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Shifting "The Dodo Paradigm": To be or Not to be

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In the 21st century the goals of mankind are evolving from raising near-term prosperity to unlimited-term sustainable survival in an acceptable state. This is bound to lead to a scientific revolution – a paradigm shift. This paper outlines the proposed "mankind self-preservation paradigm" and its main components. That paradigm will involve all disciplines related to decision-making, including economics. The paradigm refutes the very foundation of these disciplines and changes their role and capability. The proposed paradigm differs from all other similar attempts in that it is supported by a fundamentally novel mathematical and computational toolkit. Accordingly, this paper pursues two main purposes. The first is to outline the cardinal change in philosophy of economics and adjacent disciplines and to prepare ground for global society-wide modeling of the "mankind-Planet Earth" system. The second is to explicate the two most important of many principally novel components of the toolkit, (a) the multiscenario multicriterial stochastic optimization models with catastrophe-avoidance algorithm, and (b) an ensemble of strategic frontier™ with several "synthetic" decision criteria. The paper also indicates enormous potential advantages of applying that toolkit to both global and local problems facing mankind. The toolkit will always provide two new sought-for features of strategies – good adaptability for a very large range of scenarios and robustness, the ability to withstand multiple risks. The main conclusion of the paper is that only a switch to a self-preservation policy may increase the likelihood of sustainable mankind survival, and what follows afford the first steps to such a switch.

Field of Research: Multidisciplinary study involving 8 disciplines related to decision-making.

Keywords: Mankind survival, Paradigm of decision-making, Uncertainty, Confidence, Keynes, Long-range planning, International trade, Multiscenario multicriterial stochastic optimization models, "Synthetic" decision criteria, Strategic frontier™, Climate change mitigation.

1. Introduction

In idiomatic English, "going the way of dodo" means "becoming extinct." More importantly, the dodo bird became extinct in a very specific manner. It was a big flightless bird that resided on an inhabited island that had no carnivores in its fauna. Therefore, the dodo had not developed the instinct of self-preservation. However, two types of carnivores, Europeans and ship rats, came to the island in the 16th century. The dodo did not run or hide; they quickly became the epitome of legends.

The problem this paper is addressing is how to bring about a self-preservation policy, necessary for indefinite-term sustainable survival of mankind. The paper outlines the initial steps for moving in that direction.

The 21st century combines progressively worsening global perils with radical uncertainty. We expect that catastrophes will happen, but we do not know when, where, their exact

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type and consequences, or on what scale. The current main goal of mankind is *raising prosperity for a finite period*. It is myopic and is largely responsible for the present state of the planet. It absolutely lacks safeguards and, therefore, should be called "the dodo paradigm." It must be replaced by the "mankind self-preservation paradigm" (MSPP) - *attaining unlimited-term sustainable survival of mankind in an acceptable state.*

Such change has always been necessary, but its unavoidability and urgency became evident only recently. *Raising near-term prosperity* becomes a secondary goal - to be pursued only among those development strategies that have been screened for adequate survivability. Such a *paradigm shift*, predicted by Thomas Kuhn (Kuhn 1962), would involve all decision-making (DM) – including economics and a whole set of such adjacent disciplines as Operations Research/Management Science, Decision Analysis, Theory of Games, Scenario Planning, and Risk Management. It also would reduce the role of Complexity Theory.

The ultimate purpose of the scientific aspects of the proposed paradigm shift is preparing to global and society-wide modeling to derive a system of prices, international payments, technology and production and consumption change trends, and physical constraints that would protect mankind and its environment, as much as possible. The MSPP toolkit can also be applied to special problems, such as dealing with the climate change, or problems of long-range business planning.

Difference from previous studies. In all disciplines involved except Scenario Planning there were no previous studies – since the 1960s, the author's research has been moving in a fundamentally novel direction. The difference from the 1960s study in Scenario Planning is described in detail in Section 2.

The author's research thus far has indicated no other approach even remotely similar to both the proposed MSPP as a whole and its major components:

(a) "Compensated Free Trade"™ (CFT; its uniqueness is confirmed by a leading authority);
(b) Risk-Constrained Optimization™ (RCO), as well as its major parts (namely, catastrophe avoidance algorithm, multiscenario multicriterial stochastic optimization models, and an ensemble of several "synthetic" decision-making criteria and "strategic frontier"™).

The paramount significance of the proposed paradigm is evident. No survival is likely without self-preservation. The author is pessimistic as to whether any of the recommended changes will ever be realized, but at least the reasonable recommendations should be made.

This paper is extremely broad and comprehensive. It covers several long-established, extensive, and reputable disciplines, such as Economics, Operations Research, and Decision Analysis. Moreover, it brazenly purports to overturn them. Any revolution demands some justification or at least an explanation. Therefore, this paper's methodology portion is expanded into three sections. After Section 2 of Literature Review, Sections 3 describes the general goal of MSPP, and Section 4 describes its basic assumptions and methodology, with a large subsection devoted to "Compensated Free Trade"™. Section 5 is about RCO and discusses criteria of decision-making. Another subsection discusses

RCO modeling of the climate problem. Section 6 contains Conclusions and is followed by References.

Detailed explanations of the proposed multiple innovations would require expanding this paper several times. Since this is impossible, in this context the author has to refer the reader to his other publications. Their full texts or abstracts are available in the Articles section of rcosoftware.com.

2. Literature Review

In all disciplines involved except Scenario planning there were no previous studies. In proposing a new paradigm, this paper provides: (a) a concise but comprehensive criticism of the current paradigm and (b) the means of overturning its philosophy and overcoming its faults. This paper does claim priority only for (b), rather than in pointing the faults out which has been always partial and incomplete. As far as the author knows, there has never been a new toolkit suggested.

For instance, Moore talks about “our utter ignorance about far future,” but makes a wrong (too general, very often this is not true) conclusion in saying that we may act rationally pursuing just the foreseeable consequences (Moore 1903, pp. 152-153). Keynes was partially under Moore’s influence when he limited the importance of probabilities at the disposal of the decision-maker: probabilities were no more than estimates formed under existing circumstances. But on this issue Keynes correctly criticized Moore for excessive generality (Keynes 1921, pp. 309-10). Basically, Keynes assumed the impossibility of complete confidence in statistical data. “By limiting the possibility of certain knowledge Keynes increased the scope for intuitive judgment.” (Skidelsky 1983, pp. 153-154)

There exists extensive literature on saving mankind or addressing important problems that are pertinent to that process, such as improving the climate of the planet. A comprehensive paradigm shift requires solving more difficult problems and therefore a more powerful toolkit. The author does not know any approach that is even remotely similar to both the proposed MSPP as a whole and its major components:

(a) “Compensated Free Trade”™ (CFT).
(b) Risk-Constrained Optimization™ (RCO), as well as its major parts (namely, catastrophe avoidance algorithm, multiscenario multicriterial stochastic optimization models, and an ensemble of several “synthetic” DM criteria combined with “strategic frontier”™).

Uniqueness of CFT was in 2009 confirmed, in private correspondence, by Professor Peter Morici, who “does not recall such proposal.” It also received the consent of Professor Paul A. Samuelson. The author does not know of any literature on ideas, similar to CFT. As well, the absence of systems similar to RCO was confirmed in (Lempert et al. 2006). See below.

2.1 Scenario Planning

The system closest to RCO still remains "the Zone of Uncertainty" (ZU) approach that has been the predecessor of RCO (Makarov & Melentyev 1973, pp. 115-257). In the 1960s, a substantial advance was made by a group of scientists from the USSR energy industry, which, under the influence of (Luce & Raiffa 1957, pp. 278-306), used the concept of

multiple DA criteria to develop a scenario planning system called "the Zone of Uncertainty." The "Zone" was a set of candidate strategies. To select a strategy, the cost behavior of these candidates had to be evaluated on a large range of scenarios.

In the ZU system:

- A number of single-scenario "What if" linear programming models is constructed and solved;
- Groups of similar model solutions are clustered into a number of candidate strategies;
- Single-scenario linear programming models are constructed and solved for all "strategy vs. scenario" combinations;
- The obtained values of the objective function (cost) are used as payoffs in a payoff matrix;
- The “best strategy” is selected by applying to the payoff matrix the several decision criteria described in (Luce & Raiffa 1957, pp. 278-306);
- If different criteria lead to different selections, the selected candidates form ‘the Zone of Uncertainty’, and the final choice is made subjectively.

The ZU approach proved enormously progressive for its time. The methodology included an excellent mathematical description of the behavior of dynamic energy systems. Candidate strategies were developed, checked against up to 1,500 scenarios, and then eventually evaluated by several then-known criteria. The results were good, robust regional compromises between scenario-specific extreme solutions in choosing among different fuels. In 1970, many of the derived results were used in the plans for the development of the USSR energy industry (Makarov & Melentyev 1973, pp. 115-257). (As far as the author knows, the methodology is not widely used in Russia now, if it is used at all.)

The ZU approach introduced three important ideas:

- Splitting variables into “strategic” and “operational” groups and thus clearly delineating each strategy;
- Constructing contingency plans and evaluating candidate strategies by the totality of their “post-contingency-plan” outcomes for the whole range of scenarios;
- Using several DA criteria for finding the best candidates (follow-up of (Luce & Raiffa 1957, pp. 278-306)).

2.2 General Difference

In 2006, a group of RAND scientists declared that “no systematic, general approach exists for finding robust strategies using the broad range of models and data often available to decision makers” (Lempert et al. 2006, p. 514). That evaluation must have included stochastic programming and scenario planning. The RAND methodology claimed to be such a general approach, but it did not include the three extremely important ideas of ZU listed above. Contrary to (Arrow & Hurwisz 1972; Luce & Raiffa 1957, pp. 278-306), it used, for instance, a single criterion of minimax regret. In a private communication, it was also revealed that the authors were not aware of the RCO description which was already published in 2004 (Masch 2004a).

Work on RCO started in the 1960s. The embryonic version of RCO, called “Robust Optimization” and expanding ideas of ZU and (Luce & Raiffa 1957, pp. 278-306), was granted an USA patent in 1999 (Masch 1999). That version of RCO was successfully applied at one large corporation in 1992–1993 (Lindner-Dutton et al. 1994). However, RCO was drastically improved after 2000. It replaced single-scenario models by multiscenario multicriterial ones, with all the cardinal improvements stemming from it. It became a new system. Nine major improvements completely transformed the RCO methodology from ZU (Masch 2010, p. 426). In essence, only the above three ideas are the heritage of that approach in RCO.

The author cannot guarantee the verity of the strong statement above of (Lempert et al. 2006), which would, in turn, imply that all existing systems do not compare to the quality grade of ZU, achieved in the 1960s. It is always possible to miss something. However, the author relies on (Lempert et al. 2006) in their survey of literature and is not repeating it. The author has no doubt, however, that both the change of paradigm and rest of the ensemble of models and computational methods used in RCO are currently unique. Even ZU methods of the 1960s are unknown and not used in the West, not to speak of their cardinal improvement by RCO.

Problem of mankind survival and the necessary shift of paradigm, with a toolkit provided, were not previously addressed.

Since there were no studies, there were no relevant limitations.

3. The General Goals of MSPP

Senge (Senge 1990, p.6) suggests that a major breakthrough could result only from the combining of a special ensemble of efficient component technologies that come from diverse fields of science or technology, and only when all necessary components of that ensemble come together. He strongly emphasizes that the power of the ensemble comes mainly not from the individual components, but from their combined impact within the process. In his words, they form an inseparable ensemble ‘‘and are critical for each others’ success.’’ (Ibid.)

Any DM paradigm may be defined by the following major components: (1) the general goals; (2) basic assumptions and methodology; (3) criteria of DM; and (4) the toolkit. In the proposed MSPP, each of these components is altered drastically, even conceptually. These changes are strongly interconnected, fit each other perfectly, and create a powerful ensemble where the whole is much greater than the sum of its parts. Moreover, there arises a hierarchical system of ensembles at several levels – between the major components of MSPP, between the parts of its toolkit, and so on. This section is about the first component.

Mankind has faced numerous dark periods throughout its history. However, the dangers were transient and not global. The challenges of today – natural, military, geopolitical, and economic – are global and appear to be worsening as time goes on. This combination is without precedent.

The 21st century is full of perils and uncertainty. We are threatened by possible extinction of mankind, with most risk coming from human activities (Bolstrom 2013: Cookson 2015). The greatest threat comes from robots!

An even more immediate peril is the possibility of a world ruled by totalitarians or religious fanatics. The USA remains the only bulwark of Western-type regimes. Its previous advantages (size, industrial might, technological preponderance, and isolation by two oceans) either have already disappeared or are fading away rapidly. Its political system is hopelessly outdated and largely dysfunctional. While its potential adversaries concentrate power and grow its military (double-digits a year (Bitzinger 2015)), the USA on principle disperses its power wherever possible and cuts its defense budget.

Moreover, the totalitarian danger is internal, too. Interests of the middle-class, the backbone of society, are severely harmed. The balance of the three "countervailing powers" (capital, labor, and government) is an absolute must for a stable society (Galbraith 1950). That balance, roughly achieved by the 1950s, is dead. This may lead to a totalitarian regime of either left or right orientation.

Finally, there exists the danger of an immediate collapse of the global economy (Warner 2015). The lessons of 2007 are forgotten. We continue to live with a "philosophy of demand at any price," and sooner or later that will lead to a terrible crisis. It might happen any moment. Clearly, we'll have to tighten our belts.

Similarly, at any moment a terrorist act can change the global landscape in seconds. All these perils mean that we know nothing about the short-term future, even in a probabilistic sense. Such a situation calls for a *paradigm shift*, predicted by Thomas Kuhn (Kuhn 1962). In 1962, Thomas Kuhn published "The Structure of Scientific Revolutions", one of the most influential books of the 20th century (Kuhn 1962). In it, he describes how our ability to understand and deal with the real world evolves through a series of discontinuities. In a crisis current theories may crash, resulting in the birth of a new "incommensurable" paradigm, which may face a similar fate in the next crises to follow. The current state of affairs poses innumerable perils and uncertainty. This is the Kuhn's moment of 'crisis', when the needs of survival compel a shift in existing paradigms.

This shift would relate to all decision-making – to both economics and the whole set of adjacent disciplines, such as Operations Research/Management Science (OR), Decision Analysis (DA), Theory of Games, Scenario Planning, and Risk Management, as well as Complexity Theory. We will call the new paradigm "the mankind self-preservation paradigm" (MSPP).

The socio-economic problems we are facing today are characterized by an overwhelming increase in complexity and uncertainty regarding the types of changes we can expect, as well as their scale, speed, and timing. Traditionally, almost nothing has been known about future events, even in the short-term. Now "almost" has disappeared and we can only make guesses as to how the future will unfold. This is the state referred to as "radical uncertainty". Radical uncertainty in the world as a whole is only one of the factors contributing to uncertainty in any system, global or local. Let us not forget about complexity! In complex systems, even a full awareness of individual components and the laws governing their interaction is insufficient to infer the properties and behavior of the system as a whole (Johnson 2012; Lai & Han 2014, pp.188-90). The system imposes additional ("systemic") conditions and constraints that are hidden from the observer.

In this century, the goals of humankind should change. Since time immemorial, a major goal of human endeavor has been to increase prosperity. Starting from the first Industrial Revolution, we have largely achieved this goal in many parts of the world. Unfortunately,

progress in science and technology has led to the overwhelming possibility of human extinction either by such causes as overpopulation and the subsequent destruction of the environment, or through willful mutual annihilation.

The challenge of the 21st century is sustainability. We must find the ways to navigate skillfully and cautiously between wide ranges of potential dangers, both known and unknown, to ensure that the decisions we make are beneficial for the long-term survival of mankind. Even more difficult is to make mankind follow the right ways. Knowing human nature, the author is pessimistic, but we should at least know these ways. And that is the main purpose of the present paper.

But how to achieve sustainability if we do not know the potential risks? That cardinally changes the process of decision-making. Now we should strive for *adaptability* and *robustness* of the system.

Adaptability means here the capability of the system to absorb the external shock of encountering any scenario – likely, unlikely, and even improbable – without generating excessive risks. Accordingly, the *riskiness* of a scenario is important while how realistic it is – is not. (Section 5.1 describes how the DM process deals with scenario realism.) *Robustness* or *sturdiness* means the capability to withstand potential risks without creating an outcome that is considered catastrophic.

The role of the decision-makers grows enormously. Their decisions should be global and mandatory. They have to be statesmen of world class caliber. It is they that determine the survival of the system. Everything depends on their feeling of responsibility, their attitude to each of multiple potential risks, known and unknown, and their expertise (to a much lesser degree). They must participate in the strategy development process practically from the very beginning. By selecting risks to fight and the necessary degree of reducing those risks they in essence define the expected likelihood of the relevant scenarios.

Now, the ultimate scientific goal of the proposed paradigm shift is global and society-wide modeling to derive a reasonably sound strategy – a system of prices, international payments, production and consumption change trends, and physical constraints that would protect as much as possible mankind and its environment. Mankind should also be protected from totalitarianism.

Prices are extremely important. Market prices have to be pushed in the right direction. Now the author seeks protection from the current market prices, as he had sought protection from politically-motivated prices of the command economy in the USSR in the 1960s-70s.

In 1964 – 1965 the author developed a macro model for long-term planning of the Soviet economy by industries and regions (Masch 1965, 1966). It was not an abstract model but a working model intended for real planning of the economy. For several years, the model was a banner project of CEMI, the Central Economic Mathematical Institute of the Academy of Sciences of the USSR. By a government decree, 400 planning and research organizations provided the information for the model. Two articles above outline the model in Russian and in English, respectively (they are presented in the Articles section of rcosoftware.com). The author developed not only the model, but also the ensemble of algorithms for solving this extremely large and complex optimization model (millions of constraints and dozens of millions of variables) on Russian computers, able to deal just

with linear programming models of up to 400 constraints. The model was solved by 1972 but further work on it was stopped because of his emigration.

The author will not go into technical details of global society-wide modeling here; see Section 5.3, as well as (Masch 2009a).

MSPP could as well be applied to special problems, such as dealing with the climate change. In addition, major systems of the paradigm, such as RCO, can cardinally change the methodology and techniques of addressing problems of long-range business planning and research analysis.

4. Basic Assumptions and Methodology

Any unrealistic basic assumptions, made solely for convenience of analysis, are in MSPP eliminated. The economy and the market are considered an important tool of the society, but just one of them. The open-ended "man effect" in an increasingly interconnected world and in unlimited time is fully recognized. External (both nonmarket and unknown) effects of any decision are considered no less important, and usually more important than its forecasted intramarket consequences. Therefore any reductionist attempts to consider the market as an isolated closed system and to use corresponding methods and models are rejected.

The MSPP approach to basic assumptions and methodology is a generalization of the approach of Keynes. Aside from his founding of macroeconomics, the most important true legacy of Keynes is, in the author's opinion, contained in three principles, as follows.

I. Economics is based on logic of choice under uncertainty and scarcity, with uncertainty playing the main role.
II. There is no "universal economics": different economic approaches should be applied under different states of the society.
III. The market activities at a lower level of the economy should be controlled and constrained by a higher-level non-market entity, which deals with resulting externalities.

(In 2007, in a private communication, Professor Robert Skidelsky, most prominent researcher and biographer of Keynes, agreed.)

Chaotic "free market" activities, including those of the international "free market," are allowed only at the micro level. In accordance with Principle III, at the macro level the market should be controlled and regulated by non-market organizations on the basis of a broad understanding of the open-ended "man effect" in an increasingly complex interconnected world and unlimited time. The pricing mechanism of the market is still used, but prices are adjusted by "Pigovian taxes" and constraints on externalities, including "externalities of the unknown," that reflect risks of society, geopolitics, global economy, and ecology. Modeling should be society-wide and mostly global with the largest economies or blocs of economies described in greater detail.

4.1 Compensated Free Trade™

International free trade is replaced by its fundamentally novel "Compensated Free Trade"™ (CFT) version, also developed by the author (Masch 2004b, 2007, 2008, 2009b, 2010, Masch & Perlman 2005). This version is a "balanced capitalism" compromise

between free trade and protectionism – the fifth type of capitalism, to add to the four types defined in (Baumol & Litan 2007).

What is regulated here is a *common good* – the overall trade balance of a country A or a block A of countries. To avoid a "tragedy of the commons," a fee or a tax or a constraint should be imposed on its free use (Harding 1958). However, this would create a burden for the domestic economy of a deficit country A. Instead CFT shifts this burden onto the country A's trading partners by imposing constraints on A's individual trade deficits with these trading partners. The sum of these constraints should equal at least the desired overall trade deficit of A. "Punishing limits" may be imposed on misbehaving partners, while the limits for friendly and well-behaving partners may be raised.

A partner may exceed its trade balance limit if its government pays the government of country A the stipulated percentage, up to the full amount of the excess deficit. Both the number and zeal of customs inspectors dedicated to accepting goods imported from a partner would depend directly on that partner's relevant behavior. For instance, if a partner does not pony up, all imports from it could have to pass through a single customs inspector. France did that in the last century to control the import of Japanese cars.

For country A, CFT would become its powerful, versatile economic and geopolitical tool that would kill quite a surprising number of plump birds with just one stone. It would restore proper work of a now dysfunctional and out-of-balance global economy. CFT strictly follows GATT and thus cannot be forbidden by the WTO. For a trading partner of country A, CFT involves the difference between the costs of exports and imports of A to that partner. Therefore the partner cannot start a trade war by increasing tariffs on A's exports. Numerous CFT advantages, as well as its faults, have been analyzed in the author's papers referred to above.

Country A can succeed in imposing such a policy unilaterally if its market is sufficiently attractive for its trading partners. The USA, the engine, and the last resort sap of the global economy, may be the only country to meet this requirement. And it needs CTF badly: "Between 2000 and 2010, 55,000 U.S. factories closed and 5 million to 6 million jobs disappeared. … since 1979, the year of maximum manufacturing employment, the number of jobs in manufacturing has declined by 7,231,000 – or 37 percent." (Buchanan 2015) "There are now more than 100 million Americans over the age of 16 that are not working. ... the largest reduction in the workforce has been among the millennials. Today the labor force participation rate for the 16 to 24 age group is 55.1 percent, down from 60.8 percent a decade ago and more than 66 percent back in the late 1990s. We're headed toward becoming Greece, where half the young people don't work. … We have 10 percent of the workforce unemployed, in part-time work or dropped out of the workforce at a time when businesses say they can't find willing workers." (Moore 2015)

Despite the current change in the global economy and the crisis in emerging markets, these issues do not lose actuality. The USA trade deficit for the past 12 months, as of the beginning of September, 2015, equals $410 billion. (Economic 2015) "Since Bill Clinton took office, the U.S. trade deficits have totaled 11.2 trillion." (Buchanan 2015)

Blinder guesstimated the maximum number of "potentially offshorable" American jobs. He considers that "… sixty million is more than enough to create something akin to a new industrial revolution." (Bhagwati & Blinder 2009, p. 35). Gomory and Baumol expressed

similar and other concerns for a world where technological predomination of countries quickly changes (Gomory & Baumol 2001).

All these issues are tremendously important. Offshoring and globalization had destroyed the delicate balance between the three "countervailing powers" of labor, capital, and government (Galbraith 1950), created in the USA with enormous difficulties by the 1950s. Unbridled globalization undermines societies and is incompatible with democracy.

If country A were indeed the USA, CFT would deal with the labor problem outlined above and with many other difficult problems plaguing the American society. However, here the author would like to emphasize just one most important issue. CFT can be used for containment, a la Kennan, of geopolitical adversaries of the democratic world order. And in the current situation, territorial containment is impossible (Browne 2015; Mearsheimer 2014, p. 383-85) while financial containment might be very effective. The current slump of China' economy does not change the situation: it still has a 12-months trade surplus of $291 billion – 77 percent more than a year ago and sufficient for increasing its military budget (Economic 2015).

5. Risk-Constrained Optimization ™ (RCO)

5.1 General Considerations

Paradigms are likely to be shifted at times of crisis, when mankind has to overcome new difficult problems. To solve them, more powerful toolkits are needed. Perhaps there can be no paradigm shift without a revolutionary change of its toolkit. *MSPP has both conceptually and technically novel toolkit that carries out self-preservation under conditions of radical uncertainty. That completely distinguishes MSPP from any other attempt to improve DM disciplines.* The mathematical (computational) toolkit here is *Risk-Constrained Optimization™ (RCO)*; its most complete but already partly outdated description is in (Masch 2013).

Previously decisions were data-driven and, at best, related to a limited (usually small) set of likely future scenarios. Under the present conditions, we know nothing about even the short-term future. We have some technological and economic information, but that is just a scintilla of what is needed, and is completely unreliable. So we have to make decisions predominantly on the basis of our emotions, such as confidence and "animal spirits." Therefore RCO rejects the very concept of "the correct" or "the best strategy," replacing it with a "strategy that is most acceptable to decision-makers" (see Section 5.2). To protect the latter from making a serious mistake in selecting a strategy, we have to develop flexible candidate strategies, easily, without substantial risks, *adaptable* to any potential future scenarios, likely or not. These candidates must also be sufficiently *robust* to withstand as many conceivable risks as possible. We need reasonably safe candidate strategies that are like space suits protected from both "known" and "unknown" unknowns (Rumsfeld 2011, pp. xiii-xv) – somewhat different suit # 1, # 2, etc. (As examples of "unknown unknowns," Rumsfeld gives 9/11 and Pearl Harbor. He sadly qualifies this category "to be the difficult one".)

RCO does exactly that development in two stages, both involving optimization but using it for analysis, ferreting out risks, and filtering out or truncating the bad candidates, rather than for selection of the best. It starts with creating scenarios. As outlined in Section 3, the realism (or likelihood) of scenarios is not important, therefore they can be constructed by a

simple combinatorial technique. (That narrows the role of Complexity Theory, which basically has been created to construct realistic scenarios. Now we need just simple and approximate values of outcomes of extreme behavior of the complex system.) RCO is not concerned about on what scenario basis it develops the strategy. All features of basis except its riskiness become almost irrelevant.

The first stage of *strong screening* is centered on "multiscenario multicriterial stochastic" (MMS) models. The MMS models become "optimizing filters" that have two sets of criteria. The first set fights risks by applying a "catastrophe-avoidance algorithm" that imposes "risk-limiting constraints" (RLC); the second maximizes welfare. The objective function contains mostly the welfare criteria, but the obtained extreme solutions are sharply curtailed by sets of RLC. Each candidate strategy is found as a result of solving a new MMS model, with a different set of RLC. So the problem really becomes what set of RLC has to be imposed on a reasonably good welfare strategy to make it a reasonably safe space suit? Not "what to do," but rather "what not to do." Modifying the sets of RLC constraints, RCO generates a sufficient number of safe candidates for further analysis.

The MMS models with RLC completely change the role and capability of OR. In spite of their virtuosity, all optimization models and algorithms, created since the 1940s, are capable of finding no more than extreme, rather than optimal, solutions of deterministic problems and problems under modest uncertainty. In the real world, no serious problem is of that type. In contrast, RCO goes as far as possible in addressing radical uncertainty. *Currently available OR models and algorithms are great for the abstract world. MMS makes OR useful for the real world.*

The two main advantages of MMS models are as follows. First, these models are the only tool that can find a flexible and robust strategy against the background of many risks and a large range of scenarios. (Some strategies may even be compromises that will never be obtained from applying any number of single-scenario models.) Second, by changing the set of RLC, or parametrically changing their right-hand sides, we can measure the impact of different risks and different constraints on the evolving strategies.

It should be particularly emphasized that imposition of RLC means that we find the relevant scenario and its risks to be somewhat plausible. The probability that we originally assigned to that scenario should be thus somewhat raised. That is especially important for scenarios with initial zero probability. Each candidate strategy emerging from the first stage has therefore a specific set of scenario probabilities different from the original set.

I will not go into a more detailed description of the process of strong screening, addressing the reader to (Masch 2013).

When enough satisfactory candidate strategies are generated, they are subjected, at the second stage, to *weak screening* which replaces the current Decision Analysis (DA), that is reductionist and absolutely inadequate. Again, the goal is filtering rather than selection. In the current DA, all but one major criterion are "single" selection criteria (see Section 5.2). The decision-maker is assumed to know exactly, even under radical uncertainty, his level of confidence in scenario probabilities. It is either complete confidence, as in the weighted average and maximax criteria, or complete lack of confidence, as in the minimax payoff and minimax regret criteria. True, the "pessimism-optimism index" criterion is "synthetic"; it combines pessimism and optimism, but at some arbitrarily fixed intermediate level of confidence. The assumption of knowing the level of confidence is absurd – that

level is a very bad subjective “unknown.” This assumption was made just to meet the mainstay requirement of all reductionist disciplines, to have a *single best solution.*

RCO is against the very idea of the best solution. Therefore it can not only replace all “single” criteria by novel “synthetic” ones, but also introduce a fundamentally new concept of “strategic frontier”™ (see Section 5.2), where the candidate strategies are compared with each other at *all* levels of confidence at once, from complete confidence to complete lack of it. We cannot determine the proper level of confidence; therefore we look at all levels. The powerful ensemble of strategic frontier™ and several “synthetic” criteria assures reasonably good final filtering of candidates. A few good and universally safe space suits, that remain after all filtering, are presented to the decision-makers for subjective selection.

An RCO-type system has four main advantages that will make it irreplaceable for addressing difficult problems presently facing mankind. First, it allows combining different contradictory theories and data in a single model, without pre-judging them, presenting them as different scenarios and playing with their weights. Second, the system allows using very approximate input data, which in turn permits addressing off-the-cuff extremely complex problems that otherwise would require years of preliminary studies or can not be approached at all. (See Section 5.3 on the climate model.) As well, the most unreliable part of input data, scenario probabilities, is changed in the RCO process. Third, special structure of MMS allows clustering large sets of scenario submodels, thus allowing solving optimization models with a very large number of scenarios. Fourth, RCO employs an ensemble of conceptually novel techniques that, in the author’s possibly biased opinion, will eventually become an integral part of any reliable approach in long-term and complex planning and research problems. These techniques are:

(a) Multiscenario multicriterial stochastic (MMS) optimization models that include the catastrophe-avoidance algorithm.
(b) A complex of several synthetic filtering criteria, used in the framework of strategic frontier™.

Irrespective of whether we apply other components of MSPP, RCO goes as far as possible in dealing with decision-making under radical uncertainty. As far as the author knows, no other system is even remotely close to RCO in that respect.

However imperfect, RCO-type systems still may be our best, if not the only possible approaches to addressing complex societal and environmental problems that presently appear on the agenda. That also remains true for lower-level problems under radical uncertainty, including any problems of long-range planning or business research.

As far as the author knows, *for the first time since the creation in the 1940s of both computers and optimization models*, *RCO legitimizes the possibility of combined use at a high analytical level* of these two wonders of modern science and technology.

5.2 Criteria of Decision-Making

Perhaps one of the general laws of nature can be formulated as: “An organism or a system will become extinct if it does not take sufficient care of its own self-preservation.” The dodo paradigm violates that law.

In a universally recognized psychological “pyramid of needs and wishes” the first priority belongs to physiological needs, such as breathing (Maslow 1943). The next are needs of safety of the individual and his “community.” He may consider as such whatever he likes, from his family to whole mankind. Only after his needs are met, and he controls various kinds of risk in accordance with his attitudes about those risks, he can initiate satisfaction of his discretional wishes.

Conversely, economics begins immediately with the maximum satisfaction of wishes, thus making a hidden assumption about a guaranteed satisfaction of physiological needs and safety requirements. Such an assumption never has been true. In the proposed paradigm “maximization of utility” (or something similar) becomes secondary to “catastrophe avoidance.”

The catastrophe-avoidance decision, to fight or to run, is absolutely simple and does not need any intellect. Practically all living beings, from amoeba to Obama, have been using it for self-preservation from the very beginning of life on Earth. “The fittest” (in terms of the evolution theory) of these beings have survived, which means that the criterion is not at all bad. (Whereas the maximization criterion: first, is absolutely irrelevant to survival; second, requests performing complicated, incomprehensible, and unproven computations and is therefore a psychological absurdity; third, finds not an *optimal* but rather an *extreme* solution, which is risky as any extreme; fourth, is artificial.) Finally, the catastrophe avoidance is fully in the spirit of the current self-preservation goal of mankind.

In the 1940s, there appeared two new wonders of modern science and technology - computers and optimization models. But to use them to a good effect, we should unite them with beneficial laws of nature. We must combine old and new, red and blue. RCO does exactly that. At both of its stages of strong and weak screening, RCO first maximizes welfare and then truncates anything risky – filters out instead of selecting. In Section 5.1 that process was outlined for the strong screening stage. Let us look to how this is done at the stage of weak screening.

In the seminal DA book of Luce & Raiffa (1957), candidate strategies are selected under radical uncertainty on the basis of their payoffs P(i)(j) and regrets R(i)(j) under different scenarios, where payoffs are, say, profits of the post-contingency plans (Luce & Raiffa 1957, pp. 278-306). (“Regret” is the measure of opportunity lost.) i is here the index of a strategy and j – the index of a scenario.

DA does a very inferior job of strategy selection. Consider the best-known of its criteria, comparing the mathematical expectations E(i) of payoffs for Strategies i. These are the weighted averages of P(i)(j). We calculate them as if have complete confidence in scenario probabilities, as if we know their exact values. If we indeed knew those values, Strategy 1 would be better than Strategy 2, if E(1) is greater than E(2). On the other hand, consider another DA comparison criterion (“minimax”), where we have zero confidence in scenario probabilities: we believe that they are “unknowns.” In that case, Strategy 1 is better than Strategy 2, if the worst payoff P(1)(j) is better than the worst P(2)(j).

In both of these criteria we assume just one level of confidence in probability values: either we know them or we do not. Confidence is either 1.0 (the optimistic assumption about our knowledge) or 0.0 (the pessimistic assumption). Such criteria will be called “single,” and DA has four single criteria for payoffs and one – for regrets.

As a rule our level of confidence is somewhere in-between, but none of the "single" criteria of DA lets that level to be set in-between and defined by the decision-maker. Granted, DA also has a "pessimism-optimism index" criterion, which will be called "synthetic": it calculates the aggregate payoff for a strategy as a weighted combination of the values of the best and the worst payoffs for that strategy. If we assume the value of the index to be equal S, then for Strategy i the aggregate payoff equals {S x worst P(i)(j) + (1 – S) x best P(i)(j)}. Strategy 1 is better than Strategy 2, if its aggregate payoff is greater.

Single criteria evidently are too simplistic. Even worse, in the 1950s two later Nobel laureates in economics, K. Arrow and L. Hurwisz (the author of the "pessimism-optimism index" criterion) had already proven that each of the five single criteria above had some defect that, in some cases, made wrong strategy selection choices. (Arrow 1953; Arrow & Hurwisz 1972; Luce & Raiffa 1957, pp. 278-306).

That leaves as potentially valid only the "pessimism-optimism index." But how can we determine the proper value S of the index? "Confidence" is a very tricky unknown, completely specific to the decision to be made, subjective, and unstable in time. (If C is the level of confidence, S = 1 – C.) Today we have high "animal spirits," tomorrow – low. In short, it is arbitrary and unreliable.

Koppl attempted to build a "theory of confidence" to establish a sufficiently high level of short-term confidence, basing it on stability of the society (Koppl 2014). Just to start with, the trouble is that, even in short-term, societies are unstable in the 21st century. Additionally, Koppl dreams about free market while the real world goes in opposite direction. We should not undertake hopeless tasks, but rather get around the difficulties (see below).

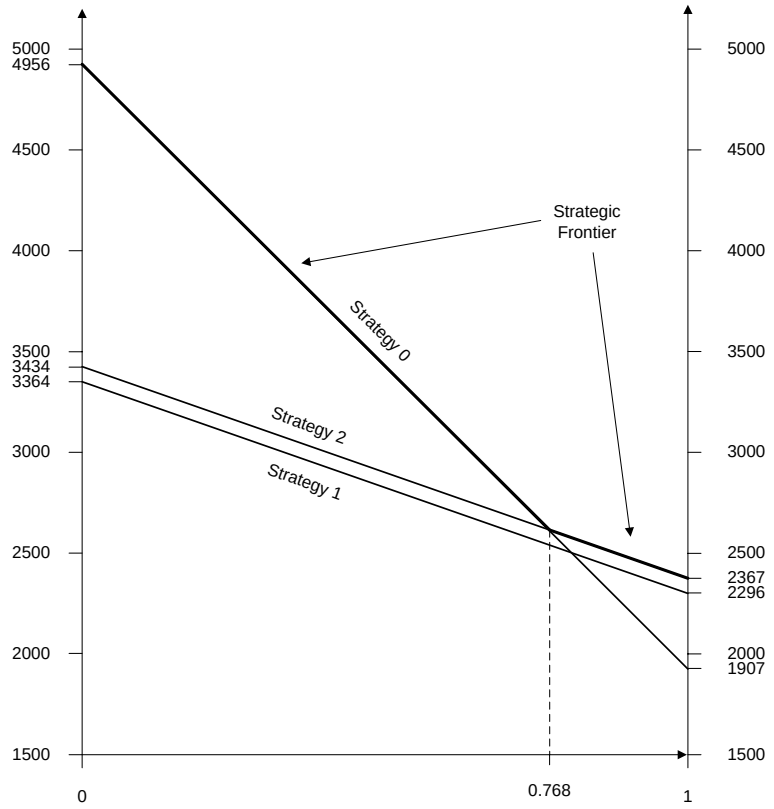
RCO thoroughly improves the comparison techniques in three directions. First, it filters out rather than selects. Second, it retains the "index of pessimism-optimism" criterion, while replacing all five "single" criteria by five new "synthetic" criteria (see (Masch 2013, Section 2.1.6), four of them originating in RCO. RCO uses all six synthetic criteria jointly but consecutively, one at a time. Each one may filter out a different set of the worst candidates.

The third direction of improving comparison is even more impressive. RCO embeds the synthetic criteria into a framework of a fundamentally novel *strategic frontier*™. Instead of comparing candidate strategies at some arbitrarily fixed *single* level of confidence, strategic frontier™ simultaneously compares them at *all* levels of confidence, from zero to 1.0 value of the index S. Strategic frontier™ from (Masch 2010, 456) for "index of pessimism-optimism" payoff criterion is demonstrated in Fig. 1.

The strategic frontier™ provides the following valuable information about the relative merits and faults of any strategy:

- The composition of the subset of strategies that form the frontier.
- The width of the interval supporting each frontier strategy.
- The order of the frontier strategies on the optimism-pessimism spectrum.
- The difference between the frontier strategy and each other strategy, which shows the possible impairment of results in choosing a non-frontier strategy.

Figure 1: Strategic Frontier for "Pessimism-Optimism Index" Criterion



The strategic frontier™ allows us to apply subjective estimates in a more prudent, convenient, and less demanding way. That is, the decision-maker does not need to specify in advance his level of confidence. (That eliminates the need in the "theory of confidence" of Koppl (Koppl 2014).) Specifically, the frontier replaces hard-to-estimate "point" indices by index ranges. For instance, the current user of the "pessimism-optimism index" criterion may ask the question: "Which strategy, 0 or 2, is better if our guesstimated value of the index equals 0.8?" This means that we compare the strategies at precisely 0.8 probability of the "bad" outcome and 0.2 of the "good" outcome Instead, when we use the strategic frontier™, it is sufficient to say that Strategy 0 is preferable if the value of the index is no more than 0.768 and Strategy 2 otherwise.

Again, the synthetic criteria and strategic frontiers™ do not select the strategy. They just shrink the list of the "finalist candidates" to a few reasonably most acceptable and safest candidates, leaving the final selection to the decision-maker. Similar to the risk-limiting constraints, they do not find the best - they eliminate the worst, which is easier. This stage is not connected with the optimization MMS models used to generate the candidate strategies. Therefore they help to compensate, to some extent, for possible flaws in these models. They are "from another field of research," as requested by Senge (Senge 1990, p. 6).

Throughout history, the general assumption was that there exists the correct and best decision. In particular, that is assumed in reductionist disciplines - economics and adjacent disciplines, such as DA, Operations Research, theory of games, and risk management. These disciplines are full of dangerous oversimplifications: ''Its (i.e., reductionism's - Author) leading article of faith is that to every scientific problem is one and only one solution.'' (Ravetz 2009)

In the maximization paradigm that assumption is further narrowed down: a strategy is the best if it leads to the greatest value of some quantity. But even without maximization, the very assumption of the existence of the best immediately restricts and damages the process of analysis and selection of a strategy. If there exists ‘‘the correct’’ decision, there also should exist ‘‘the correct’’ method of identifying that decision. This must be the one and the only one method. Different methods or different levels of confidence may give different answers. Therefore, both additional criteria and additional values of levels of confidence must be prohibited. The very concept of the existence of the correct decision thus ties the hands of decision-maker. Perilous strategies may not be detected and screened out – the very concept is dangerous. It should be replaced by a concept of the strategy that is the most acceptable (subjectively) to decision-maker(s). President Truman, who looked for a one-handed economist with one best solution, would be angry.

As far as the author knows, RCO is unique to embody this new general philosophy and its tools.

5.3 “Did You Lose the Keys Here?” “No, But the Light Is Much Better Here”

The first commandment of addressing a problem under radical uncertainty should be using only very approximate guesstimates and to commensurate modest amounts of modeling and computational effort. To do otherwise would be like using a steam hammer for cracking a nut.

In Section 5.1, the capability to use very approximate input data was indicated as one of the main advantages of RCO. Let us consider how this concept applies to the problem of dealing with long-term change of climate.

The possibility of worsening climate is a major long-term threat to mankind. Long-range climate change is influenced by a long list of important factors that includes human behavior, ecology, and solar activity. There is a scintilla of the input data needed, and it is completely unreliable. There also is no theoretical consensus about the individual impact of each important factor, about interplay of the factors, or about “systemic” superstructure of a complex adaptive system called “planet Earth.” (Gell-Mann, 1994, p. 17).

Under such classical case of radical uncertainty, it is not possible to build anything even remotely close to a reliable “likely long-term scenario.” A “precise” simulation with a few factors, where we are a little ahead in our knowledge, makes no sense since the other factors and the “systemic” conditions will completely transform the constructed scenario. Such a simulation would indeed be equivalent to searching for the keys where the light is better.

And even if we succeed in constructing a number of likely scenarios, even if we define the best plan to improve climate under each of them, how will we select one of these plans if we do not know the probability of each scenario?

No, we need not a set of disparate plans, each good for only one or a few individual scenarios. As suggested in Section 5.1, we need a strategy that is flexible over a broad range of likely, unlikely, and even improbable scenarios, as well as robust under multiple risks. We need space suits.

If we apply RCO here, the modeling and computing process would have two stages, a preliminary and a final. At the preliminary stage we just need to obtain the possible extreme values of risky outcomes of a climate model. For that purpose we may start with using for long term, year-by-year, modified short-term weather forecasting model of (Palmer 2014). Its "high resolution" version, which increases the amount of weather data 10,000 times, will not be needed. Also, the weather observation grid will not cover the total surface of the planet. It will include just a small number of cells, both typical and extreme. Instead we may simulate some exaggerated extreme values of model parameters to generate additional "fake" observation points.

This simulating model will provide extreme outcome values of risky variables, such as the air temperature, for planet conditions close to the current ones. The results are then simplified as much as possible. For instance, years in a 100-year planning period are aggregated into a few large subperiods.

Now we can construct the multiscenario multicriterial RCO model. It attempts to include every major "unknown" factor that would impact the climate, both natural (such as volcanic activity) and mankind-related (such as consequences of overpopulation, carbon and sulfur emissions, chemical waste, deforestation, and use of renewable fuels). For each such factor, the model provides an "uncertainty generator". It would have several numerical values or qualitative states. All values or states are included into the model simultaneously. The model will itself choose among them. For each value or state are provided a range of possible probabilities ("probability interval" of (Keynes 1921, pp. 158-163)) and the type of probability distribution function. (Not probabilities equal to 0.8 but, say, being between 0.7 and 0.9 with uniform probability distribution.) We also would specify the impact of the factor on climate. A scenario is formed by selecting one value or state for each factor. Factor's interplay and "systemic" condition are also taken into consideration. *All this data is "guesstimated" as necessary.* Analysts and decision-makers add their own scenarios, if so desired. Differential equations, the most time-consuming part of any model, are not needed anymore.

As indicated in Sections 3 and 5.1, important is riskiness of scenarios rather than how realistic they are. Scenarios can be likely, unlikely, and even improbable. Their initial probability depends on simulated probabilities of the relevant points of participating "scenario generators."

This process may lead to an astronomical number of scenarios. But they are clustered into a number of groups that is small enough to be efficiently handled by the computers available.

An RCO multiscenario multicriterial stochastic (MMS) optimization model is constructed (Masch 2013). A two-stage RCO process is applied, as outlined in Section 5.1. The climate-improving activities are parametrically changed as desired, to determine the importance of both scenario risks and the climate-improving human activities. In the end, a small number of reasonably good and reasonably safe candidate strategies are presented to decision-makers for their subjective selection of the strategy to be implemented.

Of course, this is just a preliminary draft of the process; it would be modified and streamlined.

The process is not easy, but the problem is tremendously important. It also is no less difficult – how to make life-or-death for mankind decisions when we know next-to-nothing. It promises, however, a strategy reasonably flexible and robust, adaptable to a broad range of likely, unlikely, and even improbable scenarios.

An alternative "high resolution" model of (Palmer 2014) promises just disparate plans that probably would be good to at most a few likely scenarios – which is extremely dangerous. For that worthless and risky reward it demands hundreds of millions of dollars annually and many years of simulation (which is here looking under the street lamp - exact and difficult processing of completely unreliable data) on a monstrous "exascale" computer, more than 100 times faster than the presently existing supercomputers. Taking this request for granted without checking its justification, the USA Department of Energy cites climate modeling as the first major important reason for starting work on "exascale" (Peterson 2015).

6. Conclusions

The study underlying this paper is completely original. Since there were no previous studies, this paper does neither support nor contradict them. Time has come for a shift of paradigm; further delay is dangerous.

The proposed paradigm and its toolkit are full to the brim of fundamentally novel, both conceptually and technically, ideas, methods, models, and algorithms. Most of them are outlined in the cited author's publications. The cardinal distinction of the proposed mankind self-preservation paradigm from other mankind-saving theories is that it is supported by a toolkit that comprises several major conceptual and technical innovations.

The significance of the paradigm is that it refutes the very foundation of economics and changes the role and capability of such adjacent disciplines as Operations Research and Decision Analysis, eliminating their reductionism and making them usable in real world. The paradigm also narrows the role of Complexity Theory.

In particular, in its obsession with "free market," economics deliberately shuts its eyes to "the commons tragedy" over the overall trading balances of countries in global trade. This is an inexcusable error. "Compensated Free Trade"™, a major component of the paradigm, corrects the error.

The main implication of the study is that if mankind does not follow the approach of self-preservation, its likelihood of survival may drastically decrease. Science may show the direction to go but, without proper actions, it will not save mankind. If mankind does not abandon the ways of dodo, it will go the way of dodo.

As all new research, this study should be expanded in several directions, such as criteria of collective decision-making. As everything else, this study is not perfect. In (Keynes 1921, p. v) Keynes remarks: "There is much here, therefore, which is novel, and, being novel, unsifted, inaccurate, or deficient." No revolution is tidy. So let us be vigilant – and tolerant.

The self-preservation of mankind would require fundamental unpopular changes. They might be implemented only if we are frightened by a serious shock. Let us pray that the shock would not be too serious. Amen.

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