Abstract 1:

Biophysical limits are becoming binding constraints on mature economies, and the data needed for policy-makers to understand and manage this reality are not universally available. In this chapter, we discuss the problems that arise from relying solely on the Solow growth model to describe an economy that is deeply interconnected to the biosphere. We point out that mainstream economists forecast low growth rates for mature economies for the foreseeable future because traditional drivers of economic growth (growth rates of capital and labor productivity) have plateaued. The guiding premise of this book is that stalled economic growth can be the natural outcome of mature economies reaching a limit of the supply of energy and other forms of natural capital. Thus, mainstream policy recommendations based on a Solow growth model that would spur consumption and investment to invigorate economic growth may actually backfire: expansion of the stock of capital in the economy can contribute to the slowdown of economic growth. The chapter ends with a call for acknowledging the \emph{biophysical} constraints of the economy and adjusting national accounting accordingly.

Abstract 2:

In this chapter, we describe the development of approaches to the relationship between the economy and the biosphere. The historical development takes place over three eras, the era of abundance, the era of energy constraints, and the age of resource depletion. Each era is defined by a dominant metaphor that guides the economic model and leads to a framework for national accounting that is perceived as relevant to understanding the economy. The metaphor for the economy has evolved from the clockwork mechanism of classical physics (economy isolated from the environment) to an engine (the economy is dependent on an inexhaustible supply of inputs from the environment). The chapter then suggests that the previous metaphors are insufficient for the age of resource depletion and suggests a new metaphor: the economy is society's \emph{metabolism}. Next, the way in which the metabolism metaphor leads to an expanded understanding of the requirements for national accounting is described. An argument is made for accounting a nation's wealth (manufactured and natural capital) in addition to its income (GDP). The chapter ends with a description of the structure of the rest of the book.

Abstract 3:

In this chapter we will develop a framework for accounting material flows and accumulations within economies. We will begin by looking at accounting in everyday life before using concepts from thermodynamics, such as system boundaries, control volumes as well as the First Law of Thermodynamics, to develop a rigorous accounting procedure. This procedure is applied first to a one-sector then two-sector model of the economy, in order to build up to a general framework for material accounting. We then apply the framework to the real-world example of the US auto industry.

Abstract 4:

In this chapter, we develop equations, assisted by the First Law of Thermodynamics, that describe the flow of direct energy through economies. The equations are applied to example economies with increasing levels of disaggregation. Finally, the energy flows for our running example, the US auto industry, are discussed.

Abstract 5:

This chapter develops equations that describe the accumulation and flow of embodied energy through economies. We noted that waste heat from a sector is additive to the energy embodied within products of a sector, thereby providing the mechanism for accumulating embodied energy along the manufacturing supply chain. The embodied energy accounting equations were applied to example economies~A--C. % chktex 8 Finally, we discussed embodied energy in the context of our running example, the US auto industry. We found that there are a few historical estimates of energy embodied within automobiles.

Abstract 6:

In this chapter, we develop techniques to account for flows of economic value through economies. We employ the prevailing subjective theory of value for our framework, that is, we use the value of market transactions to value physical flows of materials and energy. As part of the methodology section, we discuss the limitations to relying solely on valuations obtainable from market transactions and call for additional non-market valuation methods to be employed in national accounting. In particular, we point to the System of Environmental Economic Accounts (SEEA), the international standard developed by the UN\@. We then develop value accounting equations and apply them to example economies~A--C. % chktex 8 This chapter introduces two new terms to capture value-added (and destroyed) within economic sectors, and demonstrate that these terms capture the value for GDP in national accounts. Finally, we illustrate how our framework can be populated with data from current national accounts to derive inter-sectoral value flows, using national accounting data for the auto industry for illustration. This section of the chapter also contains a discussion of the potential problems with including intangible intellectual property assets in the nations measure of its capital stock.

Abstract 7:

In this chapter, we derive algebraic equations that describe the energy intensity (in units of J/\$) of products of economic sectors. The algebraic equations are applied to Examples~A--C to derive a matrix equation % chktex 8 for a vector of energy intensities for the entire economy. We review several studies of energy intensity in the literature and note a wide range of results from one study to the next. The estimates of energy intensity also vary with time. The range of energy intensities for the auto sector is $0.83 \times 10^{4}$ kJ/\$ to $11.6 \times 10^{4}$ kJ/\$.

Abstract 8:

In this chapter, we discuss several implications that arise from the detailed development of our dynamic framework for material, energy, and value accounting. The first implications are for the energy I-O method itself. We recommend a physical accounting framework that fully accounts for capital stock and energy input from society (final consumption) to the economy. We then discuss implications for economic ``development,'' namely that economic growth could be considered a ``fully coupled'' problem: understanding it requires breadth of knowledge and appreciation for interactions among many important and complementary factors, including financial capital, physical capital and associated ambodied energy, direct energy, resources, and societal inputs. Each, alone, is necessary, but not sufficient, for economic development. We discuss implications for recycling and reuse of materials as well as the concept of dematerialziation. Finally, we view the concept of a steady-state economy through the lens of our framework. We find that there are many potential definitions of a steady-state economy, none of which are fully satisfying when compared against the ideal of sustainability.

Abstract 9:

This chapter briefly summarizes the book and highlights the need for additional data on both inter-sector flows and accumulation of manufactured capital and associated embodied energy. We continue with a call to action, a list containing several tasks that should be undertaken to modify national accounting. Finally, we note that moving forward on these issues will be politically difficult, but necessary, to adapt to the age of resource depletion