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article:

emerging economic sectors in the third millennium: *introduction and overview of the 'big five'*

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This introductory article, the first in a series of six, will describe the impending waves of economic activity projected to dominate the advanced economies over the course of the new millennium. Successive economic shifts suggest how investment opportunities and dead-ends, new growth sectors and declining ones, jobs and livelihoods, and the overall socioeconomic scaffolding of advanced nations will change in the centuries to come. This coverage will shed light on the changing landscape of economic developments, indicate a sense of timing and importance, and provide perspectives on new potentialities.

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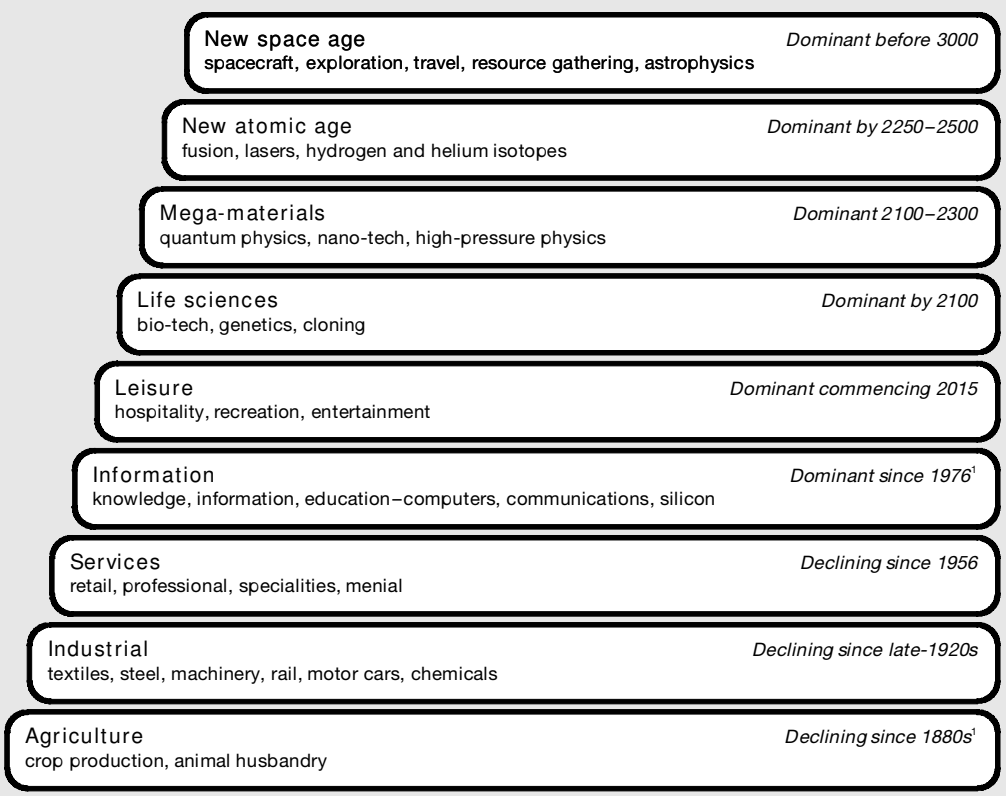
The much-discussed Third Economic Wave broke long ago. Actually, there have been four, not three, successive waves of economic development through which the USA and other advanced economies have progressed, so far. Each era was based on a different set of economic pursuits.

Past economic waves

Successive waves of economic change that dominated advanced-affluent nations and permeated every facet of society over past centuries include:

- *The agricultural age*, involved in wresting sustenance and livelihoods from the land. Jobs in the USA peaked in this sector during the 1880s.
- *The industrial era* focused on mass production of fabricated goods. Jobs in the USA peaked in this sector during the 1920s and have been declining since that time.
- *The service era* undertakings involved employing the skills of third party providers to render specialized expertise which the consumer could not perform so well or preferred not to do themselves. Jobs peaked in this sector during the mid-1950s.
- *The information era* technologies rely on intellect and knowledge that educate, entertain, and manage human affairs. US employment in this sector has been dominant since the late-1970s (see Figure 1).

Figure 1 Beyond the Third Wave – the nine eras of economic sector dominance



[1] Percent employment and/or GDP dominance/decline in comparison with all other economic sectors

Knowledge-education-information undertakings, essentially made possible by communication and computer technologies, are the current linchpins of post-industrial countries. Still reaching towards peak dominance, this current economic wave will begin to be eclipsed in as few as 15 years. Soon thereafter, it will be supplanted by another surging wave of economic activities. Less than two decades is a short enough span of time to start seriously thinking about what stands in the wings.

Coming economic waves: the big five

What should planners and policy makers be eyeing? What kinds of new economic activity come next? Where are the new investment opportunities? What training should tomorrow's workers be pursuing? Currently on the horizon are at least five economic fields of endeavour that will dominate jobs, economic output and GDP:

- The leisure era, centred on hospitality, recreation and entertainment, on the way to becoming the dominant sphere of economic activity beyond 2015;
- The life sciences era, acquiring dominance by 2100;
- The mega-materials era, achieving dominance between 2100–2300;
- The new atomic age, taking off between 2250–2500; and
- The new space age, commencing around 2500–3000.

Surprisingly, each of these economic mainsprings have been developing and gathering momentum for as long as a century! Careful research reveals that the roots of fundamental economic change take hold over decades, even centuries before breaking, reaching dominance and peaking. Each of the impending new economic 'centres of gravity' already are well into their early stages of development and drive toward dominance.

Ebbs and flows between economic sectors

As economic dominance shifts from one sector to another, the relative importance of activities associated with ascendant and declining undertakings also changes. Each one of these new waves of economic activity will enjoy a brief predominance, similar to the previous Big Four. Successive waves of economic activities, each in its own turn and time, will become the economic 'centre of gravity' of individual nations. Dominance will mark the time from which the particular economic undertaking becomes the modal or largest provider of employment. Shortly thereafter, that sector will account for the biggest share of gross domestic product. Eventually, it too will wane as a new centre of economic interest takes centre stage.

These changes do not mean that previous economic activities will disappear. Relative importance ebbs and flows between economic sectors. Looming changes brought about by these Big Five enterprises will promote as well as destroy jobs and earnings, re-shape economies, and affect the world economy. Declining sectors displaced by newer ascending technologies will be hardest hit. Organized activities involved in eclipsed sectors may simply become less important, as the onus of leadership passes to others that step in to take up where others falter or fail. Planning focused on where things are headed and assessing how to deal with massive change that accompanies such transitions is essential to help minimize dislocations. Survival of entire industries and future economic growth overall depends on staying at the forefront of emerging technologies.

Impending change and rates of progress can be presaged by tracking recent innovations in laboratories and amongst researchers engaged in staking out new frontiers, the proliferation of start-up enterprise pursuing cutting-edge ideas, accounts of public records of inventions and patent applications or grants. Assessing

the investments that risk-taking venture capitalists make – in anticipation of imminent breakthroughs which are likely to catapult a new wave of technology upon society – provides other glimmerings.

Long-term nature of economic development

Sudden surprises involving these impending economic 'centres of gravity' should not catch informed persons unaware. There are no 'discontinuities' in long-term perspectives. 'Agriculture', consisting of little more than mere scavenging, was underway by 3.4–4 million BC with the emergence of the hominid line, humankind's apelike ancestors. Organized foraging, hunting and gathering commenced around 2.4 million BC. Cultivation of crops began around 10 000 BC, domestication of animals by 9000 BC. Numerous incremental and defining, but only temporarily dominant, modes or emphases punctuate the course of time. The current changeover in agriculture involves the transition to genetic engineered cropping.

By the same token, 'manufacturing' of hand tools began about 2 000 000 BC, and 'production' of garments and textiles emerged about 100 000 BC. 'Services', including trade and discovery of new areas, was underway well before 10 000 BC.

Epochs of major economic change take a long time to build. They require even longer periods of time to accommodate and adjust to impacts imposed on socioeconomic systems. Over 100 years were required to develop and optimize contemporary technologies associated with taking the Industrial Revolution to its highest point. Working out the social and political impacts of the contemporary Industrial Revolution, still ongoing, has taken much longer. At least 250 years have been needed to discern these secondary effects, realize their significance, and take steps to contain or ameliorate adverse impacts. Anticipating wrenching change – whether fast or slow – enables informed decision makers to optimize the good and minimize the bad.

The point is that major economic epochs do not emerge suddenly as a 'bolt out of the blue'. Each of these entrepreneurial sectors already have reached milestones in their ascendance and been building momentum involving modern day permutations for thousands of years. Historical timelines, such as the ones indicated, are both awesome and humbling.

Nature of big five undertakings

Some activities and features of the impending Big Five major technologies soon to engulf advanced nations, reshape entire economies and drastically alter human life – each to be featured and explained in this series of five articles – include:

Leisure time era (commencing by 2015) – hospitality, recreation and entertainment. Leisure time pursuits have been a part of human activity from the very outset. The change about to be fully felt occurs when 'free time' dominates total individual lifetime activity.

Life sciences era (2100) – bio-tech, genetics, cloning, genetic engineering, transgenics, and 'pharming', among others. Theoretical underpinnings can be traced back more than a century. The pace began to accelerate with the human genome project, and it reached a dramatic turning point with the cloning of Dolly.

Mega-materials era (2200–2300) – quantum mechanics/electrodynamics/chromodynamics, particle physics, nanotechnologies, isotopes/allotropes/chirality, microscopic imaging and particle-resolving systems constitute the major core

technologies. This sector began to take off with the development of plastics, bullet-proof Kevlar, ceramic engineering, high-strength alloys, composites, silicon, super-alloys, fullerenes, high-temperature superconductors, sonoluminescence, superfluidity, crystallography, cryogenics, semiconductors, time/temperature/pressure variable materials, nanotechnologies, antimatter and designer materials of every sort imaginable.

New atomic age (2100–2500) – thermonuclear fusion, hydrogen and helium isotopes, and lasers constitute the key technologies upon which almost every energy-dependent activity will depend. Paramountcy of these activities looms every-closer as finite fossil fuels – first petroleum, then natural gas, and finally coal – are depleted. This era reaches its apex a century or more into the future. Roots of coming change, however, originate far back in time. Commencing with theoretical foundations, this early phase came of age with 'splitting the atom'. Early experiments that led to atomic fission were followed by development of fusion and thermonuclear explosives. Breakthroughs essential to harnessing fusion centre on advances in magnetohydrodynamics, inertial confinement techniques, laser-induced implosion and quantum physics.

New space age (2500–3000) – astrophysics, cosmology, spacecraft development, exploration, travel, and resource gathering are among the pivotal activities propelling this stage of development. The beginnings of this sector can be traced back to gunpowder and rockets developments over 2000 years ago. World War II rockets and jet aircraft accelerated the pace. Sputnik, spy satellites, manned space missions, extra-planetary probes and telescopic arrays that pierce the outermost limits of the universe are amongst the activities adding to the conquest of space.

Ebbs and flows within the agri-business sector

Agri-business undertakings, responding to successive waves of economic change, demonstrate changes that alter the basic activities associated with providing food and fibre.

During the Industrial Era, first the grain millers and merchants (the 'Fortune One-Hundred' companies of their day), and then grocery manufacturers dominated the post-farmgate sector in terms of jobs and GDP generated. Shortly thereafter, service providers (retailers and wholesalers) headed the list measured by downstream employment. Along the way, food services providing food away from home, accounted for most jobs. By 1998 over 50 cents of every US food dollar went for food consumed outside the home. Food services will continue to grow in importance during the 21st century as leisure time activities occupy over 50% of an average American's lifetime and dual-income 'fast-track' householders take less time to prepare meals themselves. Further into the millennium, the emerging life sciences sector – bio-engineered food production, including nutrient composition of crops and bio-remediation to solve pollution problems will dominate the agri-business sector.

Natural fertilizers gave way to agri-chemicals, which now are being replaced by life-science-based inputs. Cell biology, DNA manipulation, and biological alteration of foodstuffs already provide inbred resistance to disease, harmful insects and other plant hazards. This change lessens the need for 'blunderbuss' broadcast of agri-chemical inputs which contribute to excessive pollution run-off. Genetic enhancement of crop yields and nutrient profiles increasingly find their way into everyday foodstuffs and animal feedstuffs. Bio-technologies will dramatically transform not only agri-businesses, but mining, waste treatment and chemical manufacturing itself. Entire secondary industry complementary activities will be a part of these massive economic changes.

More speculative is the likelihood of sector dominance based on mega materials capabilities, including synthesized foods 'customized' to meet food and fibre uniquely specific needs of particular individuals, and food 'replication' using robotic nanotechnologies. Bio-reactors and hydroponics for growing key crop components or nutrients also will figure prominently in this transformation. Eking foodstuffs from the soil is likely to become just a food production niche, perhaps even a mere curiosity. The final phase in the projected five-tiered shift, the new space age, entails satisfying agri-business needs from extra-terrestrial sources produced on orbiting space stations or other planets. Around-the-clock solar radiation, shorter crop maturation cycles, and multiple cropping on a year-in and year-out basis will greatly increase yields.

The sharp decline in prominence of farm operations is vividly underscored by employment statistics past, present and prospective. During the 1700s, US food/fibre/forestry sectors accounted for over 90% of all jobs. By 1880, the proportion fell to less than 49%, plummeted to 27% by 1920, 6% by 1960, and about 2% by 2000. By 2010, a minuscule 1–2% will be directly engaged in agricultural operations and productivity will be so prodigious that as much as 60–80% of some key US crops will continue to be exported!

Farm employment, accounting for 6.3 million jobs, continued to dwarf combined downstream sectors of agri-business, as of 1960. All other post-farmgate or 'downstream' components provided fewer jobs than were found on farms. Among downstream activities, food manufacturers dominated, employing 1.8 million, compared to 1.7 million for food services, 1.4 million for retailers and 0.8 million for wholesalers. Dominance of farm operators waned, however, as the chain of goods and services provided beyond the farmgate grew.

By 1980, grocery retail jobs surpassed those for manufacturers. Grocery retailers employed 2.3 million workers; food manufacturing employed only 1.5 million. However, all 'downstream' components still accounted for nearly the same number of jobs on farms, which stood at 3.7 million. At that time, food service providers (a leisure/hospitality/recreation/entertainment undertaking), employed far more workers than food manufacturers and grocery retailers combined: 4.5 million for food services, compared to 3.8 million for food manufacturers and grocery retailers.

By 1991, the relative dominance of job distribution became more pronounced. The hospitality sector (eating and drinking places) with 5.4 million workers, very nearly accounted for more jobs than combined employment on farms (1.8 million, food products only), in food manufacturing (1.5 million workers), and in grocery retailing and wholesaling (3.4 million workers).

Transformation of 'economic mainsprings' in advanced nations

This article series is intended to encourage conscious focus on impending developments involving the changing composition of economic undertakings in advanced nations. Consider how companies already have been transformed in response to oncoming waves of economic change. For example, DuPont shifted from being an explosives manufacturer to a chemical/petroleum business and is transitioning into a chemical/biology company. Hastening to assure crucial petroleum feedstocks, DuPont acquired Conoco (ninth largest oil producer) back in 1981 during the OPEC energy crises. Responding, in part, to impending exhaustion of petroleum resources, the company's new emphasis on phyto-chemicals and life science technologies seeks to assure renewable and sustainable feedstocks that also are 'environmentally friendly'. DuPont's goals include increasing profits based on life sciences from 15–20% in 1997 to 30% by 2002. In like manner, Eastman Chemical, to assure feedstocks for selective chemical outputs, is shifting away from petroleum (almost certainly depleted in 63–100 years), to coal which will not run out for 230–500 years.

Petroleum companies facing impending resource depletion, huge economic scales of competition, globalization of world markets, and permissive antitrust regulation, have entered into a period of mega-mergers that radically alter the industry. The new 'big five' sisters are Exxon-Mobil, BP-Amoco/Atlantic Richfield, Royal Dutch Shell, Chevron, and Texaco (with likely further consolidations involving the last two mentioned companies). All these companies have been developing alternative energy sources. A forthcoming article in this series will suggest how virtually limitless energy demands will be met.

Downstream petrochemical manufacturing, like polymers and plastics, face wrenching changes in the aftermath of petroleum feedstock depletion. Monsanto long ago moved away from polymers and plastics and is engaged headlong into becoming a leading life sciences company. Both DuPont and Monsanto recently acquired or affiliated with firms focused on the very starting point for agri-business production – seeds. The overall intent is to develop seed, plants and animals into efficient 'bio-factories' of the future.

The foregoing descriptions demonstrate how sating essential needs, like food and fibre, have changed and will continue to change. Agriculture still makes important contributions to society and the economy. The shifts outlined indicate the kinds of change involved in providing for goods and services needs. Producing foodstuffs simply responds to new and more efficient ways of satisfying them. Keeping up with the times is the name of the game.

Patterns of change in other business sectors involve similar shifts and successions. Business activities do not remain static. They must either respond to changing business environments or get left behind.

Perspectives on change

Economic sectors, to remain viable, require both anticipating and taking steps necessary to accommodate change. Awareness of radical changes, especially in these fast-paced times, is imperative. The pace of change has accelerated to the point that forecasting change is becoming more than a 'nice to have' function. The trend, direction and speed of these shifts will be covered by forthcoming articles in this series.

Staying abreast of this change requires a keen sense of where economic undertakings are headed. Changes of an increasingly scientific and hi-tech bent require new kinds of expertise within companies. They call for more science-oriented expertise to understand and respond to company emerging needs, lest host companies get left behind in the dust. One purpose of these articles is to stimulate some overarching perspectives on millennial changes that suggest opportunities for keeping up with change.

The second article in this series will focus on leisure time, which encompasses diverse economic undertakings in entertainment, hospitality and recreation. By 2015, Americans will be spending over 50% of a lifetime pursuing these interests. The article will describe why and how this economic sector will become the economic 'linchpin' of society.