Resilience: Navigating toward a Sustainable Future

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The Need for Resilience

In today's tightly connected global economy, any strategy that relies on "steady-state" conditions will be challenged by chaotic external pressures and turbulent change. There has been a sharp increase in the number of natural catastrophes during the past 32 years—a trend that has been linked to climate change.[1] Other destabilizing pressures include rapid urbanization, resource depletion, and political conflicts. As planetary systems become more tightly coupled and volatile, the incidence of "black swan" events seems to be increasing.[2] These stressors have led to a rethinking of national security priorities and a new emphasis on resilience in both business and government affairs. Resilience is defined here as *the capacity for a system to survive, adapt, and flourish in the face of turbulent change and uncertainty*.[3]

The economy bears a striking resemblance to natural ecosystems, in which all species are constantly struggling for survival and growth. Living systems such as forests and wetlands are remarkably resilient, capable of recovering from severe damage. In contrast, systems designed by humans are vulnerable to natural disasters, technological failures, and other disruptions. When adversity strikes, we try to bounce back to a familiar "normal" condition, rather than considering how to adapt to the "new normal". Human society has much to gain from studying natural systems and learning how to design for resilience.

The National Academy of Sciences (NAS) has underscored the need to build greater resilience in U.S. communities, including flexibility, adaptive capacity, and infrastructure redundancy. One recent NAS study[4] recommends that the Federal government "incorporate national resilience as a guiding principle," while a second study[5] identifies "enhancing resilience of communities to extreme events" as one of four priority areas for interagency collaboration to improve sustainability.

This paper explores a variety of solutions for strengthening both resilience and sustainability in urban communities and industrial enterprises. Understanding the dynamic relationships among human and natural systems will help planners to develop more resilient strategies that reduce vulnerability to unforeseen catastrophes, enable continued growth and prosperity, and respect ecological resource capacity.

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Sustainability: A Hopeful yet Distant Vision

The need for a transition to a sustainable economy is becoming ever more urgent. The productive capacity of the planet is already stressed in meeting current demand for energy, goods and services, while billions of people remain mired in poverty, lacking access to clean water and afflicted with disease. According to the Millennium Ecosystem Assessment, the world's ecosystems are severely degraded[6], and many believe that the global economy has already "overshot" the Earth's ecological capacity.[7] Responding to these warning signals, a variety of "sustainability principles" have been proposed by organizations such as CERES[8], UNEP[9], and the Natural Step[10]. These principles share many common elements, including elimination of waste, protection of natural resources, and assurance of equitable opportunities for present and future generations.

Some futurists paint optimistic scenarios of a cooperative, harmonious global economy, with advanced technologies enabling efficient utilization of resources.[11] The Rocky Mountain Institute claims that investing in energy efficiency and renewable sources can eliminate fossil-fuel use for electricity, vastly reduce demand for liquid fuels, generate $5 trillion of economic value, and enhance U.S. competitiveness, resilience, and security.[12] Similarly, McKinsey has projected that improvements in resource productivity can lead to a more prosperous and sustainable economy.[13]

However, human foresight is imperfect, and unforeseen circumstances could invalidate these projections. As the world grows hyper-connected and the rate of change accelerates, it becomes increasingly difficult to extrapolate from current conditions and to predict the future with confidence. The last decade has witnessed a string of unforeseen catastrophic events, including a global economic meltdown, a volcanic eruption in Iceland, an oil spill in the Gulf of Mexico, a disastrous tsunami and power blackout in Japan. To anticipate such threats and assure a sustainable future, we and others have argued for a concerted effort involving collaboration between business and government:

"…it is essential to anticipate change, understand early warning signals, and take steps to avoid, reduce, and mitigate future problems. A new, more systemic approach to problem solving is needed to avoid unintended consequences, anticipate alternative future scenarios, and strengthen resilience in the face of uncertainty."[14]

Limitations of Risk Management

Risk is a powerful concept for dealing with uncertainty, and has proved useful in many fields such as insurance and geological exploration. For the U.S. EPA and other agencies, risk assessment has become the cornerstone of regulatory decision making.[15] In the business world, it is standard practice to appoint a Chief Risk Officer and establish an "enterprise risk management" process that involves risk identification, risk assessment, and risk mitigation.[16] However, while conventional risk management is well suited for familiar disruptions such as fires and equipment outages, the most damaging disruptions tend to result from low-probability, high consequence events that are difficult or impossible to anticipate, let alone quantify.

In the face of complexity and turbulence, when disruptions are often unknowable and unforeseen, risk analysis becomes intractable and traditional risk-based practices are no longer useful. For example, the World Economic Forum publishes an annual report on a broad range of risk factors that may hinder global economic development, ranging from climate change to technological failures to political unrest.[17] In recent years, the report has shifted from estimating the relative likelihoods and consequences of specific risk factors to portraying the network of interdependencies among these factors. The 2013 report acknowledges the importance of resilience for addressing risks that are difficult to predict or manage effectively. This reflects the increasing humility of managers confronted by a fluctuating risk landscape.

There are several key limitations to the classic risk management paradigm:

- Risks cannot always be identified *a priori*. As discussed above, in a turbulent world we are often vulnerable to unprecedented or unpredictable disruptions.
- Even if risks can be identified, lack of a reliable data-set often makes it difficult to quantify the likelihood or magnitude of the most significant threats.
- Risk mitigation and recovery practices, such as business continuity management, are typically aimed at returning to “normal” conditions. Instead, we should strive to learn from disruptions and adapt the system design to overcome potential weaknesses.

Nevertheless, risk management remains an important methodology for dealing with recognized phenomena such as fires, accidents, diseases, and currency fluctuations. To address less tractable uncertainties, risk management needs to be supplemented with new methods for resilience management. According to the NAS, risk-based methods are not adequate to address complex problems such as climate change and loss of biodiversity, and more sophisticated tools are available that go beyond risk management.[18] One example of such a tool is EPA’s Climate Resilience Evaluation & Awareness Tool (CREAT), which helps drinking water and wastewater utilities to anticipate potential threats associated with climate change.[19]

A Systems Approach to Resilience and Sustainability

Systems thinking is essential for understanding the broad forces that influence resilience and sustainability. We focus here on living systems, which are complex, adaptive, and self-organizing; examples of such systems are shown in Table 1. These systems may have feedback loops and emergent properties that are not evident from studying their components. For example, by pollinating flowers, bee colonies create a positive feedback loop that reinforces the production of nectar. Similarly, by supporting social and philanthropic activities, corporations strengthen the vitality of the communities to which their employees belong. Companies like Wal-Mart and Microsoft have been compared to an ecological keystone species, occupying the hub of a business network and improving the overall health and robustness of the network.[20]

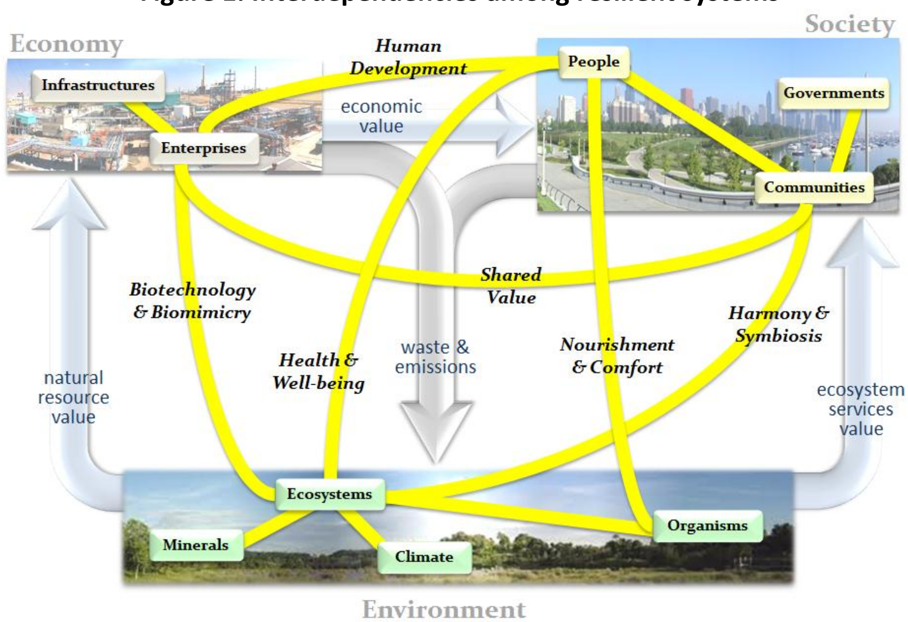
A systems approach is helpful for understanding the interdependencies among human and natural systems, and for identifying policies and practices that will help us make progress toward a resilient and sustainable society. For example, EPA has begun to use the Triple Value (3V) Model[21], depicted in Figure 1. This approach explicitly analyzes the stocks and flows of materials and energy, showing how industrial supply chains and human communities utilize ecosystem services to create value, and also generate waste and emissions that flow back into the environment.

Table 1: Examples of structure and function in living systems

System type	Structural Components	Functional Performance
Urban community	Built environment, infrastructures, and commercial, residential, or other occupants	Provide goods and services to support occupants' economic and social activities
Enterprise supply chain	Network of assets, suppliers, manufacturers, logistics providers, and customers	Fulfill customer demand through physical, informational, and financial transactions
Cattle-grazing rangeland	Organisms—cattle, vegetation—and vital resources—air, soil, water, sunlight	Nourish and sustain the web of interdependent living organisms

The yellow lines in Figure 1 indicate critical linkages among the economic, environmental and social spheres. In particular, the one-way concept of corporate social responsibility has evolved into an understanding of two-way "shared value" between communities and enterprises.[22] To achieve sustainability, we must protect critical natural capital, improve resource productivity, and avoid environmental pollution. But unexpected disruptions can injure our ability to pursue this vision. To achieve resilience, we must encourage diversity, robustness, and adaptability in both natural resources and human resources, as well as in governing institutions and supporting infrastructures.

Figure 1. Interdependencies among resilient systems



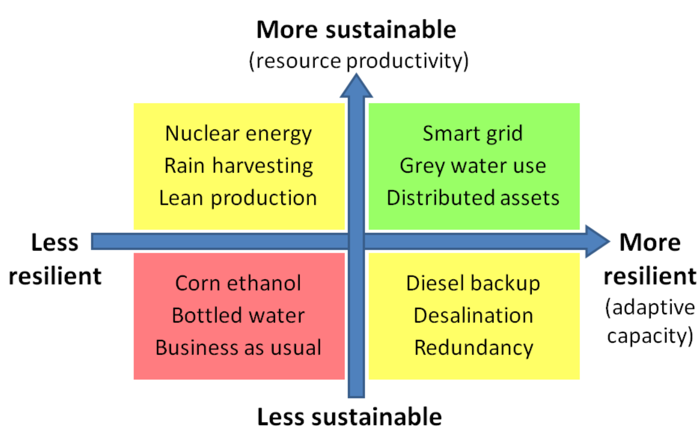
As summarized in the introduction to this issue of ***Solutions***, much has been written about the theory of resilient systems. The following sections illustrate the practical application of resilience thinking in the context of urban communities and enterprise supply chains. Table 2 lists some typical resilience indicators applicable to real world systems. There are many quantitative metrics that correspond to these indicators; for example, recoverability can be measured in terms of the time interval required to recover, the cost of recovery, or the maximum tolerable degree of disruption. Also, these indicators may be correlated; for example, stability, vulnerability, and recoverability are all dependent upon the fundamental attribute of *precariousness*[23], which indicates how close the system is to a critical threshold.

Table 2: Examples of resilience indicators in human systems

Indicator	Urban community	Enterprise supply chain
Diversity	Variety of economic sectors, resource channels, and workforce skills	Variety of markets, suppliers, facilities, and employee capabilities
Cohesion	Strength of community identity, social networks, and local coordination	Strength of corporate identity, stakeholder relationships, and collaboration
Adaptive capacity	Ability to rapidly modify urban services, standards, or management practices	Ability to rapidly modify key products, technologies, or business processes
Resource productivity	Quality of life (security, fulfillment) relative to ecological resource footprint	Shareholder value (profits, assets) relative to ecological resource footprint
Vulnerability	Presence of disruptive forces that can threaten public safety and well being	Presence of disruptive forces that can threaten business continuity
Stability	Ability to continue normal community activities when disruptions occur	Ability to continue normal supply chain activities when disruptions occur
Recoverability	Ability to overcome disruptions and restore critical public services	Ability to overcome disruptions and restore critical business operations

Generally speaking, sustainability and resilience are mutually reinforcing. The more sustainable we are, the less we expose ourselves to unpredictable disruptions; the more resilient we are, the less we risk compromising our future well-being. However, there may be trade-offs between resilience and sustainability; examples are given in Figure 2 for energy, water, and manufacturing. Some technologies and business practices are neither sustainable nor resilient; for example, corn ethanol provides an inferior return on energy and competes for agricultural resources that are critical to food security.[24] Other energy technologies, such as "smart grid", hold the promise of both increased efficiency and improved recoverability through distributed generation.[25] Rainwater harvesting is an appealing sustainability practice, but is vulnerable to droughts. Likewise, leaner production methods may reduce waste, but achieving resilience typically requires investment in reserve capacity—this is a fundamental cost-benefit trade-off for all types of systems.

Figure 2. Examples of synergies and trade-offs between sustainability and resilience



Resilience in Urban Systems

Cities are perhaps the most complex and turbulent of all human systems, yet they remain extraordinarily resilient. Like living organisms, cities have survived, adapted, and flourished through the centuries, overlaying different cultures, lifestyles and technologies in a rich and evolving mosaic. Today, cities are a crucible of change, where social, economic, and environmental pressures are intensified and the full range of sustainability issues converge.

More than 50% of the planet's inhabitants now live in cities—a result of steady migration away from rural areas and traditional lifestyles. Dozens of "megacities" support more than 20 million inhabitants, where wealth flourishes alongside poverty, crime, and despair. In such cities, the systems that supply food, water, energy, transportation, and health care are constantly stressed and often vulnerable to catastrophic failures. In the U.S., some cities have achieved revitalization, while others are plagued by urban decay and a flight to the suburbs. What all cities share are two basic challenges: balancing economic prosperity with quality of life (i.e., sustainability), and overcoming disruptions that threaten human safety and/or business continuity (i.e., resilience).

Hammarby Sjöstad, a suburb of Stockholm, Sweden, is an example of how systems thinking can help to develop sustainable and resilient communities. The goal was to build affordable homes that cut in half both energy and water use. Rather than homes operating independently, heat and power are provided by a central plant. Waste is sucked through a network of tubes, rather than being collected by trucks, and burnt in a combined heat and power plant to provide both electricity and heating. The wastewater treatment plant generates biogas from sewage and uses it to power local buses, while residual heat from warm wastewater is used for space heating.

Besides waste-to-energy, many other promising urban initiatives have been put forward, including smart growth, greener buildings, and vertical farming.[26] Innovative companies are entering this space and discovering new markets; for example, IBM has launched a worldwide "smarter cities" campaign using information technology to provide real-time intelligence. Through such initiatives, cities can serve as "living laboratories" to test innovative technologies or policies aimed at improving health, education, neighborhood stability, economic vitality, security, and safety.

U.S. Federal agencies, including the Department of Housing and Urban Development and the Department of Homeland Security, are similarly investigating community vulnerabilities and resilience improvement strategies. The combined pressures of economic growth, declining infrastructure, and competition for access to land and other natural resources pose a significant threat to energy and food security. National security is no longer merely concerned with defense of U.S. interests against hostile attacks, but also includes protection of our sources of food, energy, water, and materials, which are the foundation of community prosperity.[27]

In particular, many urban communities are concerned about the "stress nexus" that connects water, energy and food. Dwindling water resources threaten to disrupt energy and food production, while rising energy prices threaten to increase the costs of supplying both food and water. Moreover, all three of these critical resources are dependent on the availability of land, materials, and infrastructures, all of which in turn depend upon natural capital. There are also hidden feedback loops; for example, efforts improve energy resilience by producing bio-based fuels may conflict with assurance of a food supply. Few people foresaw that corn ethanol production in the U.S. might drive up food prices in Mexico, or that floods in the Mississippi basin might cause biofuel shortages.

To understand and manage such "wicked" problems will require a different approach to governance at the community and broader levels. Short-sighted decisions can lead to unexpected consequences and destabilization of existing systems. One recent report has proposed that governments can take a more adaptive approach called "anticipatory governance".[28] This will require improving foresight in the face of uncertainty, integration of multi-disciplinary knowledge into cohesive policies, networked coordination of governance bodies, and monitoring of consequences for purposes of adaptive management.

Box 1: Systems Thinking at a Regional Scale

The U.S. EPA has been investigating how a systems approach can help to strengthen community sustainability and resilience. Working with a variety of stakeholders, EPA is developing integrated regional economic models that are capable of anticipating emerging environmental issues and the potential consequences of policy interventions. For example, a Triple Value Simulation (3VS) model was developed for the Narragansett Bay watershed in New England to help evaluate alternative strategies for reducing nutrient pollution in coastal waters.[29] The health of the Bay is jeopardized by excessive releases of nitrogen and phosphorus from wastewater treatment, agriculture, stormwater runoff, and other sources. Excessive nutrient overloads cause algae blooms that can degrade or destroy aquatic ecosystems and interfere with fishing, recreation and tourism.

The 3VS model is based on an integrated assessment methodology called "system dynamics," and is designed to help policy makers and regional stakeholders explore a variety of sustainable and resilient solutions in the face of growing population and climate change. A user-friendly, dashboard-style graphical interface enables users to construct alternative intervention scenarios aimed at reducing adverse nutrient impacts to the watershed. The model then displays the simulated outcomes of these interventions in graphical form, projecting over a 40-year time horizon the expected changes in a variety of economic indicators such as tourism revenue, social indicators such as beach visits, and environmental indicators such as nutrient concentrations. This pioneering effort has yielded insights about how point source controls such as advanced wastewater treatment can be supplemented by less capital- and energy-intensive methods, such as "green infrastructure," to filter non-point pollution, attenuate stormwater and sequester carbon.

Resilience in Enterprise Systems

Most leading corporations have adopted corporate social responsibility and sustainability principles, helping to protect their reputation and license to operate. Nevertheless, many have found it difficult to translate broad goals and policies into day-to-day decision-making. One of the greatest barriers to adoption of sustainability is simply language. A "sustainable business" is expected to grow, but sustainability seems to imply resource constraints and *status quo*, rather than opportunities for continued innovation and growth.

Another, more challenging barrier is relevance. The abstract notion of protecting future generations seems remote in the face of contemporary business pressures, and some believe that expenditures on sustainability will diminish profits. While it has been shown repeatedly that improved efficiency and resource conservation reduces operating costs, the business case for sustainability often rests on enhancing intangible value drivers such as "license to operate".

Finally, a third barrier is turbulence—the inevitable short-term crises that distract businesses from their long-term goals. Companies are increasingly expected to disclose "material" risks that could affect their operations. However, many large corporations are slow to react to such risks until they reach a state of urgency and require a drastic response. In contrast, agile companies seem to thrive on chaos, discerning opportunities and consistently building shareholder wealth.

In the wake of disruptions such as natural disasters and power failures, resilient enterprises quickly recover and sometimes are able to gain a lasting advantage over their less nimble competitors. A classic example is Nokia's success in overcoming a March 2000 supply interruption that crippled its competitor, Ericsson, enabling Nokia to increase its market share in cellular phones. Scholars have defined strategic resilience as the ability to dynamically re-invent business models and strategies as circumstances change.[30] Others define resilience in more traditional terms that focus on business continuity—"the ability to recover from unexpected disruptions" including chemical spills, information technology failures, natural disasters, or terrorist attacks.[31]

The average life expectancy of large corporations worldwide is less than 50 years—in effect, most companies die prematurely. One study found four factors that distinguish longer-lived companies: sensitivity and adaptability to the business environment, cohesion and sense of identity, tolerance of diversity and decentralization, and conservative use of capital.[32] This suggests that a corporation be viewed as a resilient, adaptive organism rather than a machine engineered to deliver profits; in fact, resilience is essential for sustained profitability. Another study found that the main drivers of financial success were not technology-based but rather organic traits—achievement-oriented culture, flexible and responsive structure, clear and focused strategy, and flawless execution.[33]

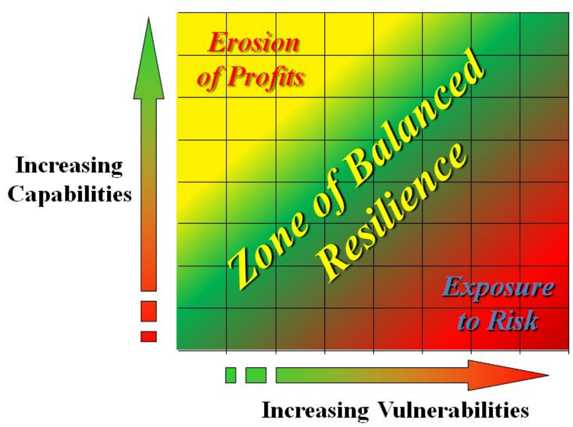
The 2013 World Economic Forum in Davos was marked by a new emphasis on "resilient dynamism" as a critical business imperative. Evidently, multi-national corporations have begun to recognize the need for resilience in a world of ever-increasing complexity, connectivity, and turbulence. The trends toward globalization and outsourcing have created complex supply networks that are vulnerable to many types of disruptions.[34] Economic volatility and international security concerns have only increased the likelihood of such disruptions. In the automotive industry, for example, companies discovered that the adoption of "lean" production systems, which are highly efficient in a stable environment, has increased susceptibility to business interruptions caused by schedule delays and other fluctuations (see Figure 2).

Major business disruptions are not always triggered by catastrophic events. In a complex supply network, small disturbances can occasionally cascade into massive discontinuities that have lasting impacts on the business. For example, a 2002 labor dispute in California shut down West Coast ports for several weeks, costing U.S. companies roughly $1 billion per day. Non-linearity implies that radical shifts can occur suddenly, when conditions reach a "tipping point." Unfortunately, the very system complexity that generates these disturbances makes it virtually impossible to predict their nature or timing. Smooth changes can usually be tolerated by adjusting the system behavior, but real systems don't have smooth curves. In this light, the challenge is for companies to design their products, processes, and operating practices to be *inherently resilient*, as discussed below.

Box 2: Supply Chain Resilience in a Global Enterprise

Nowhere is the importance of resilience more evident than in the field of supply chain management, where the weakest link can interrupt the entire chain. Supply chain disruptions can cause an immediate sharp decline in shareholder value, and some companies never fully recover. The Ohio State University (OSU) has developed a framework for supply chain resilience based on a "business fitness" index that compares *vulnerabilities* to *capabilities*.[35] Vulnerability factors include turbulence, deliberate threats, external pressures, resource limits, sensitivity, connectivity, and supplier/customer disruptions. Capability factors include flexibility, capacity, efficiency, visibility, adaptability, anticipation, recovery, dispersion, collaboration, organization, market position, security, and financial strength. OSU's research suggests that supply chain performance can be measurably improved when the portfolio of capabilities is correctly balanced to match the pattern of vulnerabilities. As shown in Figure 3, highly vulnerable companies with inadequate capabilities may be at risk; conversely, companies with unnecessarily high investment in capabilities may erode their profitability. This approach has been successfully adopted by Dow Chemical and others.[36]

Figure 3. Supply chain resilience framework



Design for Resilience

Improving resilience in both communities and enterprises will depend on innovation in the design of products, processes, and infrastructure systems. Over the last several decades, the scope of design has broadened from a focus on the artifact (building or product) to an integrated view of the system in which it operates, including broader concerns about unintended environmental and social consequences. Design for resilience (DFR) is a further step in that evolution, concerned with the fitness of products, processes, buildings and infrastructure for a changing environment.[37]

As suggested in Box 3, there are many possible approaches for companies as well as communities to pursue DFR innovations. For example, a collection of distributed electric generators (e.g., fuel cells) connected to a power grid provides "structural" resilience, since it can compensate for disruptions to a central power station. Similarly, a geographically dispersed workforce is less vulnerable to catastrophic events that might disable a centralized facility. Alternatively, flexibility of operating facilities and versatility of employee skills are examples of "functional" resilience that strengthen the ability of an organization to overcome interruptions in critical resource flows.

Box 3: Principles of Design for Resilience

1. The resilience of human systems, including communities, infrastructures, and enterprises, may be jeopardized by biophysical and socio-economic constraints and/or disruptions.
2. Human interventions, including policies and technologies, can improve the ability of a system to remain in a desired state or enable the system to shift to a preferred state.
3. Indicators of relative resilience can be defined for specific categories of similar systems, thus enabling system comparison, monitoring, and adaptive management.
4. Human foresight about potential future disruptions can guide the selection of a portfolio of interventions that maintain and/or strengthen the resilience of managed systems.
5. Even in the absence of foresight, it is possible to increase the "inherent" resilience of a system by improving characteristics such as diversity, dispersion, flexibility, redundancy, and buffering.
6. Additional information about the probabilities and/or consequences of specific perturbation scenarios can support the application of risk assessment and management methods.
7. Resilience is a necessary but not sufficient condition for achieving sustainability; in particular, there may be trade-offs between short-term resilience and long-term sustainability.

DFR will help an enterprise or a community to strengthen its position with respect to the network of interdependent systems in which it operates. As observed by strategy expert Michael Porter, growth and prosperity are linked to the health of the "competitive context", the social and environmental assets that provide employee talent, market demand, and a reliable supply of materials and energy.[38] Any type of product, process, or service innovation can influence these linkages in numerous ways. Thus, "design" is more than just creating an artifact; it is a deliberate intervention within a complex set of relationships.

One important design principle for DFR is "inherency"—making resilience a natural property of the design rather than an added feature. For example, in emergency operations, a decentralized, multi-agent communications system is inherently less vulnerable to disruption than a centralized system, even though the latter may have invested in costly "fail-safe" technologies.

Possible targets for DFR interventions include the following.

- Improving the foresight, productivity, agility, and effectiveness of business processes, from order fulfillment to knowledge management. An example is improvement in demand forecasting using artificial intelligence tools to interpret early warning signals.

- Improving the quality, reliability, productivity, capacity, and adaptability of available resources, including human, ecological, structural, and technological assets. An example is designing closed-loop production processes that recycle industrial waste and/or process water, thus conserving resources while reducing dependence on external supplies.
- Improving collaboration, creativity, communication, and credibility in the context of key stakeholder relationships, including employees, suppliers, contractors, customers, investors, regulators, communities, and advocacy groups. An example would be pursuing stakeholder engagement around climate resilience and adaptation strategies.

Above all, DFR requires systems thinking, since the health and vitality of a community or enterprise depends on the three types of capital identified in the Triple Value Model—human, natural, and economic capital. Therefore, companies and communities that wish to assure their resilience must reach beyond their own boundaries, develop an understanding of the intricate systems in which they participate, and strive for continuous innovation and renewal.

Conclusion: Toward a Sustainable Future

Sustainability is often misinterpreted as a goal to which we should collectively aspire. In fact, sustainability is not a reachable end state; rather, it is a characteristic of a dynamic, evolving system. Long-term sustainability will result not from movement along a smooth trajectory, but rather from continuous adaptation to changing conditions. Therefore, a sustainable society must be based on a dynamic world-view in which growth and transformation are inevitable.

Resilience is a fundamental attribute of living systems, enabling them to resist disorder and thrive in an ever-changing world. As systems grow larger and more structured, their resilience can wane, making them vulnerable to external disruptions and internal decay. For both communities and enterprises, a resilience mindset involves embracing variability rather than struggling to maintain constancy. Instead of resisting deviations from a "normal" state, resilient organizations recognize early signals of change and respond swiftly to maintain their performance and continuity. At the same time, their planning horizon must be long enough to support sustainability aspirations and to consider the trade-offs between short-term gains and long-term outcomes.

A systems approach reveals how enterprises and communities are linked to the environment, and how they can flourish in harmony with natural systems. We are beginning to understand the resilience of these systems, and to study their cyclical patterns of growth, collapse, and renewal. But traditional modeling and forecasting tools are only valid in small regions of time and space where conditions remain relatively constant. Research is needed to develop more robust, dynamic models of resilient systems, enabling us to better prepare for extreme disruptions.

Finally, it is important to understand the limitations of resilience thinking:

- Resilience is essentially an amoral concept; it is entirely possible for highly resilient systems (e.g., dictatorships) to violate core human values. The primary motivation for survival and growth must be supplemented by a commitment to justice and human rights.

- Resilience is typically utilitarian in the pursuit of persistence and performance. It preserves the system function and identity but does not necessarily consider whether the system has a transcendent purpose such as creating value for society.

The world will face daunting challenges in the decades ahead: population will grow to 9 billion people, with an increasing majority living in cities, and the pressures on natural resources will continue to mount. To sustain a growing, vibrant economy will require transformative innovations in urban planning, industrial technology, and environmental policy. Business and government must become stronger partners, and better communication will be needed to help citizens understand the complexity of these challenges. In the "new normal" of turbulent change, we must learn collectively to become more resilient in order to assure a safe, secure, and prosperous future for ourselves and future generations.

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