Material Handling System Costing Module
Experiential Learning Based Exercise

Prepared for:
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Summary

In this module, students will use "rules-of-thumb[1]" to provide an estimate of how much a material handling system will cost. Two competing material handling systems with different design philosophies and capabilities[2] will be used to highlight how alternatives can be evaluated. The goals of this module are: 1) to give some appreciation to the students with respect to how much material handling equipment costs; and 2) provide them with a framework for making decisions between competing material handling systems.

NOTE: The module is described from the instructor's perspective, and, as such, it is not intended to be a student handout to be used in a class.

The outline of this module follows the "Teaching Through the Cycle" education paradigm by Harb *et al* (1991). That is, through the course of teaching the module, one must answer the following four questions in the students' minds: "Why?," "What?," "How?," and "What If?" Why is this topic important for me to study? What do I need to know to understand this topic? How do I work with the material? What do I do if something about the problem changes?

Why?

In most "facilities" courses the use of material handling equipment is discussed. General rules are developed to determine when certain types of equipment are employed, and equipment costs may also be discussed. What is not often done is to put together a rough estimate on how much a certain system design will cost. This, however, is a task that facilities engineers are often asked to do and this module will, hopefully, provide them with an experience in performing this type of analysis. It provides some understanding of what needs to be done in estimating costs. The point to stress to the student is that they will be expected to do this type of problem analysis and thus they need some background on the technique and access to resource materials to be successful.

What?

The activity is to provide an estimate of the costs for a material handling system that has been proposed for a new facility. The activity requires the

[1] In our example, based on material that appeared in Gross & Associates, "Rules of Thumb," © 1999.
[2] In our example, based on material that originally appeared in the Design Plans and Ideas section of Modern Materials Handling, © 1996-2001, Cahners Business Information, a division of Reed Elsevier.

estimation of the number of units of the various types of equipment that will be required. To complete the assignment, the total of all material handling equipment needs must be projected to estimate final cost.

To perform these estimates, the students need a basic set of cost and throughput guidelines. It is suggested that the brochure: "Rules of Thumb," published and distributed yearly by Gross & Associates (a material handling consulting firm), 167 Main Street, Woodbridge, NJ 07095, (732) 636-2666, (732) 636-2799 (fax), www.GrossAssociates.com or similar guidelines be employed. Note that Gross & Associates will send to a professor as many copies of this brochure as are needed for a class for educational purposes. Also, they have a web-based calculator that can be used as well. "Rules of Thumb" provides per unit cost information on material handling equipment. It is important to point out to the students that they could get this information from specific material handling vendors (especially using the Web), but they soon realize that this would be very time-consuming. This is a good opportunity to stress that their final estimate will not be binding, but will provide a rough estimate of the system design costs.

The "Rules of Thumb" brochure also provides a few guidelines on equipment throughput (e.g., 10-15 pallets per hour for a counter-balanced lift truck). This is an even better opportunity to discuss why the throughput numbers would not likely be absolutely accurate estimates. Here, then, the students can be prompted to discuss what other information would be needed to develop an accurate estimate of the throughput capability of each piece of equipment.

To facilitate discussion, two proposed designs for the same facility should be employed. One design will usually be "manual" and the other "semi-automated." The instructor could also use a "completely automated" design. Each one of the facilities will have slightly different capabilities due to the level of automation. These designs can be obtained from *Design Plans & Idea*, which is a supplement to *Modern Materials Handling*, www.mmh.com/designplansandideas. Note that the above website includes PDF documents of the design plans as well as the articles that describe the application.

How?

The students (teams) are provided with a one-page drawing of the facilities along with a scale to measure distances on the drawing. A spreadsheet with each of the material handling equipment categories contained in the "Rules of Thumb" brochure is provided. An example estimate of some of the material handling devices should be performed to illustrate how the spreadsheet will

be utilized to estimate the cost of the material handling system design. This spreadsheet can be obtained from the author via e-mail, rmeller@vt.edu.

The class is broken into groups to develop estimates of the various categories of equipment (e.g., building size and requirements, industrial trucks, conveyors, storage racks, etc.). I usually have the students focus on the industrial trucks and I compute the values for racking, conveyors, etc. Typically, more than one group is given the same category and any differences are explored. It is sometimes quite easy to have group estimates that vary wildly. The ensuing discussion concerning these differences is another opportunity to reinforce the importance of various assumptions on the throughput and cost numbers being developed. This is also a good opportunity to discuss the sensitivity of the recommended design (which is a good lead into the "What If?" part of the module).

What If?

Contrasting the two designs is a good opportunity to discuss what-if scenarios. What if there is an increase in demand/throughput? What if the price of conveyors is off by 25%? What if a piece of equipment is not in the "Rules of Thumb" brochure? What if the building costs are less or more than assumed? What if our business changes in the next three years? Note that this goes beyond just plugging different numbers into the spreadsheet. Ideally, the students should be able to predict which design will prevail under different what-if scenarios.

Using This Module

The current method is to spend a 1-hour or 1.5-hour class period on this assignment, but ideally more time is needed. This lesson would work best in a 2-hour lab period, but I frequently use it in a 50-minute lecture. Also, since this lesson is presented in a classroom environment, a copy of the spreadsheet is projected upfront and changes to the spreadsheet are made via laptop. If done in a computer lab environment, the student teams would be able to make their own changes and explore more scenarios.

The author has not done very much to formally present final decision making choices between the two designs. Lecture-based material on engineering economy, multi-criteria decision-making, and related topics would be valuable before including this aspect. Chapter 13 of *Facilities Planning* (Tompkins *et. al.*, 2e, Wiley, 1996) provides good background coverage relative to this module. A new resource that has just been developed is JUSTMAT®, "a team centered decision support system for justifying capital investments in material handling systems." This package can be obtained from MHIA. Decision-making material

is covered in course lectures after this module. Data developed in this module is used as an example throughout the lecture.

This module has been used five[3] times and each time the students seemed to enjoy it, with commonly heard comments like, "Wow, that is a lot of money!" The monetary aspect reinforces the lesson that facilities planning projects are of strategic importance in any company.

Assignments

The attached PowerPoint presentation details the standard assignment that is presented to the students in class. Note that it is critical to walk the students through the process flow two times. The first time gives them a general overview of the flow in the facility. The second time I make notes on the process flow diagram indicating both the volume of hourly flow as well as the material handling method utilized. The process flow with and without the annotations is included. I only provide the "blank" version to the students along with a copy of any facility layouts. The student handouts are given in a separate file, but changes can be made as deemed appropriate.

As mentioned earlier, the solutions to this problem can vary widely based on the assumptions made. I have provided notes in the PowerPoint file that indicate some reasonable values that can be supported using the throughput estimates provided in the Gross & Associates, "Rules of Thumb."

Reference

Harb, J. N., Terry, R. E., Hurt, P.K., and Williamson, K. J., *Teaching Through the Cycle: Application of Learning Style Theory to Engineering Education at Brigham Young University*, Brigham Young Press (1991).

[3] Four times by the module author and another time by Jim Noble (Univ. of Missouri), who provided valuable comments to refine the module.

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