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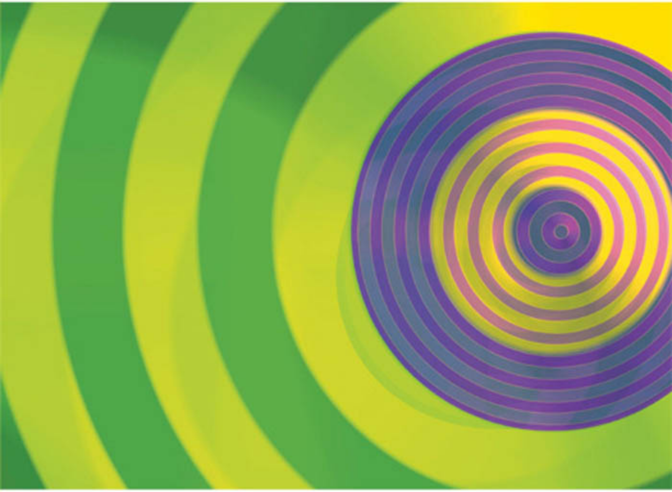

Logistics Engineering and Management

Benjamin S. Blanchard

Sixth Edition

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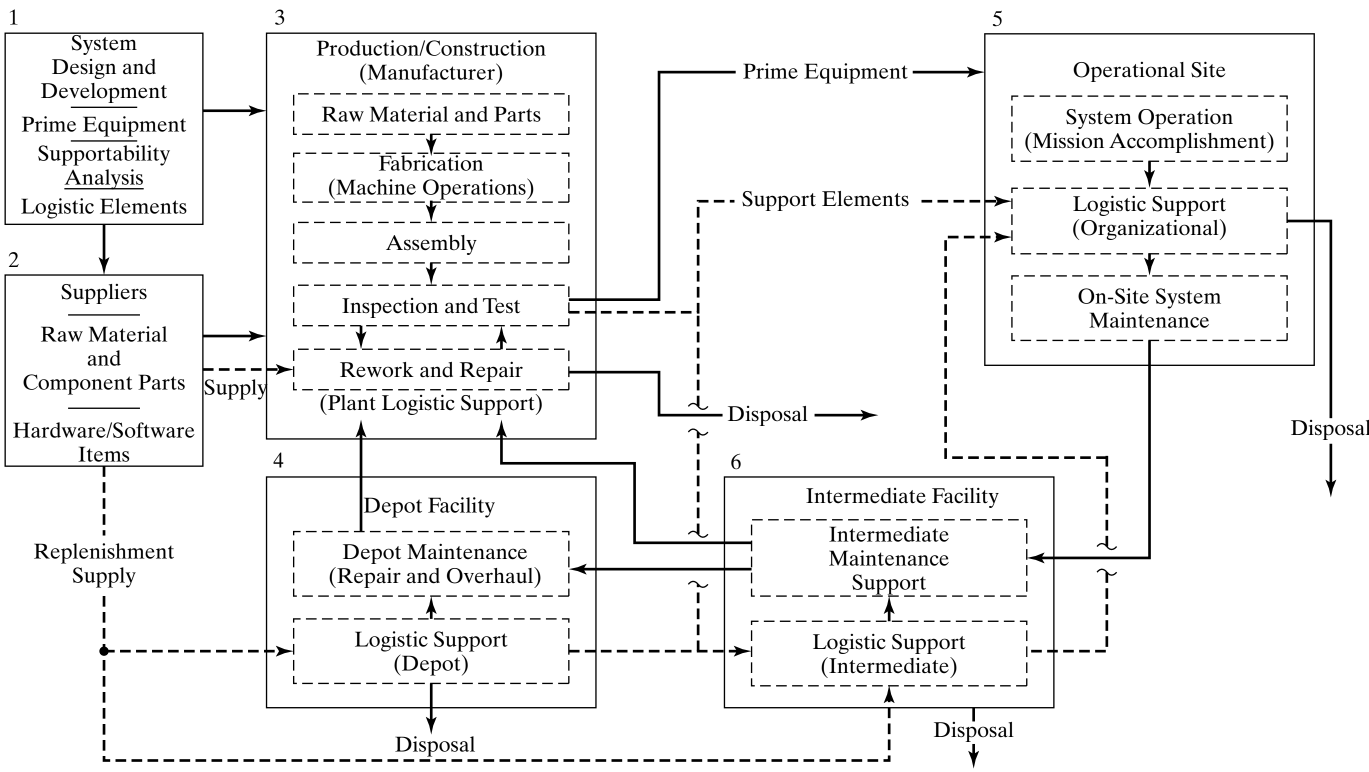

Figure 19 Operational/maintenance flow.

transportation and handling equipment, maintenance facilities, computer resources and maintenance software, and data/information resources are required for system support at all levels.

When dealing with logistics and maintenance support, one must treat the entire flow process as an entity. Each block represented in Figure 19 affects the others. The treatment of any single function must include consideration of the effects on the other functions. For instance, a system may be required to meet a specific operational effectiveness goal (e.g., operational availability of 90%), and considering that the system may fail at some point in time, a spares inventory may be required at the organizational level (block 5) to ensure that the right item is available for rapid system repair as required. Assuming that the faulty item is repairable, one has to determine the spares, test and support equipment, and personnel requirements at the intermediate level (block 6) or at the depot/manufacturer level (blocks 3 and/or 4) to support the necessary repair actions. Also, one must determine the appropriate transportation, facilities, computer resources, and technical data/information requirements to support the required maintenance activities.

The goal is to develop an overall optimum logistic support capability by evaluating alternative configurations, including the various mixes of resources at each level. Accomplishment of this goal requires a good understanding of the various logistics and maintenance support metrics presented in this chapter. These measures are all closely interrelated, and each must be addressed in the context of the system as an entity (i.e., all the activities, throughout the system life cycle, represented in Figure 19).

QUESTIONS AND PROBLEMS

1. Why is it important to establish measures of effectiveness (MOEs) for a system? When should they be established?
2. Select a system of your choice, briefly describe its purpose and the mission to be accomplished (i.e., operational scenario), and describe the MOEs that you would apply (assuming the role of the customer specifying the requirements for a new system).
3. Given the alternatives *a* through *g* shown in Figure 20, which one would you select? Why?

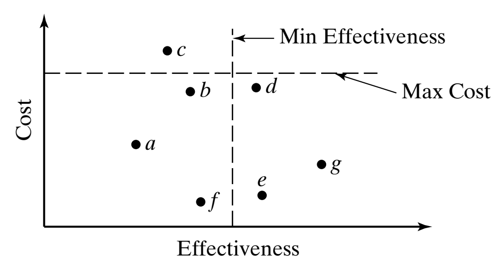

Figure 20 Effectiveness versus cost.

4. Calculate the OEE for a production system given that loading time is 460 minutes per day; downtime is 100 minutes; ideal cycle time is 10 minutes per product; actual cycle time is 15 minutes per product; the number of products scheduled for production is 22; and the number of products actually produced is 20. If this value turned out to be significantly less than your benchmark value, what steps would you take to improve the situation?

5. One of the early steps in the accomplishment of a LCCA is the development of a CBS. What is its purpose(s)? What should be included (or excluded)? Provide a hypothetical example.
6. Describe some of the most commonly used cost estimating methods. Under what conditions should they be applied?
7. What is *activity-based costing (ABC)*? Why is it important (if at all)? What are some of the differences between this method of costing and some of the more conventional approaches? (Hint: See Appendix: *Life-Cycle Cost Analysis (LCCA)*.)
8. Determine the present value cost ($) for the cost stream illustrated in Figure 21 (assume that the cost of capital is 12%). (Hint: See Appendix: *Life-Cycle Cost Analysis (LCCA)*.)

YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
8,000	9,000	12,000	12,000	13,000	14,000	15,000	15,000	16,000	17,000

PRESENT VALUE LIFE-CYCLE COST = ?

Figure 21 Cost stream for a system.

9. Assume that the annual maintenance cost for a factory, over a 10-year life cycle, is $13,000. Determine the present value cost ($), given that the cost of capital is 10%. (Hint: See Appendix: *Life-Cycle Cost Analysis (LCCA)*.)
10. Suppose that you are evaluating two different alternatives. The inflated cost stream for alternative *A* is $8,000 for year 1, $9,000 for year 2, $12,000 for year 3, $12,000 for year 4, and $13,000 for year 5. The inflated cost stream for alternative *B* is $10,000 for year 1, $12,000 for year 2, $10,000 for year 3, $9,000 for year 4, and $9,000 for year 5. Assume that the cost of capital is 12%. Which alternative would select? At what point in time will the selected alternative assume a point of preference over the other (i.e, break-even point)? (Hint: See Appendix: *Life-Cycle Cost Analysis (LCCA)*.)
11. In general, what will be the likely impact on LCC if
    - **a.** The system MTBM is decreased?
    - **b.** The MDT is decreased?
    - **c.** The MLH/OH is increased?
    - **d.** System utilization is increased?
    - **e.** Transportation time is increased?
    - **f.** The factory OEE is increased?
12. Calculate the anticipated LCC for your personal automobile (assume a 10-year life cycle). State your assumptions.
13. Provide an example of a supply chain (i.e., describe elements and objectives) and identify and describe the MOEs that you would likely apply in its evaluation.
14. Identify some quantitative measures (at least three for each, and present in order of importance, from your perspective) that you would apply in the evaluation of
    - **a.** The material purchasing process.
    - **b.** The materials flow process.

  - **c.** The transportation function.
  - **d.** The warehousing function.
  - **e.** Material recycling/disposal process.

15. Identify some quantitative measures (at least three for each, and present in order of importance, from your perspective) that you would apply in the evaluation of

  - **a.** Maintenance personnel.
  - **b.** Test and support equipment.
  - **c.** Spares/repair parts.
  - **d.** Maintenance facilities.
  - **e.** Maintenance data/information.

16. Assuming that a single component with a reliability of 0.85 is used in a unique application in the system and that one backup spare component is purchased, determine the probability of success by having a spare available in time *t* when required.

17. Assuming that the component in Problem 16 is supported with two backup spares, determine the probability of success by having two spares available when needed. Determine the probability of success for a configuration consisting of two operating components backed by two spares. (Assume that the component reliability is 0.875.)

18. There are 10 systems located at a site scheduled to perform a 20-hour mission. The system has an expected MTBF of 100 hours. What is the probability that at least 8 of these systems will operate for the duration of the mission without failure?

19. An equipment contains 30 parts of the same type. The part has a predicted mean failure frequency of 10,000 hours. The equipment operates 24 hours a day, and spares are provisioned at 90-day intervals. How many spares should be carried in the inventory to ensure a 95% probability of having a spare available when required?

20. Determine the EOQ of an item for spares inventory replenishment, where:

  - **a.** The cost per unit is $100.
  - **b.** The cost of preparing for a shipment and sending a truck to the warehouse is $25.
  - **c.** The estimated cost of holding the inventory, including capital tied up, is 25% of the initial inventory value.
  - **d.** The annual demand is 200 units. Assume that the cost per order and the inventory carrying charge is fixed.

21. Refer to Figure 16. What happens to the EOQ when the demand increases? What happens when there are outstanding backorders? What factors are included in procurement lead time?

22. Does the EOQ principle apply in the procurement of all spares? If not, describe some exceptions.

23. Assume that you are responsible for developing a test station for use in the intermediate-level maintenance shop to check out and aid in the repair of items that have failed at the organizational level. Describe some of the metrics that need to be considered as an input to the design of the test station. What would be a good objective in specifying a reliability requirement for the test station (as compared with the reliability of the prime system elements being tested)?

24. This question has been intentionally deleted in this edition.

25. Describe how the applications of EDI/EC can affect logistics and system support (provide five examples).

26. Identify some of the new technologies that have recently been introduced, and describe how these have affected logistics (provide some examples and relate these to some specific MOEs).

Logistics and Supportability Analysis

Throughout system design and development, there is ongoing system synthesis, analysis, and design optimization, leading to definition of the ultimate design configuration. As part of the design evolutionary process, many different alternatives are identified and evaluated, utilizing various analytical methods/models to facilitate the trade-off and evaluation process, and resulting in the selection of a preferred approach. Inherent within this iterative and continuous analytical process is that part of the effort that is directed to the design and evaluation of the logistics and maintenance support infrastructure, which is identified herein as the *supportability analysis* (SA).[1]

The SA includes the integration of various analytical techniques, combined to help solve a wide variety of problems, with the objective of designing and developing an effective and efficient logistic support infrastructure capability, consistent with the requirements of the system being developed and/or supported. More specifically, the SA addresses itself to the following objectives:

1. Aid in the initial establishment of supportability requirements during conceptual design. In the selection of alternative technological approaches, accomplished as

[1]For defense systems, refer to MIL-HDBK-502, "DOD Handbook-Acquisition Logistics," Department of Defense, Washington, DC, 30 May 1997. The principles and concepts associated with supportability analysis, presented in this chapter, are not new and have been previously covered under such titles as the logistics support analysis (LSA), maintenance engineering analysis (MEA), maintenance level analysis (MLA), maintenance task analysis (MTA), maintenance engineering analysis record (MEAR), maintenance analysis data system (MADS), and so on. Although the nomenclature may change from time to time, the objectives and the processes utilized in each instance are basically the same.