**Textbook Problem 1.1**

**Question**:

Write a paragraph explaining what is meant by the statement “Systems engineering is focused on the system as a whole.” State what characteristics of a system you think this statement implies, and how they apply to systems engineering.

**Response**:

The statement “Systems engineering is focused on the system as a whole” helps define the high-level scope of this relatively new branch of engineering, which exists to guide the engineering of complex systems. The aforementioned statement also helps differentiate systems engineering from traditional engineering disciplines (e.g. electrical, mechanical, software) – in essence, systems engineering represents a fine balance between detailed design, interdisciplinary communication, and project management. Characteristics of a system that this statement implies are full system operability, multidisciplinary cognizance, and interactions with internal and external interfaces. While traditional engineering occurs mostly at the component design level, the listed characteristics highlight parts of system design that are often overlooked. Understanding the workings of interrelated components from end-to-end, the contributions of different engineering disciplines to the project, and the effects of the overall environment on the system in question is an integral part of successful systems engineering. These characteristics exemplify the crux of systems engineering, and provide a solid foundation for why this discipline is now being recognized worldwide.

**Textbook Problem 1.2**

**Question**:

Discuss the difference between engineered complex systems and complex systems that are not engineered. Give three examples of the latter. Can you think of systems engineering principles that can also be applied to non-engineered complex systems?

**Response**:

Complex engineered systems contain the following three characteristics:

1. The system is an engineered item, implying that it satisfies a specific goal or need
2. Multidisciplinary approach and integration – diversity in component/system design
3. Use of advanced technology – it may very well be new, and brings risk to the system design

On the other hand, a complex system that is not engineered is designed based on well-established technology. For example, even though household appliances (e.g. refrigerators and washer/dryers) are increasingly improving in their control systems, design, and efficiency, upgrades tend to only enhance the device, not provide the primary service.

Three examples of complex systems that are not engineered:

1. Traffic Lights

This technology has existed for quite some time, and although optimization has been made to improve things like timing paradigms, the component diversity is limited.

1. Garage Door (Openers)

This technology involves both electrical and mechanical components, mainly a motor with which the garage door is pulled up/down and an opener which, via RF, triggers the motor electrically. The technology, again, is limited to a well-defined and relatively simple problem space, with not much room for future expansion.

1. Air Conditioning Wall Units

This technology utilizes both electrical and thermo-mechanical designs. Recent designs have optimized BTU, efficiency, and size, but again, the technology is well-defined.

Systems engineering principles that can also be applied to non-engineered complex systems include:

* Balancing affordability and timeliness in creating new designs/models
* Risk assessment, management, and mitigation in product improvement
* Utilizing a multidisciplinary knowledge base to upgrade the complex system

**Textbook Problem 2.2**

**Question**:

Give three key activities of a systems engineer that require technical knowledge down to the component level. Under what circumstances should the systems engineer need to probe into the subcomponent level for a particular system component?

**Response**:

Three key activities of a systems engineer that require technical knowledge down to the component level include the following:

1. Proper design and specification of all system components, including performance, reliability, and sustainability measurements
2. Effective communication with design specialists, where solutions are discussed concurrently from both the traditional and systems engineering perspectives
3. Internal and external system interface connections and input/output requirements across the different engineering disciplines

Circumstances where a systems engineer needs to probe into the subcomponent level for a particular system component include the following:

* Assessing a subcomponent failure that happens to be essential to the overall system operation
* Performing a Trade Study in order to determine the best-suited subcomponents for the system
* Technical design reviews in conjunction with becoming more familiar with advanced technology