



# From societal fragility to sustainable robustness: Some tentative technology trajectories

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## A B S T R A C T

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Centralization of production has allowed great increases to efficiency, and specialization has allowed advances that would otherwise be almost impossible. But centralized production leads to long supply lines, and specialization causes decreased accessibility of alternatives; together these increase the consumers' vulnerability to disruption of access to essential goods and services. Assessing these vulnerabilities and making at least preliminary proposals for amelioration, is a topic of this paper. Initially, the functional needs of individuals are reviewed and classified. The paper then reviews and attempts to quantify the vulnerabilities associated with present approaches to meeting those needs. Having identified both specific vulnerabilities, and common factors associated with vulnerability, the paper then considers some general principles for increasing technological and social robustness. With vulnerabilities and indicative principles for improved robustness identified, some coarse but illustrative technology trajectories are proposed. The paper covers a broad scope in limited detail: it is presented in the hope that real advance towards a more robust and decentralized sophistication can be encouraged.

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## 1. Introduction

### 1.1. Vulnerability described

#### 1.1.1. General

There is an old adage that “any city is three meals away from anarchy”. Some slight exaggeration may be detected, but the plight of an urban apartment dweller is certainly severe when suddenly deprived of cash-dispenser, supermarket, running water, sewage systems, power and communications.

#### 1.1.2. Centralization and specialization are associated with vulnerability

A neighboring rural town expects a major earthquake in the foreseeable future. At a public meeting to review disaster preparations, residents initially expressed confidence in

their communications security – noting that Internet, landline, and cellular phones were available. Residents were less confident when told that the communications for every one of these, plus the point-of-sale terminals and the Automatic Teller Machines were ALL carried via a single fiber-optic cable. They might also have noted that almost the entire communications volume depended upon one operating system, one brand of router, TCP/IP protocols only, a single DNS system, and one of only two undersea cables connecting to the rest of the world. [1]. Predictions of the collapse of financial systems were made before the new millennium, but the events starting with the American mortgage issues in 2007 have reminded us of how centralized, interconnected and ubiquitous our financial systems are. “Financial products” designed (badly) in USA cause business failures in Dunedin, and individual bankruptcies in Cape Town. Citizens with few options for storing their savings deposited them with “reputable” financial institutions only to find that their savings had vanished! Our centralized systems for distributing goods is dependent on

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transport fuel – yet most countries have few if any sources of crude oil, few ports capable of offloading tankers, perhaps only a single refinery, storage of less than 90 days, and long fuel distribution chains [2]. The very high market share of one computer operating system and software bundle has allowed relatively simple exchangeability of documents in the short-term, but causes users to be “locked in” to facilities that will inevitably be deemed obsolete: This creates a significant risk that information will be lost in the medium term as these proprietary systems cease to be supported. Electricity is the most ubiquitous energy carrier for stationary applications; Centralized power generation has minimized costs but at the expense of long distribution paths, and power grids that require progressively more stringent measures to remain stable.

We can remember that whenever a monoculture thrives, there is increased risk of an “explosion” of those who prey on it: The increased efficiencies of production that have allowed *Homo sapiens* to increase, have also resulted in our increased dependence on a progressively optimized but less diverse food sources, e.g. Rice, wheat, corn, potato, sheep and cattle. We have already seen evidence of threats (the Ug99 strain of the killer wheat fungus, potato blight), and know of the potential for yet-to-emerge insect, bacterial and viral threats. This principle is not limited to our food sources: *H. sapiens* is one of the largest monocultures, and direct threats to our species include old diseases e.g. smallpox, plus emergent diseases e.g., a mutated H5N1 influenza virus – and potentially many other natural and unnatural pathogens.

#### 1.1.3. Vulnerability widely recognized

Societal vulnerabilities are recognized quite widely – academic writers [3,4] have explored particular aspects, novelists have based apocalyptic works upon them, and one suspects that think-tanks have produced, but never published, analyses of national vulnerabilities. It is also reasonable to suggest that the rise of “survivalist cults”, “back to nature” and “self-sufficiency” movements, are each reflections of a poorly-articulated awareness of societal fragility.

#### 1.1.4. Vulnerability through lack of responsiveness

The centralized creation of consumables, and their distribution, are generally only efficient when broad-reaching polities of law and commerce were also stable: That “stability” has almost intrinsically reduced the speed of adaptation. A topical example may be seen in the greenhouse gas reduction negotiations: Our production systems promote global warming – yet precisely because of the lack of adaptability of these centralized systems, proposals to reduce greenhouse gases become mired in a morass of competing interests and arguments.

#### 1.1.5. Social effects

The focus of this paper is on technical issues of societal fragility caused by centralization, specialization and interconnectedness of supply chains: There are also, however, important sociological issues that arise from the same phenomena: Simplistic economic theory proposes that competition will control the abuse of market power – but centralization and specialization are inherently trends

towards decreased real competition – and one can readily observe examples where centralized and specialized services experience little real competition. Whenever consumers are highly dependent on the availability of particular goods and services, the suppliers acquire considerable power to dictate prices, terms and conditions. The tendency for large monocultures to encourage natural predators has been mentioned already, and large concentrations of people and centralized infrastructure certainly offer “juicy targets” for those intent on destruction. Tainter [5] argued that the societies collapse when the costs of maintaining the society exceed the marginal benefits to citizens: he envisioned that “cost” would be counted in terms of taxation and bureaucratic overhead; but distasteful invasions of privacy, constraints on freedom and burdensome legislation to control the “predators” are also significant costs.

#### 1.1.6. Gains and costs

It would, however, be naive to ignore the societal advances that have been made possible by optimized, specialized, and centralized capabilities: Life expectancy has improved with better food production [6]; healthcare has improved, infant mortality has decreased, and our lives have been enriched by access to knowledge, culture and communication. Few would willingly sacrifice these, despite a wish for greater robustness. Technical advances have also included the development of acceptable methods of restraining population growth (thus avoiding Malthus’ predictions [7]) and possible methods of reducing further environmental damage: these should not be under-valued.

#### 1.2. Defining an issue

Stated simply, while centralization and specialization have allowed goods and services to be produced with unprecedented efficiency, the precise corollary has been vulnerability to disruption of the central creation and distribution facilities, and to the facilities for the re-centralization of wealth. “The best of both worlds” is a theme of this paper.

#### 1.3. Lessons from history

Tainter, Diamond [8] et al. do not speak of “the failure of individuals to survive”, or “the failure of species to survive”. Both of these authors analyze historical examples of the “Collapse” of “SOCIETY”, i.e., the process by which individuals’ existence changes from that of a specialized contributor within an interconnected and specialized societal structure, to a self-dependent existence at some lower state of sophistication. Tainter has asserted that societies become prone to collapse when the incremental costs of maintenance outweigh the benefits to the individual. Diamond basically asserts that societies collapse when natural resources are mis-managed. These authors do essay definitions of “society” and to a lesser degree definitions of “collapse” – but the lack of granularity in the terminology masks important issues.

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