A Snapshot of our Economic System

We will develop a model of the economic system as it operates in first world countries. This model will help us to understand how the system works, how it interacts with the natural systems and how it is structured for perpetual growth rather than for sustainability.

The economic system does two things; it supplies us with goods and services and it provides us with a means to believe we merit those goods and services. It incorporates a community of systems; inorganic systems (including machines, highways and computers), living systems (including people, plants and animals), and belief systems (including skills and myths as colored by human emotions) which interact with and continuously modify one another.

Our model starts with the economic system's physical structure and the flow of goods through it. That physical part will subsequently be fleshed out with the living systems and belief systems which make it the most complex and interesting system ever developed by mankind. In another essay we'll trace the evolution of this economic system from its simple beginnings in loosely coupled hunter-gatherer societies to its present complex, global and highly interconnected condition. The evolutionary picture will indicate how a few dozen significant physical and mental innovations and the distribution of abundant resources evolved the system we have today.

Physical Structure and Material flow

Figure 1, illustrates the physical infrastructure of the economic system and the primary flow of goods through it. The dotted line represents a boundary between nature and the economic system. The oil rig represents the industries which extract raw materials from nature by pumping, mining, logging, lumbering, hunting, fishing and farming. The highway represents the transportation system of vehicles, roads, ships, waterways, ports, pipelines, railroads and airlines. The dotted path that connects the heads of the human figures represents the communication system of postal systems, telephone systems, education systems, books, newspapers, radio, television, internet and computers. The factory represents the manufacturing infrastructure which converts raw materials into products. The dump truck represents waste disposal systems, which return our wastes to nature. The smaller human figures represent people as workers and managers. The large human figure represents people as consumers, investors and government agents.

Materials flow from left to right. Resources are extracted from nature and transported to manufacturers who transform them into products, package them and re-transport them to markets where users purchase them, use them and eventually dispose of them. Waste management companies transport disposed products (including solid wastes and sewage) to remote disposal sites where they are returned to nature as solid, liquid and gaseous pollutants.

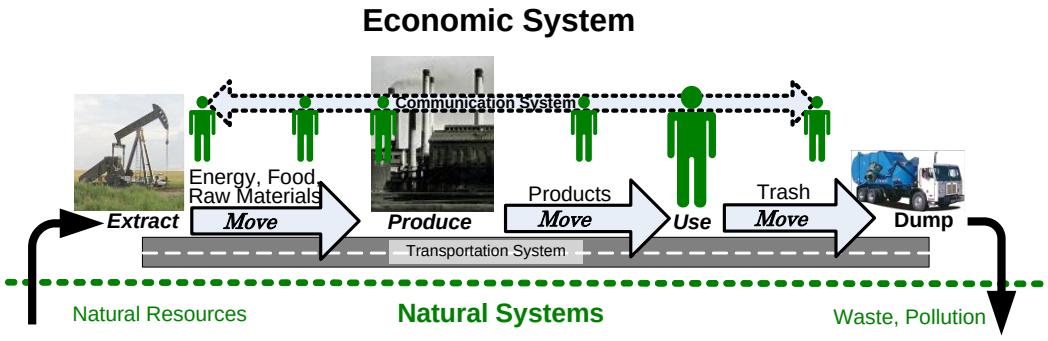

Figure 2.1: Material Flow in the post-industrial economic system.
Resources are extracted from nature and moved via a transportation system to businesses which turn them into products. Products are moved to markets where users buy them, use them and eventually trash their remains. The trash is transported to sites where it is returned to nature as waste and pollution. Information about the flow of goods is exchanged over a communication system. Those who use include consumers, investors and agents for the government. In the USA, consumers represent ~70% of users.

This simplified view omits some significant aspects of the actual system. For example, it doesn't specifically show the waste and pollution from the production, transportation, communication and governmental systems. It also doesn't show what happens to goods and services between the time they are acquired and the time they are disposed of. The simple reason is that these details don't change the basic picture. For example, consumers purchase, consume and dispose of food in a matter of days or weeks. They buy cars and homes to use for years or decades and often resell them to other consumers. Sooner or later cars are scrapped and homes demolished, completing the process as shown.

Since the economic system serves two functions, to supply goods and services and to provide a culturally acceptable means of meriting them, an individual usually acts in more than one capacity: as a part of the human infrastructure, as a consumer, as an investor, or as a government agent. The fact that two or more roles are interconnected within individuals significantly affects the dynamics of the system, as we shall later demonstrate.

Financial structure and money flow

Figure 2.2 adds the financial structure and the flows of money and credits to the physical structure and flows of Fig. 2.1. The dollar signs represent money and credit. The finance building represents institutions which manage money and credit such as banks, savings and loans, and credit card companies. The government building represents government agencies which partially regulate the flow of money and credit, such as the Federal Reserve. The communication infrastructure connects economic decision makers throughout the system. Financial institutions and government agencies operate through the communications infrastructure to exercise some controls on funds and funds flow, to siphon off some funds for governmental uses and to influence people's beliefs about capital and credit, their access to it and their uses of it.

Let's trace the primary flow of capital through this system. We'll start with Users. They drive the flow of products and the flow of funds when they buy goods and services. Each user transaction works like a dual pump, one pump pushes capital (or commits to push capital) from a user to a supplier while the other pump pulls a product or service from that supplier to the user. The collective transactions of users are the primary drivers of the overall flow of materials and money. Suppliers take the money they acquire from users, and in similar pumping actions exchange most of these funds for raw materials, for transportation, for wages and for taxes, and accumulate some of them as profits. Sooner or later, all funds wind up in financial institutions which redistribute them to the users' pool of earnings, savings, investments, credit and taxes, available for another go around. Governments partially regulate this flow of funds by controlling how much money they print and by imposing requirements on financial institutions regarding assets and debt limits and by setting some key interest rates for institutional borrowing.

The flow of funds effectively lubricates the flow of goods and services; however the two flows are quite different. Goods undergo a one-way flow from extraction to dumping whereas funds are completely recycled. Goods and services flow through the transportation infrastructure, whereas the vast majority of funds are transferred electronically through the communication infrastructure. It takes time and physical energy to move goods; it takes a negligible amount of time and energy to transfer funds. Goods and services will dissipate over time unless energy is used to maintain them. Goods require energy to construct and transport and some of them are lost as waste or scrap as they flow through the system. Eventually they wear out or breakdown and become unusable. On the other hand, funds not only recycle unscathed, they often increase arbitrarily and dramatically as they go around the loop. How this magic happens will be explained in the next chapter.

Waste Management

Figure 2 also shows a second flow of money from users to waste management companies so that these organizations will dispose of wastes in a convenient and timely manner. This money flow is relatively tiny, roughly 0.5% of the flow in the other direction. However, even this minor cost and the slight inconvenience of putting things in the trash or down the sink slightly discourages consumption and waste. This in turn impedes economic growth by reducing the rate at which we dispose of things and buy replacements. Waste management companies prosper as the volume of wastes increase. Consequently they do their bit to encourage consumers to buy and dispose of products by making it easy, convenient and cheap.

They have been effective. They maximize customer convenience by collecting all forms of waste in single containers. They minimize incremental costs to consumers by charging fixed monthly rates, by becoming ever more centralized and standardized, and by using the least expensive means of disposal, which is: to pre-compact all forms of waste into a single mass at curbside, including toxic waste and potentially recyclable waste, transport it to huge sanitary landfills, often hundreds of miles away, dump it and later bury it under a layer of earth. Governments have eagerly co-operated (to promote economic growth) by granting waste management monopolies, by enabling convenient if not socially desirable transfer stations, by minimizing regulations on collection, transporting and dumping, and by limiting waste management's liability for pollution to 30 years from the time a dump is filled. [1]

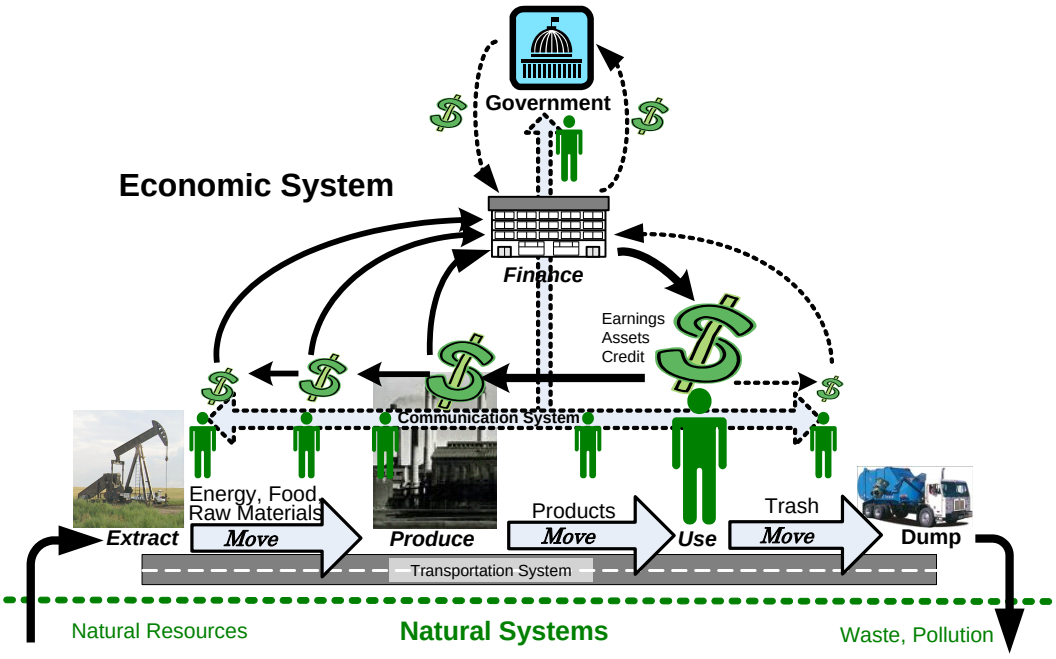

Figure 2.2: A flow of money and credit drives the flow of materials.
The collective buying action of users (consumers, investors and government agents) initiates exchanges of money and credits for goods and services. Later exchanges between producers, workers, and suppliers of raw materials drive some of the funds further up the supply chain. Eventually all funds accrue, through financial institutions, to the earnings, savings or credit of users, available for another cycle. Governments partially throttle the availability of funds by regulating financial institutions and by injecting or removing liquidity. There is a relatively tiny counter flow of funds from the users to those who transport and dump their trash. Note that "money" is completely recycled within the economic system while materials start flowing when extracted and stop flowing when dumped.

Flow rates

The flows of goods and services through the system are driven by the combined actions of consumers, investors and government agents. In the US economy, consumers drive about 70% of the total flow with investors and government agents accounting for the other 30%. Consumers buy goods and services to use. Investors "buy" in order to build, service or maintain the privately owned portion of the economic infrastructure in anticipation of future profits from consumer transactions. Government agents "buy" in order to build, service or maintain the public portion of the economic infrastructure, thereby insuring the public good and future tax revenues from consumers and businesses. Government services include programs for welfare and defense, which provide the necessary civic stability to enable a flourishing economy.

The rate at which consumers buy products is constrained by their collective beliefs about their needs, wants, competitive alternatives, assets, available credit, and their present and future earnings. These beliefs are not entirely rational or based on facts; they are largely myths shaped by culture, history, ignorance, and by marketing and advertising from suppliers, financial institutions and governments. These beliefs can be altered rapidly by emotions such as fear or desire.

Employees and managers in business and government believe that their organizations must grow to remain healthy and competitive. Their organizations, with few exceptions, have a chronic surplus of products and ready access to abundant sources of energy, materials, capital and labor. To help their organizations grow, they support well funded campaigns to promote consumer waste, disposable products, and deliberate product obsolescence. They also promote massive government subsidies for a global transportation system and for transparent economic borders that maximize the flow of goods.[2] Business and banking institutions also grow and prosper by expanding their markets to economies outside their homelands. These actions are wise and prudent tactics for the institutions in question in the context of the structure of the economic system, a free-market culture and a surplus of all resources

necessary to extract, produce and transport goods to the consumer.

For most of the last 300 years, and particularly since the end of WWII, industrialized economies have produced chronic surpluses of goods, services and capital. They have produced more goods than users needed, wanted, or could pay for and have created more credit than consumers and investors have earned. The chronic excesses of products come from a superabundance of raw materials and cheap energy (primarily from fossil fuels), a surplus of human labor, and advances in science and automation. The chronic excesses of funds come from processes that have been decoupled from physical constraints, like the gold standard of old, and from government policies that inject excess liquidity into the system to promote growth or to avoid recessions, and most of all from easy and impersonal credit based on historic models of risk and growth rather than on the credit worthiness of individuals.

Excess funds are systematically generated by Generally Accepted Accounting Principles (GAAP) and by institutions of credit such as the home loan and credit card companies. GAAP enables individuals and businesses to create wealth from nothing through mechanisms such as "good will" and "exploitable natural resources," and by periodically marking to market the values of real, personal and intellectual property. Credit institutions further inflate funds when they ignore credit risks and lend on projected wages or on 100% of market value for certain assets such as real property.[3]

These chronic excesses of goods and funds have made the consumer "king," both the primary engine and primary throttle for the flow of capital and goods. Although being king is comforting and ego satisfying for consumers, it is a source of anxiety, vulnerability and frustration for suppliers and for governments. To encourage consumers to buy their surpluses, suppliers maintain elaborate sales and marketing systems and provide easy credit. Financial institutions provide easy and ubiquitous credit and heavily advertise their loan products to encourage consumers to borrow their capital surpluses. Financial regulators, such as the Federal Reserve, inject funds into the system and tacitly permit shaky lending practices that increase tax revenues and encourage consumers to borrow and buy.

The combined efforts of manufacturers and financial institutions, cheered on by governmental policies, have been so successful over the last 60 years that a saving and recycling ethic, produced by a chronic shortage of money and credit during the Great Depression and chronic shortages of consumer goods during WWII, has been transformed, in just two generations, to one of borrowing, consuming and dumping. One result of this transformation is the systematic plunge in consumer savings. From the end of WWII until 1986, the US consumers' annually saved more than 8.5% of their income. From 1986 to 2006, as the Greatest Generation[1] retired, that savings rate dropped each year to reach a negative 1% in 2006! To make up for this savings shortfall our government, investors and consumers borrow from the rest of the world. Over the past 10 years the USA borrowed over $4 trillion from the rest of the world to finance its economic growth and flow of goods. In the year 2006 it borrowed roughly $800 billion to fund more than 7% of its GDP spending. Approximately half of these sums were borrowed by the Federal Government to fund its deficits, and the other half borrowed by consumers and investors.[2]

In spite of a transformation from savings to borrowing by consumers, manufacturers still have chronic surpluses of goods and services so that they must ceaselessly develop new products for old customers, encourage consumers to buy disposable products, promote ever higher levels of consumer debt and develop new customers and new markets by encouraging population growth and by supporting economic globalization.

The drive to promote consumption and waste is due to the structure of the economic system which requires growth to operate profitably. This need is merely augmented by human greed and shortsightedness.

Energy

The economic system is dynamic and requires a prodigious and continuous supply of energy to extract raw materials, to transport them to factories, to construct them into products, to transport them to consumers and finally to transport trash from consumers to dumping sites. People and animals supplied most of this energy until well into the 19th century, and their limitations dictated how much could be done and how much it cost to transport things by land.

Today, the primary sources of energy are engines powered by burning fossil fuels. There are three primary forms of fossil fuels: oil, natural gas and coal. Oil is the dominant source of transportation fuel because its energy content is high, it has been easy and cheap to obtain, and as a liquid at room temperature and atmospheric pressures it is easily transported and easily stored. However, we are using it faster than we are finding new sources and most of it comes from unstable and distant regions of the economic system.

Human Labor

People who operate machines are paid for their skills, not their physical labor. Machines have largely replaced the working poor. Machines can operate in miserable

[1] Tom Brokaw's name for the generation of adults who were raised during the Depression and fought in WWII

[2] Source: Bureau of Economic Analysis, *www.bea.gov*

conditions, receiving just enough fuel and maintenance to keep them going. People who are paid for directly providing physical energy, such as farm laborers, have physically demanding jobs that are less desirable, and poorly paid. Because few of us raised and educated within our economic system are willing to do these jobs, they are most often filled by legal and illegal migrant workers, people who reached adulthood outside this system, or by poorly educated people within our system who lack the skills for better jobs.

Perpetual economic growth

The postindustrial economic system, as it is today, requires perpetual growth in consumer demand to remain healthy. It's time to look at this in more detail. Factors which necessitate demand growth are: the need for full employment, the wish for an ever better standard of living, the desire for security after retirement, the need to increase profits, and the need to increase tax revenues without increasing tax rates.

In the normal course of events, any producer can and will systematically reduce the labor required to make a product. The reduction in labor comes through improvements in techniques and by replacing it with machines thereby increasing profits and making the producer more competitive. That means, however, that a constant demand for products eventually produces a decline in employment. However, a decline in employment reduces labor's access to capital which reduces product demand thereby further reducing employment. This is called a recession and during a recession, standards of living fall and many people are left in the cold.

Actually, the situation is even more dynamic. The market for any product has two phases: its growth phase and its saturation or steady-state phase. During the growth phase, demand increases rapidly as consumers become aware of the product and make their initial purchases. However, as the market saturates, demand drops off sharply and the rate of new purchases approaches the rate at which consumers consume or trash earlier purchases. In products such as automobiles, the annual trash rate is about 5% of the total in use. To grow the global automotive market, producers must either convince users to buy more cars per person or they must encourage population growth.

Growth is not merely an imperative for producers; it is an imperative for individuals as well. Many of us now count on increases in the value of our homes to fund our living standards and our retirement years. But property values ultimately reflect the supply/demand balance. Increasing property values require growing populations of ever wealthier people; or, as we have recently experienced, foolish lending practices which create unqualified buyers who drive up prices and are then unable to repay their loans.

Globalization

The majority of educated people and political leaders in advanced economies passionately believe that our economic system should become ever more global. They believe that a global system is the most efficient producer of material goods and will ultimately provide the highest average standards of living. They believe that a global economic system will promote international co-operation and eliminate wars. Some even believe it will spread Democracy; which they also believe is the ultimate form of government.

Globalization has been the official policy of our government under Republican and Democratic leadership, the World Trade Organization and the World Bank.

However, I propose that these beliefs in globalization are a matter of faith and not the result of careful analysis and planning; for they have do not explain what will happen when the system runs out of backwards economies to supply cheap labor and cheap raw materials; nor how it will be managed when energy shortages savagely inflate production and transportation costs, or how a global economy relates to manageable political systems, or how long it can last. But globalization advocates believe, on what might best be described as blind faith, that it will bring about the best of all possible worlds. I no longer agree with them or with globalization, and will make the case for a sustainable and healthy alternative in this book.

However, I have some empathy for these people; I was one of them for decades. As CEO of an electronics company I devoted considerable time in the 1980s developing international trade, particularly trade with China. Those efforts went well beyond stimulating more business for my own company. They supported free exchanges of technology and massive increases in levels of trade and were driven in part by my firm conviction that economic globalization would promote peace and prosperity. I still believe that there was some truth in that conviction, but only a temporary truth. The benefits of globalization and the benefits of growth are transitory, not sustainable.

Natural Systems

Our economic system utterly depends on natural systems for energy, raw materials, food and waste processing. Unfortunately we take nature for granted while we systematically abuse it and seriously reduce its capacity to provide any of these functions.

When we extract fossil fuels, and use energy sources that took millions of years to produce. When we mine, use once and throw away minerals, we consume something that

natural systems developed and stored over millions of years. When topsoil is lost to shortsighted farming practices, it will not be replenished within hundreds of years. When we extract fresh water (sometimes referred to as "fossil water") from aquifers, we deplete resources that frequently took thousands of years and an ice age or two to develop. Worldwide, we have already seriously depleted most major aquifers and we continue to deplete them at an ever increasing rate. [4-6]

We have already over-fished our oceans and depleted populations of species such as salmon, tuna and cod by over 90% and the global population of other edible fish by over 50%. Fish can repopulate themselves provided we don't continue to over-fish or destroy their food chains and habitats. Unfortunately, we have few safeguards to prevent over-fishing, or food chain and habitat destruction because our oceans are largely a part of the commons and not adequately regulated. Furthermore, advances in technology have enabled fisherman to efficiently hunt down and decimate fish populations anywhere in the ocean. We have already destroyed significant habitats through trawling and through pollution. [7] [8]

One example of the impact of pollution is a dead zone the size of New Jersey in the Gulf of Mexico between the mouth of the Mississippi and Texas. Fifty years ago this area was rich in sea life, but now its waters are deoxygenated as a result of pollution from farms and industry along the Mississippi river and its tributaries. Nitrogen runoff from farms (primarily growing corn for ethanol and export) and Phosphorous from industry feed algae blooms in the Mississippi river. The algae deplete the oxygen in the water before it reaches the Gulf of Mexico and where its outflow creates a dead zone. Dead zones like this are at the mouths of most of the world's major rivers, annihilating once rich fisheries.

Industrial agriculture is our modern means of extracting food from soil and fresh water. As we transport food from where it is grown to where it is ultimately consumed and disposed of, we remove nutrients that are essential to growing the next generation of food. In early agriculture food was grown locally. When soil nutrients were exhausted, populations either starved or moved. Many peoples recycled their human and animal wastes back to the soil to maintain its fertility. This practice was dominant in Europe and the United States until the latter half of the 19th century when chemical fertilizers began to replace recycled wastes, and when farms and consumers became too distant from one another for recycling. Now we transport fertilizers thousands of miles, from factories to farmlands and bury most food wastes along with all our other trash in landfills.

Logging depletes populations of timber, which to some extent can repopulate themselves provided we don't destroy the habitats upon which they depend. However, as in agriculture, either we or nature must eventually replace essential nutrients when we log and transport timber out of the forests. When we don't interfere with nature, essential nutrients are recycled locally to sustain fertility from one generation to the next. When we get involved, we remove and transport those nutrients to distant locals. Thus far we have done little to sustain the fertility of forestlands and we are systematically draining them of nutrients. In northern latitudes the soil often has large reserves of nutrients that can take centuries to drain. However, near the equator, rain forests are stimulated by abundant water and by constant and plentiful solar energy and almost all nutrients are in the plants, not in the soil. Logging, or simply removing large quantities of fruits or nuts, rapidly depletes fertility and undermines the web of life in these areas.

Transportation

A significant aspect of the post-industrial economic system is its transportation system. It is a system that has evolved in just the last 200 years from a collection of local communities connected mainly by waterways to a global network connected by roads, rails, pipelines, waterways and air. Today we transport most raw materials thousands of miles from places of extraction to the factories where they are processed; processing itself often involves several intermediate steps at different factories so that product subassemblies (including their packaging) are often transported thousands of additional miles from factory to factory. Completed products are then transported thousands of miles more and systematically distributed to consumers located around the world. Solid waste is transported hundreds, and sometimes thousands, of miles from users to dumping sites.

Cheap and rapid transportation is essential to the survival of this economic system. We have achieved it by building a global infrastructure of highways, waterways and airways that are traveled by modern vehicles powered engines fed by fossil fuels. So as to provide a rapid, cheap and massive flow of goods we have standardized our transport systems, attempted to minimize wars (at least in regions critical to trade and transport), attempted to rationalize governments (sometimes using external force), eliminated tariffs and regulations, and minimized border inspections.

Unfortunately, this transport system has also begun to homogenize eco-systems and induce mass extinctions by carrying hitchhikers (alien species of plants, rodents, sea life, insects and microbes) from native areas where they are kept in check by evolved natural systems to areas where they thrive without checks and balances. It facilitates smuggling and illegal immigration which on the one hand fills unattractive and low paying jobs and on the other makes it difficult to manage borders.

There are also technical weaknesses in the global transport system: 1) transport fuel must be cheap, compact, portable and easily transferred from suppliers to individual users, 2) transport energy is immediately lost and is unrecoverable, 3) transport vehicles create massive air pollution and contribute to global warming, 4) the system is extremely vulnerable to sabotage or political crises.

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