv) DSL
 - v) T-carrier (T1, T3)
- 4) Radio Paging Services
- 5) Satellite Services
- 6) Cable TV

These services can be purchased separately from private companies. It's also possible to get most, and sometimes all services, from a single company. Some prices are regulated.

Telecommunication Services Providers

<http://www.wwt.net>

West Wisconsin Telcom.

<http://www.ameritech.com>

Ameritech.

<http://www.charter.com>

Charter Communications

4.2. Processing Equipment and Tooling

This section considers *Material Handling Equipment Vendors* data, as well as *Processing Equipment & Tooling*.

Machines are part of “the backbone of an industry and their selection requires careful evaluation of what is needed and what is available” (Sule, 1988, p. 140). “Machines are an integral part of manufacturing, yet seldom do we find an engineer developing production arrangements who also possesses expertise in machines. Some basic data such as types of machines, the names of suppliers, the range of costs, and the associated capacities are needed to begin the machine selection process” (Sule, 1988, p. 140). This section is aimed at answering these kinds of questions.

Globalization is a key factor to be considered here. The designer must decide whether it is cheaper to have local equipment vendors to fabricate the equipment needed –with local parts and according to the specifications provided, or import the equipment in question.

- **Processing Equipment & Tooling**

Thomas Register (<http://www.thomasregister.com>) serves very well as a tool to:

- Submit RFQs.
- Place orders online.
- View and download CAD drawings.
- View online company catalogs and websites.

When it comes to process and tooling equipment, a search can be done using these words as parameters.

- **Material Handling Equipment Vendor**

The Material Handling Institute of America (<http://www.mhia.org/mp/>) offers lists of material handling equipment by company, product type, and/or location.

A very useful web site in regards to these topics is Manufacturing Center (<http://www.manufacturingcenter.com/>), which features a directory of products and services (<http://www.manufacturingcenter.com/tooling/directory/default.asp>).

4.3. Raw Materials

Suppliers and *Specifications & Standards* are covered under this section.

Intelligent choice of raw material sources can only be made from examination of factual information. The charted data should include details for each major material from all possible origins. These details include location, availability, price, and terms of sale (Yaseen, 1955, p. 33).

Again, the designer shall compare the availability of local suppliers and compare them against foreign ones. Hopefully, cheaper ones can be found locally, without compromising quality and reliability.

- **Suppliers**

Thomas Register (<http://www.thomasregister.com>) is an excellent source of where to find suppliers. As explained before, it can also be used to submit RFQs, place orders online, view and download CAD drawings, and view online company catalogs and websites. When it comes to material procurement, a search can be done by type - aluminum, plastics, etc. The results can then be narrowed down to the desired states or provinces in the US and Canada.

- **Specifications & Standards**

Key to Metals (<http://www.key-to-metals.com/>) offers several engineering, industry, and scientific articles (<http://www.key-to-metals.com/Articles.htm>) whenever a quick reference from the theory and practice of nonferrous metals technology and application is needed.

A special challenge is posed to facility designers when dealing with the availability of a given material that was originally used in the country of origin and is to be found in the local markets where the manufacturing setting is to be located. That material may not be readily available in some cases. For example, if a Chinese firm decides to build a plant in the US to make cashmere sweaters, they will not be able to locally find cashmere hair, the fine downy undercoat hair of the Cashmere goat found in some countries of Asia and the Middle East. In this case, it will be necessary to either import it or find a product with similar characteristics.

4.4. Transportation and Distribution

Shipping Costs, The Transportation Network, Useful Links/Resources, Freight Forwarders, and Maps are the items covered under this section.

“All manufacturing operations require inbound movement of raw materials and outbound movement of the finished product to the market. Accordingly, it is vital for the executive contemplating new plant location to understand the intricacies of the complex transportation system at his disposal” (Yaseen, 1955, p. 15).

This section is aimed at providing links and info on the transportation system in the US, so these intricacies can be understood and to help the designer decide whether it is cost effective to ship in foreign equipment, tooling, materials or not.

- **Shipping Costs**

The links listed below cover international and domestic (US) shipping services and ground, sea, and air freight rates.

| |
|--|
| Sample Shipping Companies & Costs |
|--|

| |
|---|
| http://www.discount-shipping.net |
|---|

| |
|---|
| http://www.htsservices.com/shirate.htm |
|---|

- **The Transportation Network**

The transportation network in the US consists of the following:

- Highway.
- Air.
- Rail.
- Urban transit.

- Water.
- Pipeline.

The Bureau of Transportation Statistics web site (www.bts.org) features statistics and detailed information on these items (<http://www.bts.gov/publications/pocketguide/>).

Engineers need accurate information on the modes of transportation available so they can map out specific feasible modes and routes.

- **Useful Links/Resources**

Some valuable links of sites that offer information of ports of entry, directories of trucking companies and typical quotes for ground transportation, are listed below.

| |
|-------------------------------|
| Useful Links/Resources |
|-------------------------------|

- | |
|--|
| <p>http://www.customs.ustras.gov/location/ports/index.htm [Ports of entry in the US] http://www.truklink.com/cgi-bin/industry_sites.asp [Directory of trucking companies] http://www.fedexfreight.fedex.com/rate.jsp [Customized rate quotes]</p> |
|--|

- **Freight Forwarders**

“An international freight forwarder is an agent for the exporter in moving cargo to an overseas destination. These agents are familiar with the import rules and regulations of foreign countries, the export regulations of the U.S. government, the methods of shipping, and the documents related to foreign trade” (Unz & Co., 1998, ¶ 3).

Foreign companies need freight forwarders because they can assist “in preparing price quotations by advising on freight costs, port charges, consular fees, costs of special documentation, insurance costs, and their handling fees. They recommend the

packing methods that will protect the merchandise during transit or can arrange to have the merchandise packed at the port or containerized. If the exporter prefers, freight forwarders can reserve the necessary space on a vessel, aircraft, train, or truck” (Unz & Co., 1998, ¶ 4).

Freight Forwarders

www.forwarders.com [Directory of freight forwarding services]
www.BuyerZone.com [Get Quotes from Multiple Vendors]
<http://www.unzco.com/basicguide/toc.html> [Basic guide to exporting]
http://www.ams.usda.gov/tmd/freight/freight_forwarder.htm [Guide to selecting the right international freight forwarder]

- **Maps**

Links to sites that offer maps of the major rail companies in the US can be found below.

Rail Systems

<http://www.amtrak.com/pdf/national.pdf> [Amtrak]
<http://www.uprr.com/aboutup/maps/sysmap/upsy0007.pdf> [Union Pacific]
<http://www.railamerica.com/railmaps.htm> [Rail America]
http://www.csx.com/index.cfm?fuseaction=start.check_locat [CSX]
http://www.ksesi.com/system_map.pdf [Kansas City Southern]

4.5. Regulations & Standards

This section covers *ISO Standards*, *The CE Mark*, *Underwriters Laboratory/OSHA/EPA*, and *Customs & Tariffs*.

Most manufacturers are at the mercy of government regulatory judgments and not knowing what regulations they are going to be subject to can lead to the following costs: cost of compliance, capital gain and losses, and time delays (Schmenner, 1982, p. 41). Special attention is to be paid to Environmental, Safety, and Health (EHS) regulations. There are stringent requirements and attendant penalties, which makes imperative to give them adequate consideration during the initial design phases of a new facility.

- **ISO Standards**

ISO standards include ISO 9000 and ISO 14000. ISO 9000 is a series of standards that define, establish, and maintain an effective quality system for manufacturing and service industries. The ISO 14000 standards provide a system that enables organizations to organize and improve their environmental management efforts. Adherence to both standards is voluntary. Nevertheless, competitiveness can be attained by obtaining the ISO certification because it provides a common understanding between trading partners and it can contribute with customers' acceptance of the company's products because it is an indication of quality and safety.

The International Organization for Standardization (www.iso.org) offers comprehensive information on what ISO 9000 and 14000 are, how to select and use the right standard, and quality management principles. (<http://www.iso.ch/iso/en/iso9000-14000/tour/magical.html>).

The Standards Council of Canada (<http://www.scc.ca>) also offers detailed information on the ISO 9000 (http://www.scc.ca/standards/iso9000/index_e.html) and ISO 14000 (http://www.scc.ca/standards/iso14000/index_e.html) standards.

- **The CE Mark**

The CE mark appears on products that meet safety standards that apply to all countries of the European Union (EU). It was created and introduced to facilitate the free movement of goods (and services) within the European Union. (British-American Chamber of Commerce, 2001, ¶ 2).

Companies must seek to affix the CE mark on their products because if they do not carry it and are not in compliance with the directives, they may be restricted, prohibited from sale or forced to withdraw from the European market (British-American Chamber of Commerce, 2001, ¶ 4).

The following web sites offer information on the CE mark, what it is, directives, how to affix it, etc.

| |
|----------------|
| CE Mark |
|----------------|

| |
|---|
| http://www.bacsf.org/cemark9.htm |
|---|

| |
|---|
| http://www.cetest.nl/cemark0.htm |
|---|

- **Underwriters Laboratory/OSHA/EPA**

Underwriters Laboratories (www.ul.com) is an independent, not for profit organization, which offers third party product safety testing and certification. It helps companies achieve global acceptance for their products, whether it is an electrical device, a programmable system or a company's quality process.

UL Certification confirms that a company's products meet or exceed rigorous UL environmental, public health, and safety standards. It is optional in some cases but everyone uses it.

OSHA (www.osha.gov), the Occupational Safety and Health Administration, “is a government agency that was established to protect workers from serious injury and illnesses they may be exposed to in their workplaces. OSHA develops and enforces regulations, referred to as OSHA Standards, which address the myriad of possible hazards faced by today's workers” (Howstuffworks, Inc., 1998-2002, ¶ 1). Its website offers comprehensive information on how to deal with hazardous materials, develop safety and health standards, inspect workplaces, etc.

In the US it is mandatory for employers to have a Material Safety Data Sheet (MSDS) available to employees and emergency personnel for each hazardous material they deal with. Also, hazardous waste is to be properly disposed of.

EPA (www.epa.gov), The Environmental Protection Agency, is responsible for enforcing and assuring compliance with environmental regulations. EPA's enforcement efforts focus on assisting businesses and communities with compliance training and guidance. Its web site offers handy information on several topics related to material recycling, among others. In the case of the metalworking industry, for instance, it presents detailed information on recycled used oil management standards. The document offers info on standards for disposal of used oils and use as a dust suppressant, controls on disposal, and has a specific section on Metalworking Oils and whether they can be classified as recyclable or not.

- **Customs & Tariffs**

The United States Customs Service is the primary enforcement agency protecting the Nation's borders. To the importer, Customs provides advice, protection, and control of merchandise shipped into the country.

Tariffs refer to the duties imposed on the value of goods imported into a country. Manufacturing companies may have the need to import raw material, equipment and/or machinery, etc. They will be subject to tariffs in order for them to be allowed in the US.

The US-Customs web site (<http://www.customs.gov>) offers information pertinent to this topic. Of special interest is this link that serves as a general guideline to importing into the US: <http://www.customs.ustreas.gov/impoexpo/import.htm>.

This site at Golden Gate University also offers a comprehensive guide to importing into the US: <http://internet.ggu.edu/~emilian/ops113/importing.html>.

The United States International Trade Commission's Interactive Tariff and Trade DataWeb (<http://dataweb.usitc.gov>) allows users to look up any item (<http://dataweb.usitc.gov/scripts/tariff2002.asp>) to be imported into the US and find related info on tariffs and trade information for that product. It also lists tariffs by chapter (<http://dataweb.usitc.gov/scripts/tariff/toc.html>).

Chapter 5

Conclusions and Recommendations

Designing and setting up a manufacturing facility is a very complex task that requires a thorough understanding of the environment it is to function in. Deep knowledge of as many factors involved in the process as possible is required to make sound decisions and to produce the desired outcome.

The problem involves a lot of variables to be considered by those trying to establish a manufacturing plant in a foreign country, where different regulations, and measurement systems, for instance, are in place. This study considered the particular case when foreign companies target the US to set up a manufacturing plant.

Most business issues –i.e. competitive analysis, are covered by traditional Production and Operation Management books. Based on that, it was decided not to include them here. It made more sense to cover subjects hard to find information on. The ones researched here were:

- Building and Utility Requirements.
- Processing Equipment and Tooling.
- Raw Materials.
- Transportation and Distribution.
- Regulations.

The info compiled and presented here –and at the web site previously referred to, can be of help to anybody seeking to set up a manufacturing facility in the US. Although

a rough estimate, at least 80 hours were spent on internet searching. That definitely represents a time saver to anyone looking for that information.

Future studies shall consider the inclusion of information on the American with Disabilities Act (ADA). Facilities planners who intend to design facilities in the US must understand what barriers are and to make workplaces free of them, in order for them to be in compliance with the regulations regarding this issue. The ADA will definitely impact the approach used to design any given facility –from the parking lot to entrances an exits, offices, and restrooms.

In general, there is a need to include all factors affecting the facilities design process in future studies.

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