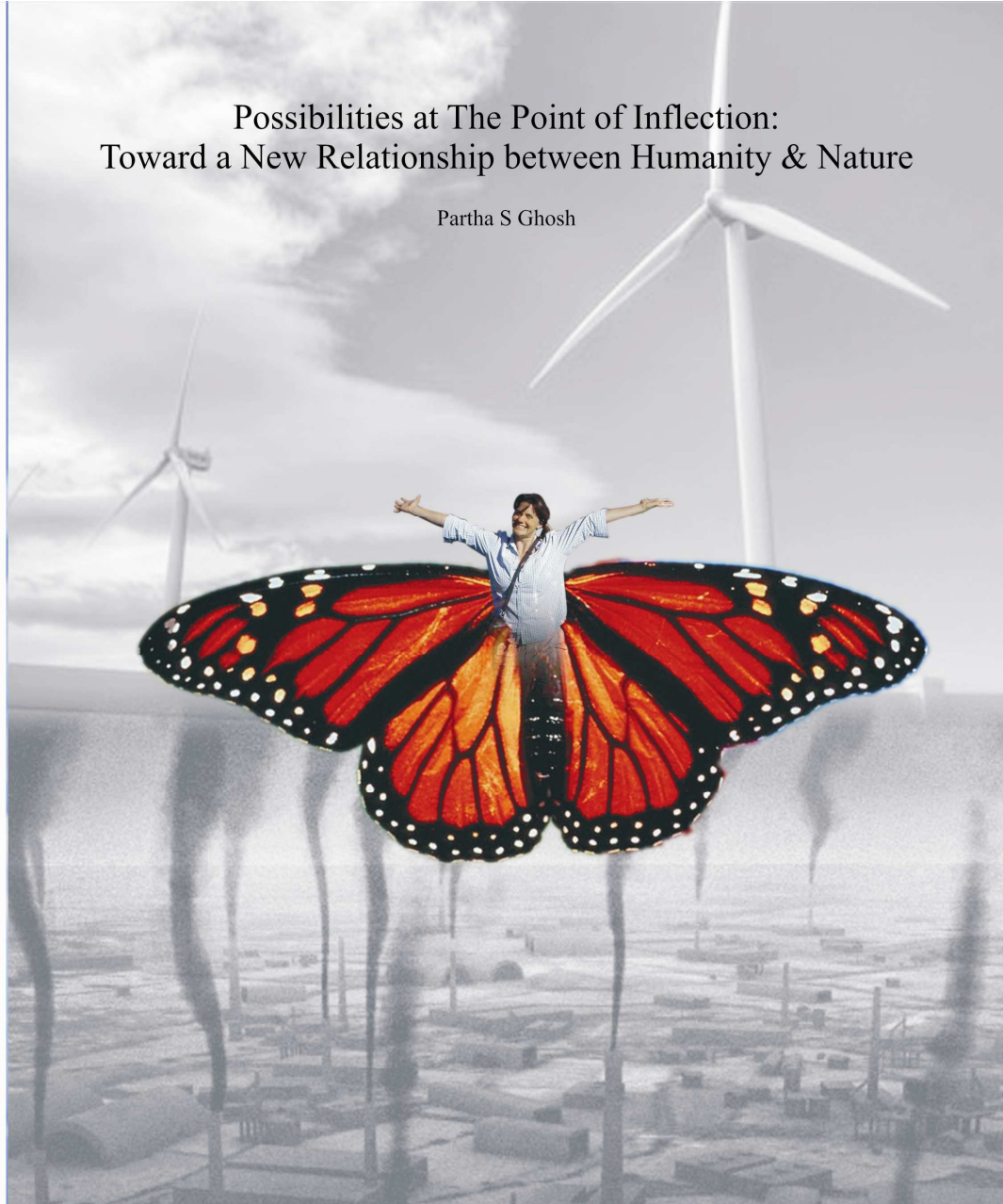


Possibilities at The Point of Inflection:
Toward a New Relationship between Humanity & Nature

Partha S Ghosh





The current global economic meltdown in the midst of accelerating imbalances in the 3Es, - *Energy, Ecology and Equity* while unwelcome, indeed *offers* an opportune time for us to step back and explore how the fundamental backbone of the global industrial world could be reinvented, and how our basic conscience that drives our consumption and resource allocation behavior could be reshaped and repurposed.

This reinvention of the future must help to facilitate a new relationship between human and nature, which is not *extractive* but *enriching*, which is not *consumption centric* but *conservation centric*. In the process social and economic structures will need to be reconfigured so that resource allocation process will become *more distributed/ decentralized* and value addition model could move from being *linear* to *circular*, possibly giving birth to new form of capitalism which I call “*cellular capitalism*”.

This discussion explores the “essential logic” that should harness the power of emerging bio, nano, info and opto technologies in harmony with each other and with traditional wisdom, - to drive the next era advancement of our civilization. After all life on our planet is a grand dynamic experiment; we might not know what the best answers might be to the emerging questions, but what we know that when human ingenuity has been put to creative work, our collective social intelligence has always uncovered *better ways of living*.

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There is an emerging consensus world wide, that the way the current global economic system has evolved in the last 500 years based on the extraction and processing of natural resources, that it is not sustainable. Particularly as the most dominant raw materials, crude oil and natural gas supplies are becoming increasingly limited, if we do not find alternative approaches to fuel economic advance, not only will current economic constructs of G8 will be challenged, and all the enthusiasm with the rapidly developing regions like Brazil, China, Indonesia, India and many others to undergo *over due* economic development, will be quickly derailed. In turn, international cooperative processes such as the institutional mechanisms (WTO, World Bank, IMF, UNDP etc.) for policy and monetary coordination which have been developing during the post World-war II and post Cold war era across national borders, will get severely strained, their credibility undermined, and their basic survival as a result, could well be threatened.

Energy and mineral resources politics has always been complex. With increasing shortages in midst of rising aspirations for economic advance in under privileged regions, the politics of earth's resources will become exponentially more complex and viscous. Resultant stress and strain on international trade and investments, and geo political equations could be significant, so significant that if not addressed in a preemptive fashion lot of the positive effects of socio economic advance due to the two industrial revolutions (*Steam engines in seventeen hundreds, Internal combustion in the nineteen hundreds and jet engines in the 20th century*) and recent information revolution (*The convergence engine effects*²) could get erased in a hurry, and new cracks in the geo political architecture as we know it today will appear and rapidly deepen and widen.

What is more challenging is that even if we had easy access to unlimited resources, the global economic system is at that stage of its development curve where the atmosphere and the ecological dynamics of the planet itself have reached a limit in terms of how much green house gases including carbon dioxide it could accommodate without seriously damaging the hydrosphere, biosphere, and geo-sphere. The recent increase in the frequency of floods and droughts, typhoons and tornados on the one hand, and the drying up of rivers and lakes (e.g., Lake Chad, Dead Sea), deforestation of the Amazon, and disappearance of snow-capped

²Economic value created through the convergence of the four Cs: Communication (broadband wireless connectivity towards "always on" infinite bandwidth), Computing (distributed embedded intelligence with increasing processing power for crunching of data/information real time), Content (interactive knowledge- informative to promotional) and Commerce (electronic and mobile, - enabling short and long micro transactions) leading to development of mobile 24/7 knowledge based services and businesses.

mountains in the different continents on the other, are just a few early signals underscoring the seriousness and complexity of the challenges ahead.

Especially for developing countries like Bangladesh and India, where the population density is high and seventy percent of the people live in the rural sector, the problem is even more serious and immediate. In fact estimates by various agencies indicate that, as global warming will hit hard the poorest regions of the world, close to billion people will be malnourished

Accordingly both on the supply and demand side of economic equations we need to change. *Change we me must*, not only for the short term by consuming less and/or by demanding more efficiency of what we use today, but also for the long term by inventing and putting in place processes which could fundamentally reconstitute our production and consumption instincts. Such a change cannot happen by simple linear extension of the current ways of being and economic thinking in the future, we must first envision a future with a zero base mind set, with *eco-neutral* resolve, and then work back to define the issues that we must address today.

Only, such an approach will give birth to a full range of new concepts of community, education, governance, health care, industry and work, which I believe will open up new wealth creation and employment possibilities that could not only offset the ill effects of the meltdown (economic and environmental) but create new growth pathways which could draw significantly more people from under privileged economic backgrounds in the global market place.

For example, through the renewal of Chemical Engineering discipline in integration with Information, Biological and Genetic Sciences for reinventing the 19th and 20th century industrial models for 21st century agro based development, which are energy efficient and eco friendly, - could not only create new jobs in the rural sectors world wide, but also accelerate wealth creation processes both in developed and developing regions of the world. Such a change over will require developing businesses, which beyond food and fibers are nature (renewable resource) based, are service focused to avoid extinction (disposable of non renewable resources) and enable extension of "*shortening life cycles*" of consumer durables. Most importantly, if engineered with open mind sets, the new dynamic could lead to development of a long over due "*equitable wealth creation engine*".

In order to achieve such a virtuous dynamics at the different echelons of value addition and economic being we have to drive the convergence of multiple disciplines of thinking and engineering with as much vigor, as we have to think of new "social constructs" with "out-of-the-box" possibilities with "*systems engineering*" rigor in our minds.



Structuring Choices at the Point of Inflection

In the recent years the initial signs of progress because of the initiatives put in place by Governments and businesses to move towards renewable energy resources and a more energy efficient eco friendly future are indeed encouraging. Energy intensity per unit GDP/capita has enjoyed substantive decline, and share of bio-fuels, geo-thermal, solar and wind although still small, is on the rise. While we must sustain our commitment to the next generation products and services, it is important to realize that just extending the current product concepts and social constructs which are more energy efficient and/or eco friendly while necessary, are not sufficient, definitely not sustainable long-term.

For example, with new hybrid or electric cars, while per car carbon foot print will definitely decrease, but if urbanization and motorization continue to follow the same linear path that we have followed in the last hundred years, absent fast and reliable public transport system, increased traffic, infrastructure and parking space requirements in emerging mega cities from Shanghai to Sao Palo, from Manila to Mexico city, will lead to a new category of issues related to traffic jams, parking space requirements in commercial centers, which could be costly and destabilizing, and could significantly slow down productivity gains as longer waits in choked city centers, could only shrink our productive time.

Similarly if our buying habits are only shaped by promotions such as “*buy three get one free*”, in perhaps more energy efficient super markets, our consumption behaviors become wasteful and often excessive. Average households tempted by such incentives end up making their living space become impulsive (sometimes decadent) consumption space, often only to help obesity and/or to downgrade the quality of living.

In order to break away from such trends, we have to go beyond “*doing more and better of the same, with less*”, so that we could give birth to fundamentally new social and economic constructs both at the macro policy and micro economic levels. In order to do so, I believe two types of strategic initiatives, not in isolation from, but in perfect sync with each other are necessary:

1. Short term “quick win” initiatives to do with less and more efficiently of the extensions of the same concepts of value propositions from the past
2. Longer term “change “ initiatives that will enable of development new path ways of social and economic advance

Below I have laid out a few initial ideas to illustrate the nature of changes we must consider which will enable quick wins, and yet be transformational.

Making Balance Sheets become more conservation inspired

If manufactures of all durable goods from batteries, electric bulbs, to cars and home appliances instead of selling the products they manufacture, rent/lease them to their users, new forms of business models could emerge, which might trigger a fundamental change in the behaviors and economic rationale both in manufactures as well as consumers. From accounting stand point the products will be treated as assets in the balance sheets of the manufacturing company, and the functionalities the products perform and the associated services will be so priced, - that they will constitute principal source of revenues. Such a shift in business model, as illustrated in exhibit 1, could lead to a range of high value added service focused opportunities which companies could participate in, while having transformational effect on how today's industries are structured and value propositions are defined, in turn develop eco friendly partnerships with the consumers.

Exhibit1: Knowledge Intensive services (holistic solutions) will help creation of New Industrial Ecologies

The Emerging Paradigm (illustrative not comprehensive)

	Old Paradigm	New Paradigm
Automotive	<ul style="list-style-type: none">Product Concept: • Typical Attributes of a carPricing Model: • Lease vs. buy (\$/unit)Industry Structure: • Vertical flows (provider centric)	Life Service Model <ul style="list-style-type: none">• Mobility (life cycle) experience• Service package (\$/m, \$/trip)• Integration of multiple value providers (customer centric)
HVAC Equipment	<ul style="list-style-type: none">Product Concept: • Hardware with 1 to 5 years warrantyPricing Model: • \$/unitIndustry Structure: • Scale driven	Service Model <ul style="list-style-type: none">• Home and/or office comfort• \$/month service fee per unit space• Solution/scope driven
Engines	<ul style="list-style-type: none">Product Concept: • Performance of source of powerPricing Model: • \$/unit for different HPsIndustry Structure: • Engine technology centric	Pay per use Model <ul style="list-style-type: none">• Power solutions• \$/power supply-cycle, \$/unit-time• Service/network centric
Pharmaceuticals	<ul style="list-style-type: none">Product Concept: • Unit dosagePricing Model: • \$/unitIndustry Structure: • Oligopoly around makers	Pay per prevention Model <ul style="list-style-type: none">• Cure of root cause• \$/cure, \$/treatment efficiency• Health solutions integrators (on and off-line)

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In fact, in the last ten years, a few forward looking companies have made impressive progress in this direction. For example, Interface, an Atlanta based company has a tradition of evaluating the life cycle impact of its products on the Earth from the raw materials to customer use patterns to the end of life cycle of its products, and in turn it recovers significant percent of its raw materials for entry into its manufacturing system. In the process company has successfully switched from selling carpets to providing carpeting services which is not only more profitable and eco friendly (as close to ninety percent of the polymers are recycled) but it also, in the process builds an annuity business model “locking in” the customers for the long-term, with emphasis on cooperative relationship, not on transaction oriented opportunistic interface, with its customers.

Fast Forwarding Fad in design and manufacturing philosophy: Since the early years of the 20th century as mass production gained in dominance, design philosophy has been essentially driven by how the point of equilibrium between flexibility (for customization), standardization (for mass production) is economically attained for securing competitive advantage. However in a resource constrained and eco sensitive environment we need to consider shifting toward a design philosophy which will (i) enable life cycle extension of products through *upgrades of only those components and functionalities which are influenced by technological changes, and (ii) ensure recycling of passive components (e.g. product-frames, chases etc.) at the end of multiple cycles of upgrades.* As products reach the “true end of the life cycle” state, Chemical Industry particularly in concert with Convergent industry (*product of convergence of computing, communication, content and commerce*) must find ways to develop processes which will enable each industry to recycle the atoms and molecules extracted from the nature in a cost effective fashion, while helping creation of product concepts whose life cycles are extended with continuous upgrades not by disposing of products, but enabling development of the functionalities which could be achieved through digital upgrades or easy to replace modules. For example in the mobile communication space Modu mobile (modumobile.com) upgrades the basic phone functionality with easy to replace modules so that without changing the whole mobile phone, users could leverage the latest technologies.

Reinvigorating the Agro sector with a wider and a bold vision: In parallel, leaderships of all the nations must commit to repurpose their Agricultural sector not only as source of food but as the source of a full range of raw materials which could serve as renewable resources for Construction materials, Chemicals, Dyes, Energy, Fragrances and Fibers, Polymers and

Pharmaceuticals. Today we understand the science behind most of the materials mother nature provides us, what we need to work on is how we apply our knowledge in biological, genetic and information sciences to improve the productivity of land for different climatic conditions, improve the yield of the desired active ingredients for different species that we cultivate, while preserving if not enriching the ecological balance. Particularly in those nations where a large percentages are still in the rural sector such a strategic shift is not only required from an ecological stand-point, it will also help the nations to activate their rural sector with a new vision. Such a vision will not follow the conventional urbanization route of economic advancement of the 19th and the 20th century, but it must activate each village to become value addition center of the agricultural/natural resource base of the local region and culture, in turn create self sufficient cells of economic activities, networked with other centers for efficient use of scarce resources and knowledge. In an era of broadband connectivity, it is a possibility that is a relatively easy to take realize, an avenue which we must not miss.³

³When established with respect for every person's fundamental desire for self expression in harmony with the local environment, and intelligently networked & socialized with other communities (much like the way www/internet has formed communities), a new form of “economic-ism” could indeed be in the realm of possibility, which I have often termed “X” ism: an “ism” which is at the cross roads of multiple disciplines, multiple lines of enquiry, and thought processes on socio-economic constructs.



Especially the nations in the tropical zones who enjoy biological diversity, extensive sunshine and rivers, if their leaderships view the potential of “eco-friendly economic dynamics” with a holistic, systems engineering and strategic perspectives, multiple industries could indeed give birth to economic models which could be a source of inspiration for other regions to draw strength from.

In moving forward with such possibilities, we must realize that for the first time in our history, humankind has arrived at a point which offers us a “generational opportunity”⁴ to fundamentally change the relationship of man with nature, to counter today's challenges of imbalances of the 3Es, and to explore the possibilities which are truly respectful of the divine potential of earth's fragile ecosystem.

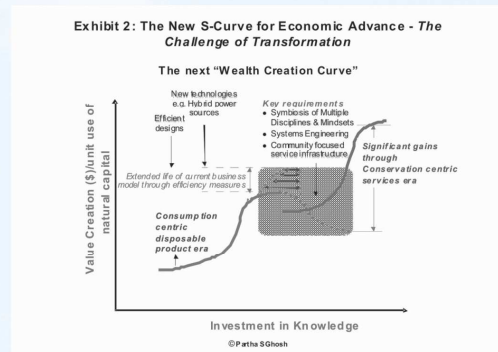


Exhibit 2 visualizes the nature of change that could occur if we undertake three distinct types of fundamental programs to (i) improve productivity of raw materials through improved use of functionalities of materials facilitated by “solutions selling” (toward enhanced conservation) (ii) increase efficiency of conversion through bio-mimicry and process intensification routes, and (iii) enhance usability of scarce resources through advanced recovery systems supplemented by an expanded and enhanced role of agro based industries.

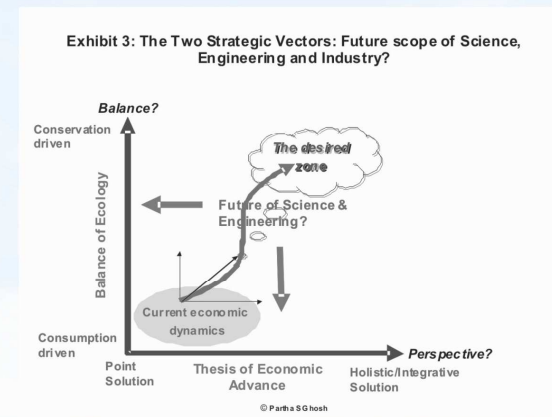
⁴By generational shift, I mean a discontinuous change in the ways we have evolved as a civilization, where our essential logic of development has been “human centered” celebrating Darwinian theory, as articulated by Spencer “survival of the fittest”, at the cost of undermining the “fitness of the whole”. I believe we have to now accept that the “fitness of nature” should be first revered, which in turn will drive the fitness of our advancement. In the same spirit, within the mainstream of our future economic rationale, we have to revive the principle with which Aristotle worked towards moral justice, fairness and ethics in the context of human interactions, and what Confucius (551-479 BC), preached and practiced such concern for the larger environment, what he termed as the Golden Rule: “What you do not wish for yourself, do not do to others;” “Since you yourself desire standing then help others achieve it, since you yourself desire success then help others attain it”, as much as we have to reposition the philosophy and teachings on “harmony with nature” in the Vedas, which developed in the Indo-Gangetic plain (more than 3000 years ago), - to enable the kind of generational shift that we require to undertake define and programs for the survival of our planet

Business and Industry, Academia & Governments in concert with each other have to develop a “disengagement strategy” from the extractive relationship we have with nature, to enable a new relationship which will fundamentally enrich the nature toward a better thermodynamic and kinetic balance of our creative process, self expression and consumption behaviors

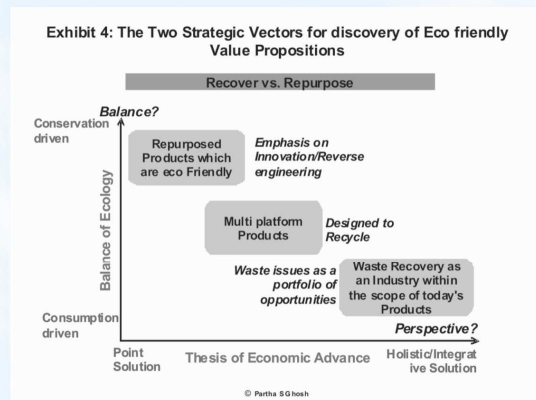
Waste of Nations: Accounting for the New Wealth

Indeed as modern civilization continues to uncover the laws of nature at an unprecedented speed leading to exponential growth of our technological power, today we do have the tools to launch and manage both - the disengagement process from the past, and the engagement dynamics with the future, in an economically viable and spiritually unperturbed fashion.

As the Exhibit 3 illustrates a framework that all industries both new and conventional could use to examine how their current value propositions and value delivery models could evolve along the two fundamental vectors: (i) *Balance of Ecology* and (ii) *Thesis of Economic advance*.



The *Balance of Ecology* vector (the vertical vector in exhibit 3) emphasizes how future value propositions could be weighted more toward conservation in contrast to one way consumption of resources, while the second one (the horizontal vector) captures the basic thesis of economic advance which leverages *systems engineering approach* to enable the development of integrative value propositions which are more holistic, not isolated remedies/point solutions.



The framework as shown in Exhibit 4 could help companies create multiple innovation platforms to transition their value propositions toward 3E friendly solutions. In view of the expanded space the two vectors help create, the Strategic degrees of freedom for almost all the industries to create value, - from Aerospace, Automation to Consumer & Office Electronics, from Home Appliances to Healthcare equipment, to identify and develop new wealth creation opportunities could indeed expand dramatically (illustrated earlier in exhibit 1). Indeed a conscious effort by leaderships of these industries to move up and move right along the two vectors (Exhibit 4) could lead to the development of innovative services which will enable energy efficiency and eco friendliness, while ensuring more responsible stewardship of hardware. So in short, eco friendliness does not mean we have to give up on economic growth, in fact we could *accelerate our growth, that too in a more equitable fashion*.

From linear to circular model: A play of 5Rs

In order to transition to the most desirable space in the expanded playing field (*the top right hand corner of Exhibits 3 & 4*) industries have to learn how to evolve and manage the development of a new industry which could create a full set of flows backward from users to providers. Building on the experience of organizations, to name a few, the likes of Waste Management (for collecting garbage), Interface (managing polymers of carpets as recyclable assets, and UPSs, Fedexes (helping companies deliver to, and pick up returns from, a diffused user base), companies will need to design creative ways of implementing five process steps, - the 5Rs: (1)

Reclaiming the products back at the end of the life cycle from user base (ii) Reverse logistics to move used products back to the manufacturer. (iii) Recovery of the most valuable molecules and functionalities from the used products (iv) Re-entry of the recovered resources to the manufacturing process and finally (v) Re-purposing /reconfiguring the re-entered resources with the current products (some times time lags between recovered materials/components could be ten years or more vis-à-vis the products which are in the pipe line) in the production process today.

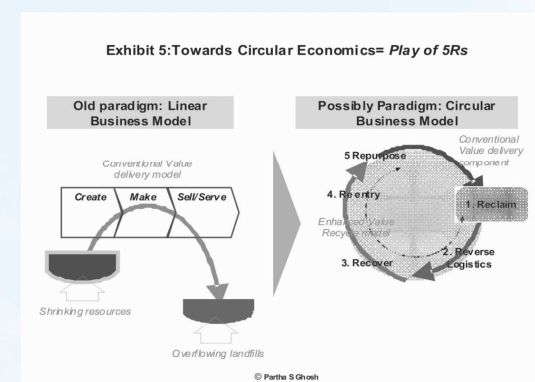


Exhibit 5 shows how different manufacturing industries could conceptually switch from a “linear -resource to landfill” model to a “circular” model while opening up the possibilities of new industries which could participate in any one or more of the 5Rs. Clearly chemistry and chemical engineering disciplines will have to learn how to mimic natural processes and in turn apply its rich knowledge base from unit operations, life sciences to surface properties of matter, in conjunction with information & communication services⁵ to recover materials from waste with as much innovative vigor, as was required to extract value from nature in the 19th and 20th century. In fact, in the recent years several University labs and start-ups have begun work in this direction, which could indeed help large organizations to close the loops of their conventional business processes.

⁵For example extensive use of RFID technologies to track products from factory to end of life cycle will enable more effective execution of 5Rs, in turn stewardship of nature's atoms and molecules, as our natural capital.

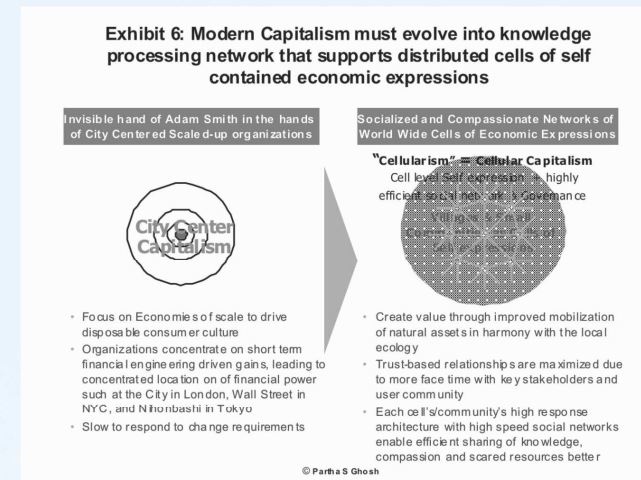
Demand side changes are essential

Although the supply-side changes may be slow in coming, the recent surge in activities partly boosted by the National stimulus packages around the world, will definitely help industries, - old and new to transition towards the new direction. Changes on the supply side alone are not sufficient. We have to make equally significant changes on the demand side, - buying and consumption behaviors, to move towards a dynamics - which will enable us to attain an optimal ecological equilibrium, - *however dynamic such an equilibrium might be.*

We have to agree to new forms of human interactions between work and home, education and entertainment, providing for more economic resiliency and community spirit, driven by new forms of public transportation system and/or new forms of community oriented work spaces, significantly reducing work related travel and logistics requirements.

In the same spirit, instead of being victimized by discounts promoted by “*economies of scale*” selling prompts, - such as “*buy three get one free*” when we really need one, if we take ten minutes walk to our local stores, and we only buy goods and services that we need, we might be able to break away from current rationale of “*economies of scale*” to create economies of “*small is beautiful*” and/or building on the Japanese manufacturing practices, *attain* economies of “*just in time*” at the household level.

In fact, for the desired supply side “conservation focused” circular model to work, demand side changes are essential, so that cellular structure of supply and demand relationship could indeed develop in small communities. For example, switching back to more frequent on foot/bicycle visits to the local store for small scale shopping will not only reduce our energy bill but will foster a more personalized relationship between the seller and buyer so that new forms of manufacturing and selling configurations could jive with our consumption and conservation behaviors in our kitchens and toilets. We must realize that how we separate and discard our garbage in the kitchen and/or the toilet could well determine the effectiveness of the *economics of the 5Rs*. Part 2 of this book highlights how many such little actions which are in place are changing our economic rationale/behavior either as a provider or as a user. Now, we have to bring together these ideas, and then codify, popularize, and institutionalize them at community, state, national and global levels of integration.

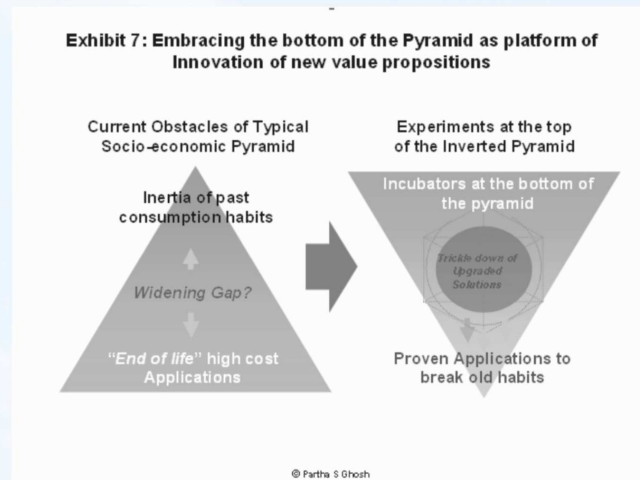


In the process, as shown in Exhibit 6 we could evolve an economic structure, where economic decision making instead of being concentrated in city centers could gradually get distributed in small communities in which the value creation and deployment ecosystem are in perfect harmony with the local resource base, networked (digitally and physically) with other communities for sharing of scarce resources and knowledge

Emerging Nations as *Incubators* new social constructs Not easy adopters of end of life cycle technologies

Clearly the opportunities ahead in repurposing today's delivery processes and value propositions which are all *3E sensitive* are significant. Equally challenging is the magnitude of the obstacles that we must overcome in order to address the issues, and to build consensus toward a set of well coordinated action programs. While the leaderships of advanced markets perhaps are more conscious of the fragile nature of the ecosystem of today's economies, the inertia and momentum of investment and consumption habits, in spite of all the incentives and penalties, will take time to change, - seriously increasing the possibility of our planet reaching an irreversible state of bio-chemical “draw down”, from where we could only move towards the collapse (*sudden death*) of our ecosystem.

So we must act now. And what better place we could begin the birth of the new concepts of economics and of living, -from *value creation to value delivery*, than those parts of the world which are least effected by the 19th and 20th century models. Although it underscores how modern economics has failed to spread the benefits of the marvels of modern technologies to large segments of the global population, it is indeed fortunate that close to three quarters of the world population is very little effected by the 20th century economic advance. So we have to relate with the bottom seventy percent of economy with a new perspective, as possible incubators of new economic models, such that as they are “proven-in”, they could ultimately get accepted by the developed markets.



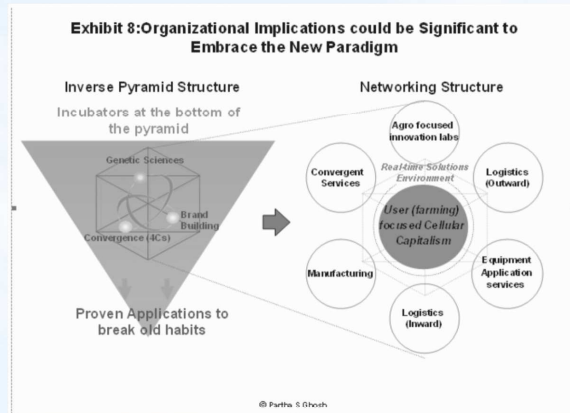
As the Exhibit 7, shows by inverting our conventional view of the economic pyramid (in which the distance between the bottom and the top has only been widening), visually and physically we could indeed view the bottom as a wide opportunity base, on which multiple new formats of closed loop - *value creation, value consumption and value recovery* could be experimented with. In fact, social and economic costs of these experiments could indeed be low, as in such environments inertia of old consumption habits is close to zero and labor costs are low; and as the experiments

succeed at the top of the wider base of the inverted pyramid (right side of the Exhibit 7), trickle down effect on the economic apex could be significantly faster and efficient. Endowed and privileged segments of society when they have access to new formats which are well proven, they turn out to be fast adopters, enabling them to disengage from the comforts of the old “3E insensitive” consumption models, thereby accelerating the transformation process, which we so much desire, but yet falter repeatedly

In order to create this global dynamic, we have to immediately focus our attention to those regions like ASEAN, Brazil, China and India who have developed the confidence to pursue their own development paths but are in a hurry to adopt the obsolete 20th century models from TIRAD (North America, EU and East Asia) markets. The leaderships of these regions must consider taking a break from the excitement of adopting consumption habits from the advanced markets, and instead develop and experiment with robust views of the likely future scenarios, which are more sustainable and equitable. In the process these economies may be able to leap frog into the future economic paradigm from where the more developed regions world can draw inspiration from, - to begin the *transformative shift*, while lesser developed nations will now have more sustainable and equitable models to follow.

Accordingly the leaderships of the BRIC nations in concert with the G7 leadership instead of just having extended discussions on how to tweak and refine carbon trading and greenhouse gas emission rules, governance and compliance processes of Kyoto protocol for example, should consider taking a holistic approach to the long range issues on the 3Es, so that a new vision of the global economic system emerges. In the process we could move away from the habit of creating isolated “point remedies” toward nurturing “dynamic & complete” solutions, which give birth to new socio economic, geo political constructs, and different roles different nations could play to incubate new ideas, fuse those ideas with the wisdom of harmonizing with nature as the old scriptures of different nations and faiths have underscored.

Exhibit 8 illustrates how through strategic introduction of new socio-economic concepts shaped by fusion of technologies could lead to cellular economic structures, while digital and physical networking will enable sharing of knowledge and scarce resources across communities world wide.

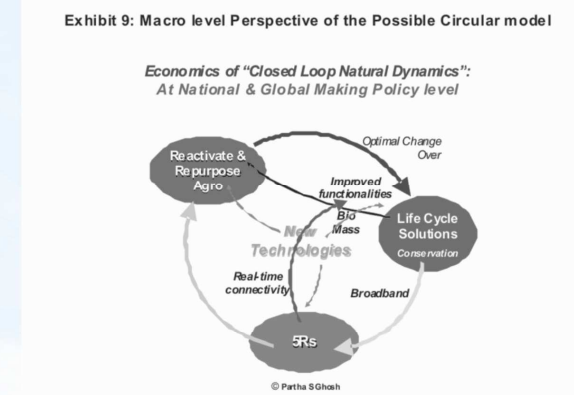


Each cell celebrates the power of self and local eco expression, while network enables the interconnectivity of our conscience for greater goodness to enable socialization of knowledge and sharing of scarce resources

In view of this perspective, as the Global companies engage with developing regions such as China and India, instead of just transplanting 20th century “3E insensitive” technologies, they could use the economic vibrancy of these regions to develop, experiment and prove in new business models. Indeed today we have access to a wide range of basic tools that we could mix, match, and mobilize to meet the new underlying demands of society. The future winners will need to develop the art and science of connecting different technologies with different demand side forces to create new business models.

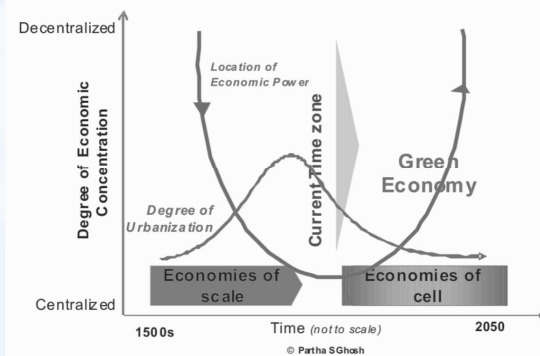
For example in serving the agricultural sector in developing regions of the world instead of just selling expensive seeds and/or pesticides which are “point products”, companies like Bayers, DuPonts, Monsanto could offer holistic solutions to villages including development of biofuels, fuel cells/solar energy, multiple crop systems both for improving the productivity of farmers and expanding the value propositions of their products. In the process multinationals could rationalize the wealth creation and distribution process of developing regions in such a fashion which will reverse the urbanization process which has become one of the choke points following the 19th century and 20th century industrialization.

The future winners will need to develop the art and science of connecting different technologies with different demand side forces to create new business models. It will indeed require tremendous courage and commitment for a small group of industry leaders, - to rise to the challenge, and direct their IP and capital resources towards alternative capital creation processes which are sustainable and will enrich the “natural capital” of the planet. *Both the invisible hand of the market in concert with strategic leadership of the governments* now have a historic opportunity to significantly shift the wealth creation equation to circular construct (Exhibit 9) at the macro level. At a policy making level nations must view the future economic architecture to enable - (i) Repurposing and reactivating the agro sector to play an expanded role as the source of renewable materials with high value added functionalities, (ii) renewing manufacturing sector as provider of life cycle solutions/services for customized value propositions, and (iii) developing a new set of industries eco-system around the 5Rs discussed earlier.



In view of the mega possibilities ahead and the generational change that we require, a vision of how the transformation process of our civilization that might emerge is captured in Exhibit 10. While the industrialization over the past 500 years led to urbanization in developed nations causing concentration of our economic decision making and resource allocation process, in the next 50 years to enable the shift toward better balance of the 3Es, given the technologies available and resources unavailable, we should consider to move towards a more networked social structures, leading to perhaps decentralization and diffusion of economic decision making.

Exhibit 10: Toward an Enlightened Civilization



Although much of economic thinking and decision making in the last 100 years has been influenced by “*economies of scale*”, I believe we are now at a point to embrace Joseph Schumpeter’s “*small is beautiful*” economic rationale as we move towards a more cellular structure, where non renewable resources are treated as reusable and recyclable assets, services around them provide growth opportunities, and renewable resources fuel the economic nervous system. What we need to understand and develop is what I will call “*economies of cell*”, in other words how to make small ecosystems of economic activities efficient and sustainable, and how each one should best interact with the others, - both digitally (for sharing knowledge, enable transactions) and physically to share scarce resources in a most optimal fashion.

In view of the above, to enable our civilization to move towards the new paradigm I have taken the liberty to highlight some of the guiding principles which we might consider debating and discussing to shape a more forward looking agenda:

1. All strategic initiatives undertaken by the G7 should include the viewpoints of other nations so that the action programs that emerge are naturally *all inclusive*, “*future in*” as opposed to “*current out*”; in turn cooperative processes between developed and developing regions should not be limited to how to constraint the business models of the 20th century, but how to incubate new models which are not limited by rules but

inspired by the possibilities of the new ecosystem that we could innovate and implement for a sustainable future

2. Policy frameworks that are adopted must ensure that a creative mix of *loose and tight properties* are developed and deployed so that some strict guidelines are adhered to in creating new economic constructs within a very flexible system which will draw free market capital towards newer, riskier, or unproven technologies. As alternative technologies are developed, instead of waiting to find which technology should be the winning one we must consider taking a *pluralistic approach* in pursuing advancement and commercialization of technologies.
3. In order to ensure that the size and complexity of the issues are contained, as much as possible efforts should be channeled toward the demand side of the equation to *shape consumer instincts*, - to reduce waste, enable conservation, and change consumption habits; most importantly education system along with engineering disciplines must be positioned to play a *lead role* as opposed to just a support role.

In order to celebrate the above thoughts a *dynamic partnership* between private and public sectors should drive the design of the working processes so that in turn they could trigger and track change within any nation and/or across nations. After all times of significant discontinuities, left to the free market alone, often our economic rationale get limited by today's financial frameworks and as a result while we might all we agree to the importance to think and act new, we end of chasing and serving the old.

Investment community must take a long term view to enable industry to unlock their knowledge assets in addressing long term issues and creating mega opportunities. When Apple launched the first personal computer, Microsoft developed MS DOS and subsequently when internet was rolled out, little did we realize how the digital economy will change the way we think, work and play, and little did we realize the trillion Dollars of impact the Information and Communication technologies will have on our civilization. Significantly larger will be the size of the economic impact of the transition process to the new eco system, which we must cultivate strategically, - *with wide angle lens, and through bold moves*.

In the same spirit, Engineering professionals must view their role with a wider perspective so that they can proactively shape outcomes, as opposed to being passive observers of outcomes influenced by those who may not have a full enough grasp of the engineering and scientific disciplines to make the difficult and complex choices related to 3Es.



It is my strong conviction that if in the next several years, we could organize different strategic programs we have discussed in this thought piece, and if we as a society do not get too much consumed by the 19th and 20th century economic and business models and short term business instincts, we could well lead a paradigm shift which our future generation will welcome. This shift must help nations and societies to make a fundamental shift from a linear economic model which is “*extraction-to-consumption*” centric to a circular economic model which is “*enrichment-to-conservation*” centric, - improving geo-political equations and saving the natural capital of our fragile but fair planet.





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