

01.1 intro.it The systems approach

1 Simon Ramo and Richard Booton, Jr.—the folks who brought us the intercontinental ballistic missile (ICBM) (thanks? ...I mean thanks. But, thanks?)—defined **systems engineering** to be

the design of the whole as distinguished from the design of the parts.
(*Booton and Ramo, 1984*)

Like the ICBM, many modern technologies require this systems engineering design approach.

2 A key aspect of the systems engineering design process is the **mathematical modeling** of the system—the development of a dynamic system representation.

3 Dynamic systems exhibit behavior that can be characterized through analysis and called the system's **properties**. A property of a dynamic system might be how long it takes for it to respond to a given input or which types of inputs would cause a damaging response. Clearly, such properties are of significant interest to the design process.

4 This Part of the text focuses on **electromechanical systems**: systems with an interface between electronics and mechanical subsystems. These are ubiquitous: manufacturing plants, power plants, vehicles, robots, consumer products, anything with a motor—all include electromechanical systems. In ??, we will consider more types of systems (e.g. fluid and thermal) and their interactions.

5 Electromechanical systems analysis can proceed with initially separate modeling of the electronic and mechanical subsystems, then, through an unholy union, combining their equations and attempting a solution. This is fine for simple systems. However, many systems will require a systematic approach.

6 We adopt a systematic approach that draws **linear graphs** (à la **graph theory**) for electronic and mechanical systems that are intentionally analogous to electronic circuit diagrams. This allows us to use a single graphical diagram to express a system's composition and interconnections. Virtually every technique from electronic circuit analysis can be applied to

these representations. Elemental equations, Kirchhoff's laws, impedance—each will be generalized. In ?? , this same graphical and electronic-analog technique will be extended to other energy domains.