**Textbook Problem 7.1**

**Question**:

Describe three principal differences between system performance requirements, which are an input to the concept definition phase, and system functional specifications, which are an output (see Figure 7-1).

**Response**:

Three principal differences between system performance requirements and system functional specifications are seen in the list below:

1. The system performance requirements exist as the technological basis for the system, which take into consideration a variety of different system concepts from the Concept Exploration Phase – measures of effectiveness (MOE) are often the source of these requirements. The system functional specifications, on the other hand, are created to serve as the formal foundation for the ensuing design phase, the Advanced Development stage of the Systems Engineering Life Cycle.
2. The specificity defined by the system functional specifications is much greater than that of the system performance requirements. The system performance requirements exist as one of the preliminary iterations of thought regarding total operation, stemming from different system concepts. The cognizance gained through the Concept Definition phase via functional analysis and formulation, concept selection, and concept validation help hone the original performance requirements into ones that define what the system must truly do in order to meet all operational requirements.
3. The scope covered by the system functional specifications is more expansive than that of the system performance requirements, given that they are an input to the Advanced Development phase of the Systems Engineering Life Cycle. Items such as system configuration and organization, RMA (reliability, maintainability, availability) requirements, and human engineering factors (e.g. safety and training) are now taken into consideration.

**Textbook Problem 7.2**

**Question**:

Both the concept exploration and concept definition phases analyze several alternative system concepts. Explain the principal differences in the objectives of this process in the two phases and in the manner which the analysis is performed.

**Response**:

In the Concept Exploration phase of the systems engineering lifecycle, the goal is to convert the operationally oriented view of the system from the Needs Analysis phase into a functionally oriented structure, one that focuses on analysis of alternatives and performance requirements formulation and validation. This analysis, based on comparative evaluations of the operational effectiveness for each idea, will help establish realistic limits for the expected effectiveness given the operational situation. Analysis of alternatives is performed using some of the following guidelines: starting with the existing predecessor system as a baseline, postulating valid replacements for prominent subsystems, and choosing modified architectures where appropriate. Effectiveness simulations may also be performed in order to preliminarily identify discriminators and key variables that are important to the design. Ideas here are explored, but no definitive selection or preferred choice is made.

In the Concept Definition phase of the systems engineering lifecycle, systems engineers are looking to down select from their options to their preferred concept prior to entering into the Advanced Development phase. Decisions in this stage must be strategic, and the criteria with which the selection will be made needs to be well defined and must encompass a variety of different components other than engineering design. The selection strategy includes, but is certainly not limited to: operational performance and compatibility, program cost and schedule, risk factors, and technological operation and upgrades. Once the different ideas are rigorously evaluated and profiled via trade studies, weighted factor analysis, and programmatic projection (e.g. work breakdown structure and risk abatement plan), it is sometimes prudent to develop system effectiveness models. In some cases, performing critical experiments gives further insight into the prospective success for a specific concept. It is important to remember that this is the stage where persuasive evidence must be produced in order to “sell the idea” and successfully push the concept forward into the Advanced Development phase. Thorough analysis across a much wider scope is essential in setting a solid foundation for a successful programmatic future.