Systems Thinking Primer for Natural Capitalism

Chapter 1: the Four Basic Shifts

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1. Overview and Goal of Primer

The aim of this primer is to develop a common "systems language" for thinking, communicating, and building shared knowledge for building environmentally sustainable enterprises and industries. As societies and organizations around the world gradually shift to seeing environmental sustainability as a strategic imperative, there is a growing need for universally accepted conceptual frameworks that are both intuitive and operational. Much of what is written today is either primarily data about declining ecosystems or proposed technical fixes, or debates about both. While this is important, it fails to lay a foundation for thinking together. Yet, thinking together is the first essential foundation if people and institutions must sustain deep change.

System dynamics is a body of theory and method that has been developing for forty years to enable practitioners and researchers to better understand complex, nonlinear social and environmental systems. Initially utilized by technical model builders, more recently it has been used as a basis for tools and processes aimed at accelerating organizational learning. Here the overall aim is to develop a common language and way of collaboratively conceptualizing highly interdependent policy and strategy issues. Repeatedly it has been shown that if people lack a common picture of the system within which they are operating, it is impossible for them to align their actions. Conversely, developing such a common picture enables natural coordination.

This Primer is meant to be used as a complement to the new book, Natural Capitalism (Paul Hawken, Amory Lovins and Hunter Lovins, Little Brown, 1999). Natural Capitalism proposes four core shifts which must be the constitutive elements of a strategy for sustainability for any enterprise. Each must be pursued if the enterprise's (or industry's) aim is long-term harmony with natural systems. Each is interdependent, creating both constraints and synergies with regard to the others. Yet, this interdependence is not easy to understand, nor its implications for specific policies and strategies. Failing to grasp this interdependence will cause firms to miss the opportunities for conceptual and practical breakthroughs, and can even leave natural systems worse off as a result of piecemeal efforts which appear sound but have long term negative consequences.

In this introductory Chapter, we show how the four basic strategies of Natural Capitalism do in fact comprise a systemic approach. We do so by developing a "five year old's" picture of how the human industrial system interacts with the natural environment. Using simple stock and flow diagrams common to system dynamics, a simple picture of the interaction of natural resources, production, goods in use, and waste generation is developed. It is then easy to begin exploring how these different flows and activities interact, and to see how the strategies of Natural Capitalism address all major facets of this system.

2. The Basics of Natural Capitalism

Natural capitalism -- what our economic system would look like if the ecosystem services were truly valued -- entails 4 basic shifts in business practice.

Shift #1: Radical Resource Productivity – dramatically increase the productivity of natural resources
Increasing resource productivity means getting more product out of each ton of natural material extracted. Changes in technology can create ways to stretch natural resources 5, 10, even 100 times further than they do today. And these resources savings can easily save money and increase profits.

Essential Argument: saving resources is possible, helping the environment and saving money

Shift #2: Biomimicry/Ecological Re-Design – shift to biologically inspired models
Shifting to a "closed loop" production systems – recycling, re-manufacturing, and industrial ecology. This is focused on the elimination of waste in the system. Such production models seek to emulate nature, where waste from any system is food for another system.

Essential Argument: Eliminating waste in production saves resources and money

Shift #3: Service and Flow Economy – Move to solutions-based business models
The overarching focus in on shift from producing and selling goods, which customers aim to acquire, to flows of services where meeting customers' real needs. In a traditional goods-based business model, the purchaser has ultimate responsibility for disposition of goods, hence most are discarded after use. In a solutions-based business model, the producer maintains ownership of goods produced, which encourages “take back” when the productive life is over, remanufacturing and recycling. This requires different expectations for both customers and producers, and fundamentally shifts the relationship between the two. Thus, basic economic arrangements support closed loop production and consumption models.

Essential Argument: Moving to leasing models shifts emphasis to providing satisfaction with as little material throughput and waste as possible in the entire economic system.

Shift #4: Investment in Natural Capital – reinvest in natural capitalism
Businesses must restore, sustain, and expand the planet’s ecosystems so that they can produce their resources and services even more abundantly. If business do not do so proactively, costs of reinvesting in natural capital will continue to increase with depleting stocks and rising ecological problems, leading to societal pressures through regulation and costly and inefficient governmental actions.

Essential Argument: This must be done to ensure that there will be resources in the future and to prevent a reputation of environmental irresponsibility; conversely, increasing environmental stewardship will provide market boost with growing consumer awareness .

3. Seeing the Elements of Natural Capitalism as a System

As a foundation for strategic thinking, what is most important about Natural Capitalism is the imperative to pursue all four basic shifts. Failure to grasp this can not only lead firms and industries to fail to realize important synergies but to inadvertently worsen the natural environment.

For example, many business readers will tend to see the first of these shifts, resource productivity, as really the "mother" of all the others. This tends to occur because "eco-efficiency" is becoming a hot topic in many businesses, and firms around the world are working to increase resource productivity. Yet, it is possible to improve resource productivity and cause natural systems to decline even further.

To see how this could happen, consider first that improving resource productivity means reducing costs of natural resource inputs to production. This is one reason that so many businesses are drawn naturally to eco-efficiency. But what then happens with the resulting profit increases? Will they be invested in further resource productivity innovations or, as the authors of Natural Capitalism hope, in the other three basic shifts? Or, will they be investing in just growing faster, perhaps in less ecoefficient businesses? In today's global capital markets profit flows to where the financial returns are highest, not where the ecological savings are greatest. So, higher resource productivity could ultimately lead to more natural resources extracted, not less. Moreover, improving resource productivity does not necessarily reduce the waste generated by the use and ultimate discard of the products produced more eco-efficiently. In fact, if increased resource productivity leads only to more growth, it is easy to see how total waste could actually increase.

Ultimately, nature does not care how "efficient" the human industrial system is -- nature cares how much resources we extract, how much waste we generate, and what collateral damage we inflict on nature's own regenerative processes.

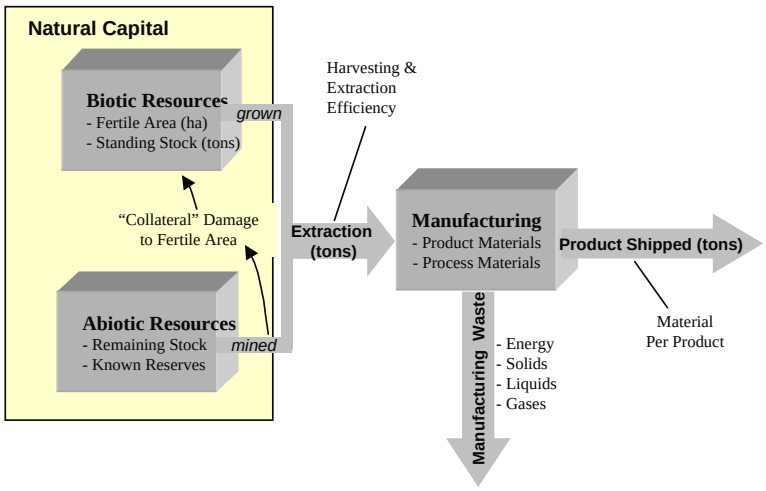
The nub of the issue is to what extent do we take into account the system as a whole. This is why there are four basic shifts underlying Natural Capitalism, not just one. The value of the Natural Capitalism framework stems from the way it, implicitly, addresses all major dimensions of how our industrial system interacts with nature. To see this, consider the following simple stock and flow picture of how the industrial production system nests within the larger natural system.

A Simple Stock-Flow Framework for Viewing the Industrial System

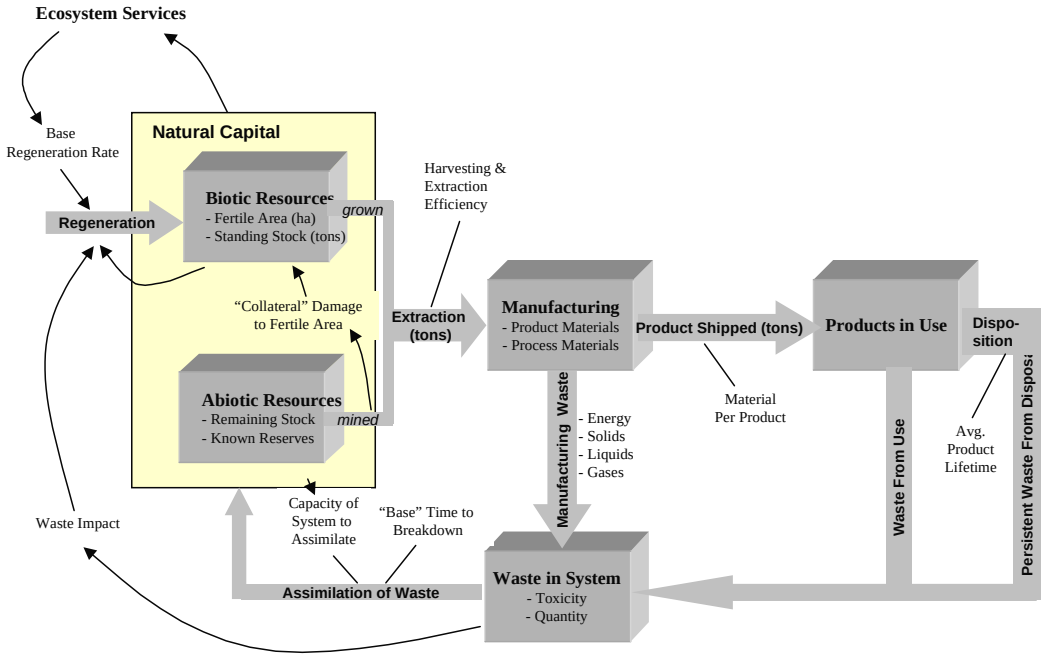
All industrial products are created based on resources extracted from nature. This flow of extracted resources (minerals, land, energy, wood, water, and so on) is processed through the many stages of industrial production to eventually become the flow of final goods produced and sold to consumers and producers. Natural resources are extracted in two ways: biotic resources like fish and timber are harvested, abiotic resources like oil and minerals are mined. These two different types of resources have different regenerative capacities: biotic resources are continually regenerated through natural growth processes, while abiotic resources, for all intents and purposes, are not regenerated, at least on a time scale relevant for human activities.

But actually only a tiny fraction of extraction becomes production -- less than 6% (by weight) when the entire industrial system is taken into account. The other 94% becomes manufacturing waste, the primary output of the present industrial production system. This is why there are large potential gains in eco-efficiency, increasing production output per unit of natural resource input. Increasing the ratio of production to extraction also reduces the proportion of waste generated as

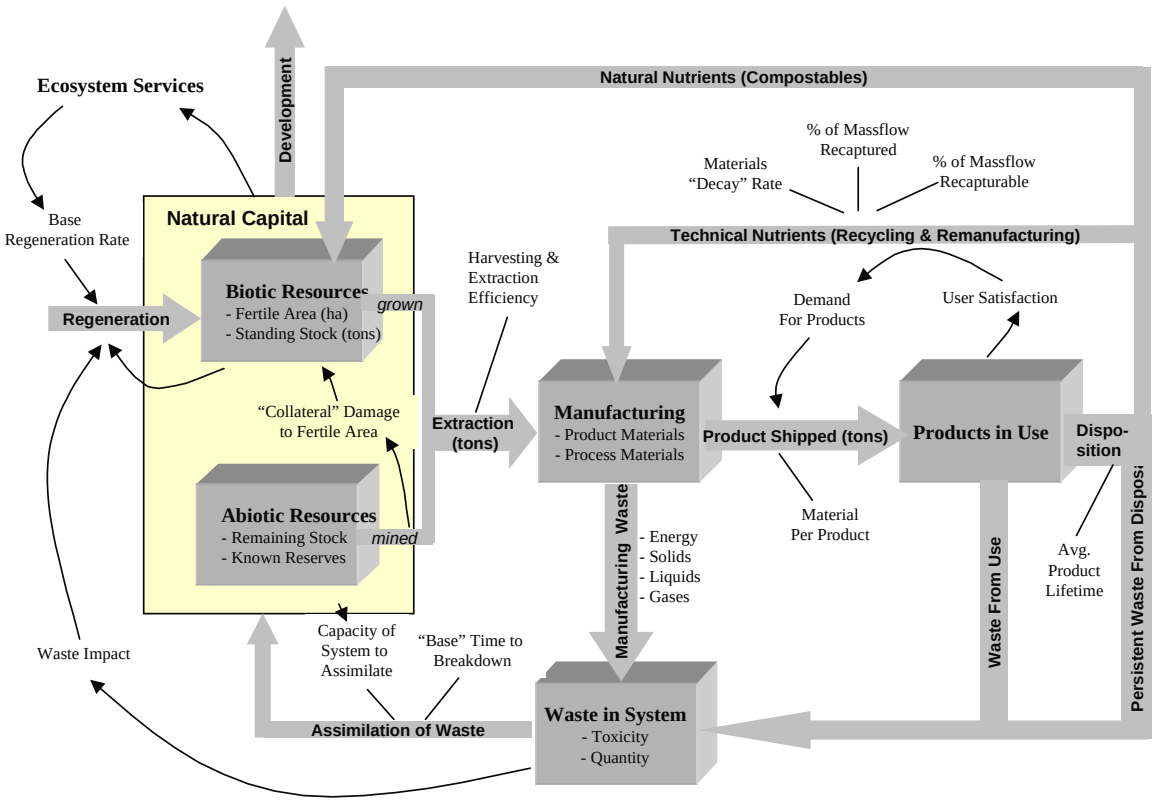
a by-product of production. This is why society wins and nature wins, at least in the short-term, from increased *resource productivity*, shift #1 of Natural Capitalism.



But, this is only one facet of a larger system. Produced goods become goods in use, the totality of all "the stuff" owned by consumers and producers, from washing machines and PC's to airplanes and machine tools. And, of course, this stuff goes somewhere once its productive lifetime is over. Typically, it too becomes waste. Moreover, other types of waste, primarily biological waste, are generated from the use of the goods, such as emissions from automobiles and industrial smoke stacks. All three of these sources of waste -- from production, use, and eventual discard of goods -- accumulate in nature, some for a very long time. Plus, accumulated waste is not benign -- much of it interacts with nature's own regenerative processes, thereby reducing the rate at which the stock of natural resources replenishes itself. All of this suggests a larger picture, reflected below.



Expanding our view of the system further, products in use can also be recycled back into the manufacturing system as either raw material that requires re-manufacturing or as directly re-usable components. The amount of material that can we recycle is a function of the % of a product that is physically recyclable, the % of those products that are re-captured through a distribution system, and the number of times the material can be recycled before its structural integrity decays. In addition, waste can be avoided by developing products out of directly compostable materials, where material returns almost directly as productive nutrients.



Our other expansion of our system's view is to include the other major source of loss of natural resources which is the conversion of the land base to "development", usually industrial and urban use, and the resulting loss of biotic natural resources.

Now, we can see where the other three "basic shifts" of Natural Capitalism come in, and why they are so important. *Ecological re-design*, shift #2, promotes the adoption of closed loop systems, just as occur in living systems. Closed loop industrial systems include industrial ecology, where the outputs of one manufacturing process are used as the inputs to another (reducing waste) and recycling/re-manufacturing, which re-captures products after consumer use (reducing waste and raw material use). Moving to a *Service Flow Economy*, shift #3, supports the ecological re-design by promoting a change in the basic producer/consumer relationship whereby the producer would maintain ownership of the physical material throughout the life of the product. The advantage of this relationship is that it creates incentives favorable for product recycling and re-manufacturing because the product must be returned to the producer after use by the consumer (A powerful illustration is the highly successful new Xerox 265 digital copier, whose 200 parts are 96% recyclable.) In addition, because the producer and customer relationship is now focused on providing services rather than products, it would be in the financial interests of the producer to find ways to provide those services with as little material use as possible. Lastly, reinvesting in *natural capital*, shift #4, focuses everyone's attention on conserving the stock of natural resources and nature's regenerative capacity, including the losses of natural resources to "development," as occurs when we pave over forests or wetlands. Ultimately, the entire system depends on this regenerative capacity and the ecosystem services provided by the current stock of natural resources -- our natural capital.

4. Using the stock and flow framework as a guide to investigating a product flow system

The following section is offered to illustrate the use of the simple stock-flow framework. The next step in developing this framework is to actually put it to use in SoL member companies and discover together how it is best used in different settings. These "reflection" questions can either be asked generically about the larger system, or about specific products systems within the larger system.

The stock and flow framework lends itself to asking questions about how the system is behaving over time and how intervening in different places in the system can change that behavior. Some of these are questions are:

What is the current state of the system? Can we map out the stocks and flows relevant to a particular product or family of products? How have the stocks and flow been changing over time?

Are there any "signals" in the system that are causing us to think that change is important? (in other words, what are we seeing around us that is motivating the desire for change in the way our resource products system works?)

for example,

1. The stock of fertile area and available resources have been declining over time for many resources
2. The stock of waste in the system is increasing, leading to concern about the concentration of toxins in the environment

What are our "goals" for this system? (How would we like to see the stocks such as natural capital, waste, and products in use, to be behaving over time?)

for example,

1. We would like the stock of fertile area and resources (particularly those with a fast natural generation rate such as trees, fish, etc) to be stable or increasing to ensure sufficient resources for the future and health ecosystem services.
2. We would like the stock of waste to be stable or declining (both in amount and in toxicity) to both protect human health and the health of the eco-systems.
3. We would like a flow of products and services from manufacturer to consumer that meet our needs

Where are the potential levers in the system?
What we ultimately would like to change in the a system is the level in the stock, such as the products/services enjoyed by consumers, the amount of waste in the system, and the resources available. The only way to change the level of stock is to change the rate of the flows. To increase the level of a stock, one can decrease the outflow, increase an inflow, or both. The start of looking for leverage points in a systems is to understand what rates causes the system to move in a desired direction (and how it might cause other effects through the system!). In examining a

particular product flow chain, each of these rates could be researched to understand what the relative cost/benefit of intervention would be.

for example,

To increase the stock of natural resources, we could….

- increase the regeneration rate of the natural resources
  - by increasing the fertile area available for regeneration
  - by decreasing the conversation rate
  - by decreasing the waste/fertile area ratio, which is reducing the growth rate (example: acid rate has been shown to decrease the growth rate in the forests of northern New England, pollution in harbors reduces the ability of fish to regenerate, etc)

- decrease the extraction rate (tons of material) by:
  - decreasing the material shipping as products, by reducing the material per product or the number of products sold/year (which can be done by increasing the lifetime of the product, or reducing demand for products)
  - decreasing the amount of the raw material that is lost as waste in the manufacturing process
  - increasing the recycling of material (both by-product and primary product material) which would reduce the amount of virgin material (from extraction) required. Recycling can be increased by increasing the fraction of the product that is recyclable, increasing the % of the products that are recyclable that are re-captured through a distribution system, or by increasing the number of times a product can recycled before the material degrades.

To decrease the stock of waste, we could….

- decrease the waste flow (and its toxicity) by:
  - reducing the manufacturing waste and associate energy waste (both of the raw material itself and all the by-products)
  - decreasing any waste from the product while it is in use
  - decreasing the waste from products being disposed (longer product life, more recycling, etc)

- increase the assimilation rate of the waste back into the environment
  - by using materials that have fast natural breakdown rates (biodegradable materials, etc)
  - by using materials that are not toxic while they are in the environment
  - by making sure that we are not exceeding the capacity of the system to breakdown the waste and creating a “backlog” (for example, the concentration of biodegradable waste from large scale animal farms often exceed the capacity of the local environment, creating problems)