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All problems arise from their root causes.

A Gentle Inquiry on How to Elevate the Earth System Governance Science and Implementation Plan to High Process Maturity

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Abstract

The business/engineering world routinely solves hugely difficult large-scale system problems, while social scientists struggle to do the same. Why the difference? Starting from that interdisciplinary question, this article explores why successful Earth System Governance (ESG) has been so impossibly hard to achieve, and concludes that if we have an open mind and are willing to borrow and adapt, then achieving successful ESG is realistically possible.

The article explains why the difference, identifies the gap to fill to close the difference, fills the gap with an innovative problem-solving process, and applies the process. Two notable process outputs, low political truth literacy as the main root cause of systemic change resistance and the Truth Literacy Training solution element, are presented. The article ends with a proposal, a look at a similar core process change, thoughts on governance, and suggestions for further research.

1. Introduction

The article reports on an innovative tool that offers social scientists a "causal telescope" for seeing the hidden causal structure of difficult large-scale social problems. If problem solvers cannot clearly see this structure, they are working blindfolded (due to reliance on a black box instead of a glass box model of the problem) and are forced to make educated guesses as to what solutions might work, leading to long trial and error.

We begin our inquiry by noting a striking pattern of behavior. The business/engineering world routinely solves hugely difficult large-scale system problems, while social scientists struggle to do the same. Businesses and engineers have solved problems like how to put a man on the moon in nine years, how to build the Panama Canal, how to eradicate smallpox, how to shrink a room sized computer so it fits in your pocket, how to clone animals, and many more. By contrast, social scientists have been unable to solve problems like large recessions, systemic discrimination, high income inequality (which includes the poverty problem), large-scale conflict like war, and the environmental sustainability problem. There are some exceptions, but the general pattern is one group usually succeeds, while the other group usually fails.

That social science lacks the capacity to routinely solve social problems is well known. "There is widespread agreement that social science research has done relatively little to solve social problems." (Weick, 1984) The "social science disciplines have historically emphasized the advancement of particular theories over the solution of practical problems." (Watts, 2017) These theories have proliferated. "For any topic X, social science has dozens, if not hundreds, of perspectives, but no single perspective on which there is anything close to universal agreement." (ibid) This lack of agreement arises from the fact that these theories lack *quantified analytical rigor*, the distinguishing hallmark of the soft sciences (Editorial, 2005; Storer, 1967). Due to lack of rigor, the theories are unable to routinely solve social problems or be more easily empirically tested, which would identify the stronger theories and strengthen theoretical consensus.

Where might we find that rigor? This report seeks to forcefully answer that question. But first we return to the pattern noted earlier: one group usually succeeds, while the other group usually fails. Why the difference?

The proximate reason is the business and engineering world solves *technical* problems, while social scientists solve *social* problems. Why might that account for such different outcomes?

We hypothesize the principal reason is that over the last few hundred years, the business/engineering world has developed a powerful collection of generic tools to solve difficult large-scale *technical* problems. By comparison the social science world lags far behind, and lacks a collection of mature generic tools designed to solve difficult large-scale *social* problems.

2. The three tools

Long inquiry found the critical tools, the ones accounting for most of the difference, fall into three main types. (Figure 1) These are:

Tool 1. *Root cause analysis*. A root cause is the deepest cause in a causal chain that can be resolved. In systems thinking terms, a root cause is that portion of a system that, at the fundamental level, explains why the system's natural behavior produces the problem symptoms rather than some other behavior. Root cause analysis is the systematic practice of finding, resolving, and preventing recurrence of the root causes of a problem. The only known method for reliably and efficiently solving difficult causal problems is root cause analysis.

Examples of mature cases of tool 1 are NASA's Root Cause Analysis Tool (NASA Safety Center, 2013) and Six Sigma, used by 82% of Fortune 100 companies (Antony, 2004). Six Sigma routinely cuts defect rates by two orders of magnitude, from roughly 6,210 defects per million transactions to 3.4 (Pyzdek, 2003, pp 5 and 60).

Tool 2. *Process-driven problem solving*. Here all problem-solving effort is driven by strict adherence to a formal process for solving that type of problem. A process is a repeatable series of steps and related practices to achieve a goal. Process maturity is a measure of how well a process solves problems the process was designed for. Process-driven problem

Due to extreme dynamic complexity

A Difficult Social Probem

can be solved only by

Tool 1
Root Cause Analysis

doing this reliably and efficiently requires

Tool 2
Process Driven Problem Solving

getting the process right for this type of problem requires
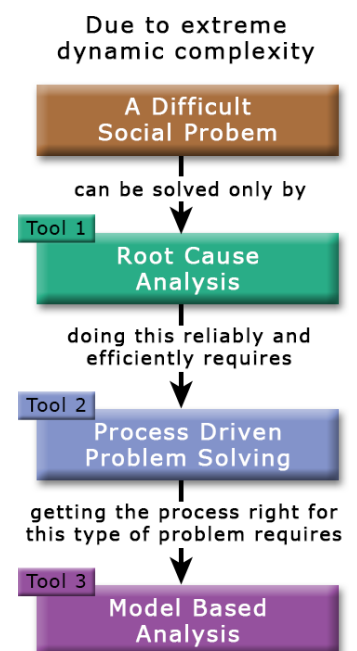
Tool 3
Model Based Analysis

Figure 1. The Three Main Tools, showing how they work together.

solving offers two key benefits: (1) The process can be uniformly learned and applied by all team members, thus making it scalable. (2) Most importantly, the process can be continuously improved until it's mature enough to solve the problem to the desired level of quality.

We have been unable to find a single case in business or engineering where process-driven problem solving was *not* used on difficult large-scale technical problems. It thus appears that process-driven problem solving is the only known method for solving problems of this class.

Examples of mature cases of tool 2 are the Toyota Production System (Ohno, 1988), Intel's Manufacturing Quality Process (Intel, 2013), and Lean (Womack, Jones, & Roos, 1990). All have exceptionally high process maturity.

Tools 1 and 2 are such a powerful combination they are used by all large companies in auto manufacturing, aircraft manufacturing and flight, pharmaceuticals, and high-tech electronics, and are rapidly spreading to other industries.

Tool 3. *Model based analysis*. A model is a simplified representation of reality. In model driven analysis, one or more models are used to discover and describe the essential causal structure of the problem and simulate its behavior. Model based analysis is required in difficult large-scale social problems for correct analysis due to extreme dynamic complexity, which causes feedback, nonlinear behavior, adaptive responses by social agents, delays in time, and so on (Sterman, 2000, p22). These characteristics make determining correct causal structure and predicting behavior impossible without a feedback loop simulation model, due to limitations of the human mind.

Examples of mature cases of tool 3 are the *Limits to Growth* project (Meadows, Meadows, Randers, & Behrens, 1972) and Jack Homer's exquisite system dynamics models on problems like worker burnout, HIV transmission, cocaine prevalence, antibiotic resistance, community collaboration, diabetes population dynamics, and national health reform (Homer, 2012).

Mature cases of the tools are *reliable*, because they achieve their goals a high percent of the time. They are also *efficient*, because they do that rapidly at minimum cost. Each tool is analytically *rigorous* if properly applied, particularly when all three are combined and system dynamics modeling is used.

3.   Applying the three tools to social problems

Model driven analysis has been applied to social problems using system dynamics, econometric, agent-based, and other forms of modeling, with various amounts of success. But root cause analysis and process-driven problem solving have never been applied because no versions that work on difficult large-scale social problems exist. In addition, all three tools need to be elegantly integrated in order to magnify and sharpen their analytical power, as industry has done so well with tools 1 and 2. That is the gap to fill.

From 2003 to 2009 Thwink.org addressed this task, beginning with deep study of how the three tools evolved and worked in the business/engineering world. During these years we iteratively developed a problem-solving process as we applied it to the environmental sustainability problem. The result was the System Improvement Process (SIP) and the analysis results in Figure 3. The process was designed from scratch to solve difficult large-scale

social problems of any type. SIP incorporates all three tools in a tightly integrated manner and is highly flexible.[1]

A causal problem occurs when problem symptoms have causes, such as illness or a car that won't start. All causal problems arise from their root causes. Thus, all causal problems are solved by solutions that resolve the root causes, whether root cause terminology is used or not. All social problems are causal problems. SIP provides social scientists with a powerful "causal telescope" for seeing the previously hidden causal structure of difficult large-scale social problems and methodically organizing and modeling that structure so that it may be correctly understood.

Figure 2 summarizes how the ESG framework (Earth System Governance Project, 2018, p21) and SIP work. By comparing the two approaches we can more clearly evaluate the opportunity of changing to a tool like SIP, since inspection shows the framework lacks the three tools.

In Figure 2A, "The purpose of this matrix is to identify and list key concepts and terminology for earth system governance research, but primarily to help generate salient research questions where contextual conditions and research lenses intersect. These questions would be applicable to a wide range of empirical domains." (ibid. p20) Three sample generated questions are shown. The framework is designed to drive problem solving by generating questions in order to "offer [the] analytical power" required for finding "policy responses." (Burch et al., 2019, p2-3)

In Figure 2B, SIP defines the problem in step 1. Step 2 decomposes the one big problem into carefully identified smaller and hence much easier to analyze subproblems. The three subproblems present in all problems of this class are shown. Each subproblem is then analyzed using steps A to E. Step 3 uses that information to converge on solution elements. Finally, step 4 implements those solution elements that have passed testing.

Compare the two matrices in Figure 2. The SIP matrix uses well-organized sequential steps to generate the key hypotheses needed to solve the problem by methodically inspecting the system and modeling its causal structure. SIP is a fill-in-the-blanks matrix, with one instruction per cell. A completed matrix contains one hypothesis per cell. Overall process design allows work to proceed *reliably*, because it's based on the three tools. The matrix allows work to proceed *efficiently*, because you always know where you are in the process and what to do next.
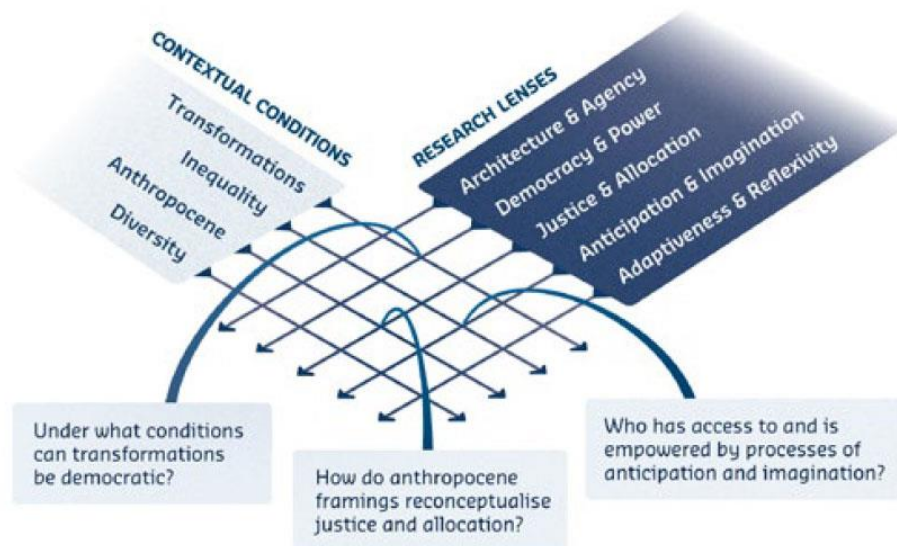
Most importantly, work proceeds with *quantified analytical rigor* since all three tools and system dynamics modeling are used. The rigor comes from uniform application of the same mature process, strict use of the matrix to build a complete glass box model of the problem with no gaps (unexplained critical relationships) in the causal structure, the way low and high leverage point hypotheses can be relatively easily empirically tested since they are so tightly focused on real world behavior, and the way system dynamics models offer a fully quantified description of the key portions of the analysis. Reliability, efficiency, and rigor are maximized by continuous process improvement.

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[1] An introduction to SIP may be found in the glossary entry for SIP at Thwink.org. How SIP works and how it was applied to the global environmental sustainability problem is described at length in the book *Cutting Through Complexity* at Thwink.org.

By contrast the framework matrix generates many general questions per cell in no particular methodical manner. There is no concept of a completed matrix. Analysts can start anywhere and do anything next. The questions are essentially creative hints at further exploration, and are not sequentially structured into "a repeatable series of steps and related practices to achieve a goal," which is the definition of a process. The framework is therefore not a process. It also does not use root cause analysis or model driven analysis.

Because the framework lacks the three tools there is no inherent expectation that framework users will proceed in a reliable and efficient manner. The framework has, however, taken the vital step of establishing the paradigm that a systematic problem-solving approach of some kind must lie at the heart of transition to successful ESG.

A. The Earth System Governance Research Framework

CONTEXTUAL CONDITIONS
Transformations
Inequality
Anthropocene
Diversity

RESEARCH LENSES
Architecture & Agency
Democracy & Power
Justice & Allocation
Anticipation & Imagination
Adaptiveness & Reflexivity

Under what conditions can transformations be democratic?

How do anthropocene framings reconceptualise justice and allocation?

Who has access to and is empowered by processes of anticipation and imagination?

B. The System Improvement Process (SIP)

— The four main steps
— The five substeps of analysis
— The standard three subproblems of the main problem

1. Problem Definition		The System Improvement Process		
Subproblems		A. How to Overcome Change Resistance	B. How to Achieve Proper Coupling	C. How to Avoid Excessive Model Drift
		Symptoms	Symptoms	Symptoms
2. Analysis	A	Find the immediate cause of the subproblem symptoms in terms of the system's dominant feedback loops.		
Spend about 80% of your time here. The problem solving battle is won or lost in this step, so take the time to get the analysis right.	B	Find the intermediate causes, low leverage points, and superficial (symptomatic) solutions.		
	C	Find the **root causes** of the intermediate causes.		
	D	Find the feedback loops that should be dominant to resolve the root causes.		
	E	Find the **high leverage points** to make those loops go dominant.		
3. Solution Convergence		Converge on solution elements to push on HLPs, with testing.		
4. Implementation		Implement solution elements that pass testing.		

Superficial Layer (rows A–B)
Fundamental Layer (rows C–E)

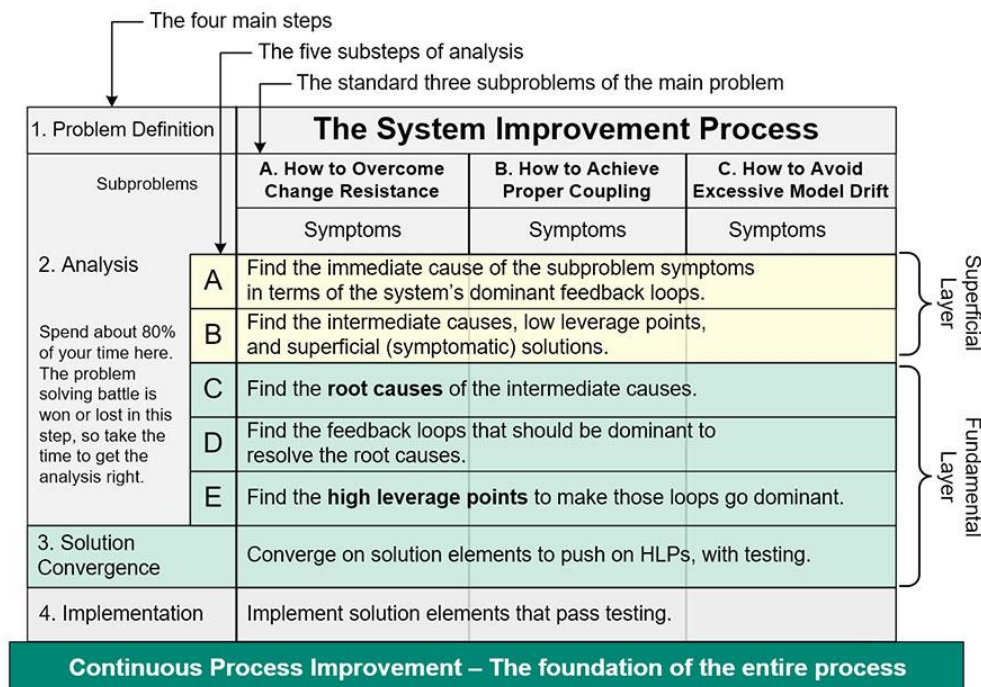**Continuous Process Improvement – The foundation of the entire process**

Figure 2. Summaries of the ESG framework and SIP. Each centers on a matrix.

This leads to *the* key conclusion of this article: Instead of coordinating research using the contextual conditions and research lenses matrix*, the ESG plan needs to coordinate research using a standard problem-solving process incorporating the three tools.* This would give the plan the reliability, efficiency, and rigor it presently lacks.

4.   Walking an analytical thread using SIP

Figure 3 summarizes the results of applying SIP to the environmental sustainability problem. To explain how SIP works and demonstrate how it may be mature enough to support the above conclusion and serve as a suitable seed process for the ESG community, let's follow the analytical thread in column A from symptom to solution element.

Analysis began with step 1, problem definition, "How to achieve global environmental sustainability in terms of the desired goal state." For climate change for example, the goal state is expressed as a certain maximum temperature rise, as set by international agreement.

Summary of Analysis Results of Executing SIP on the Global Environmental Sustainability Problem

1. Problem Definition		How to achieve global environmental sustainability in terms of the desired system goal state			
	Subproblems	**A.** How to Overcome Change Resistance	**B.** How to Achieve Life Form Proper Coupling	**C.** How to Avoid Excessive Model Drift	**D.** How to Achieve Environmental Proper Coupling
2. Analysis / A. Find immediate cause loops	Subproblem symptoms	Successful opposition to passing proposed laws for solving the environmental sustainability problem	Large for-profit corporations are dominating political decision making destructively	Inability to correct failing solutions (1) when they first start failing	The economic system is causing unsustainable environmental impact
	Improperly coupled systems	Not applicable	Corporate and human life forms	Not applicable	Economic and environment systems
	Analysis model	Basic Dueling Loops of the Political Powerplace	Complete Dueling Loops model. This adds the Alignment Growth loop.		The World's Property Management System
	Immediate cause dominant loops	The Race to the Bottom among Politicians		Intelligent Adaptation loop in evolutionary algorithm model	Industrial Growth and Limits to Growth (the IPAT factors)
B. Find inter. causes, LLPs, SSs	Intermediate causes	System acceptance of the fallacious paradigm that Economic Growth Is Good above all else	Strong resistance from corporate proxies to solving problems that corporations don't want to solve	Laws giving corporations advantages over people	Externalized costs of environmental impact
	Low leverage points	More of the truth: identify it, promote it, magnify it	Logical and emotional appeals and bargaining	Citizens must directly reverse laws that favor corporations	Internalize costs
	Symptomatic solutions	Technical research, environmental magazines and articles, awareness campaigns, marches, sit-ins, lawsuits, lobbying, etc.	Corporate social responsibility, green investment funds, NGO/corporate alliances, etc.	Media use, campaigns, lobbying to get bad laws repealed	Main solutions at system level are regulations and market-based. At agent level main solutions are 3 Rs and collective mgt.
	C. Find the **root causes** of the intermediate causes	The inherent advantage of the Race to the Bottom, which causes that loop to be dominant most of the time	Mutually exclusive goals between top two social life forms, *Corporatis profitis & Homo sapiens*	A high rate of defects in the political decision-making process	High transaction costs for managing common property sustainably
	D. Find the loops that should be dominant to resolve root cause	You Can't Fool All of the People All of the Time	Alignment Growth	A Politician Decision Making Feedback loop of some kind	Sustainability Growth and Impact Reduction
	E. Find the **high leverage points** to make those loops go dominant	Raise general ability to detect political deception from low to high.	Correctness of goals for artificial life forms. These must align with the goal of *Homo sapiens*.	Raise maturity of the political decision-making process from low to high.	Allow firms to appear to lower transaction costs for managing common property sustainably.
3. Solution Convergence		Several solution elements	Corporation 2.0, *Corporatis publicus*	Politician Decision Ratings	Common Property Rights
4. Implementation		Not yet ready for implementation because process execution is incomplete.			

Figure 3. Summary of Analysis Results. (1) to the environmental sustainability problem.

4.1. Analysis of the change resistance subproblem

Step 2 of SIP first decomposed the one big problem into four subproblems. The critical subproblem is how to overcome systemic change resistance, column A. Polls show that society knows what it should do: be environmental sustainable, with climate change as the top priority (Fagan & Huang, 2019; Taylor, 2019). But it's not doing that. The system is strongly resisting change, as seen in the subproblem symptom of "Successful opposition to passing proposed laws for solving the environmental sustainability problem."

The change resistance subproblem was then analyzed. Step A is "Find the immediate cause of the subproblem symptoms in terms of the system's dominant feedback loops." Using the model shown in Figure 4, the dominant loop was found to be *The Race to the Bottom among Politicians.* In this loop politicians compete to see who can tell the biggest most attractive lies to win supporters. This effect is so large we live in a *Post-Truth* age (McIntyre, 2018; Peters, Rider, Hyvonen, & Besley, 2018) driven by *The Politics of Lying* (Cliffe, Ramsay, & Bartlett, 2000) and corporate spin (Dinan & Miller, 2007), where *Dirty Politics* (Jamieson, 1992) using deception has become the norm.

Step B is "Find the intermediate causes, low leverage points, and superficial (symptomatic) solutions" that have thus far failed to solve the problem, because they pushed on low leverage points. By learning why past efforts failed we can avoid continuing that error.

The intermediate cause of the symptom is "System acceptance of the fallacious paradigm that Economic Growth Is Good Above All Else." For example, Herman Daly, referring to his reading *The Limits to Growth* forty years earlier when it was first published in 1972, wrote in 2012 that "it is now forty years later and economic growth is still the number one policy goal of practically all nations; that is undeniable." (Randers, 2012, p73)

The low leverage point (*true memes* on the model) for resolving the intermediate cause is "More of the truth [about the need to be sustainable and how to do that]: identify it, promote it, magnify it."

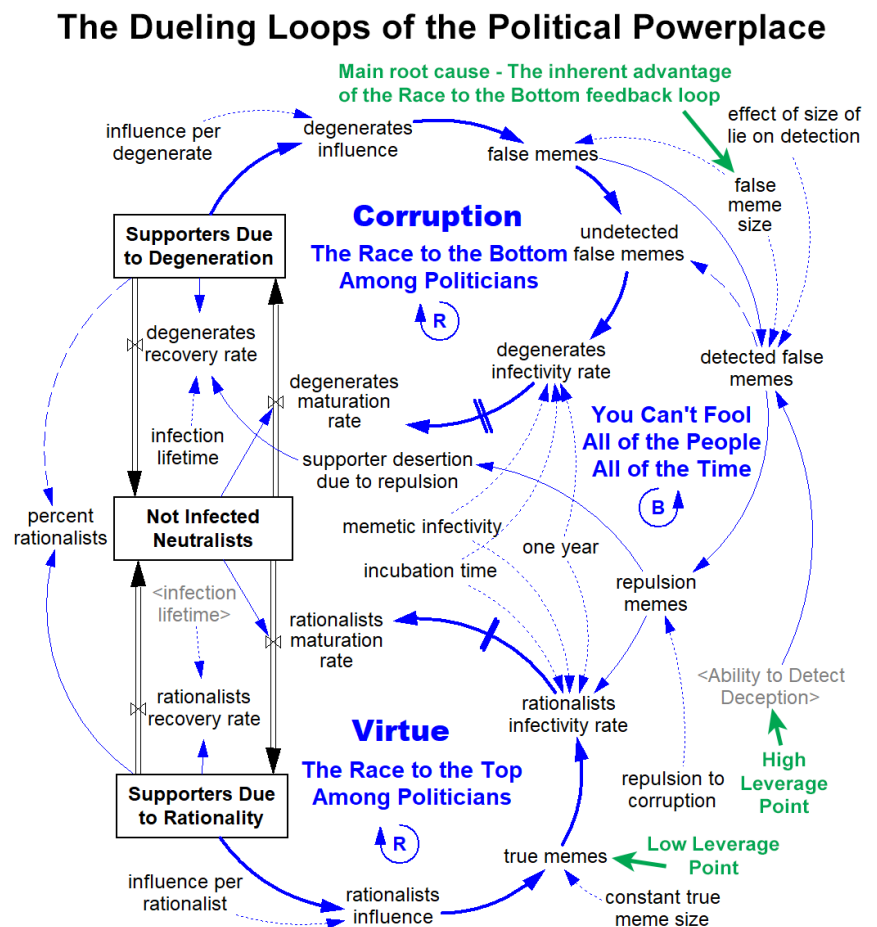### The Dueling Loops of the Political Powerplace

Figure 4. Main structure of The Dueling Loops of the Political Powerplace system dynamics simulation model. Currently *The Race to the Bottom Among Politicians* is the dominant loop most of the time. This causes lock-in to the current undesired mode, where high systemic change resistance to solving common good problems causes the human system's behavior to be environmentally unsustainable.

Superficial solution elements to identify, promote, and magnify the truth are "Technical research, environmental magazines and articles, awareness campaigns, marches, sit-ins, lawsuits, lobbying, etc." Superficial solutions fail or have much less than the intended effect because they attempt, in vain, to resolve the intermediate cause rather than the root cause.[2]

Step C penetrates to the fundamental layer of the problem with "Find the root causes of the intermediate causes." The main root cause was found to be "The inherent advantage of *The Race to the Bottom*, which causes that loop to be dominant most of the time." (*false meme size* on the model) The inherent advantage occurs because the attractive power of false memes (political deception) can exceed that of true memes (the political truth in terms of optimizing the long-term common good of all), since the size of a falsehood (and hence its attractive power) can be inflated while the size of a truth cannot. Alternatively, we can go even deeper and summarize the root cause as *low political truth literacy*. Truth literacy is the ability to tell truth from deception. The higher a person's truth literacy, the higher the percentage of deceptive claims they can spot and not be fooled.

Step D is "Find the feedback loops that should be dominant to resolve the root causes." The loop that should be dominant is *You Can't Fool All of the People All of the Time*. Once the root cause is resolved and that loop goes dominant, deception no longer works well. Dueling loop dominance would then rapidly shift from *The Race to the Bottom* to *The Race to the Top*, as politicians change their strategy from competing to see who can tell the biggest most attractive lies to gain supporters, to who can tell the biggest most attractive truths.

Step E is "Find the high leverage points to make those loops go dominant." The high leverage point is "Raise general ability to detect political deception" or more briefly "Raise political truth literacy." (*Ability to Detect Deception* on the model)

Note what we've accomplished up to this point. We put the causal telescope to our eyes and looked at the same system we've seen before. But now we see so much more. The missing detail is there, so a series of specific steps thoughtfully applied took what we could see and used it to build a model of the essential causal structure of the subproblem. That structure was always there, but now that we have the right tool, we can plainly see it.

This results in powerful new insights. We now clearly know *what not to do* (don't keep pushing on the low leverage point) and *what to do* (push only on the high leverage point with enough force to resolve the root cause). In terms of synthesis and discovery, the hardest part of our work is done. We have a correct diagnosis. The process is now so correctly focused that remaining work is relatively straightforward, though it will take time and some iteration. We know our target: push on the high leverage point to raise truth literacy from low to high. Next, the process determines how to do that.

4.2. *Testing the high leverage point with an empirical study*

Step 3, solution convergence, determines how to push on the high leverage point. A high leverage point is a solution strategy that can be realized with one or more solution elements. The change resistance subproblem is so hard to solve that the solution convergence step designed nine sample solution elements for raising political truth literacy. One is The Truth

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[2] For a different model explaining change resistance, low leverage point behavior, the effect of implicit system goals on change resistance, Classic Activism, and the Forces Resisting Change see (Harich, 2010).

Test, also called Truth Literacy Training. The idea is to train voters on how to tell truth from deception, so they can make better voting decisions.

To test how well Truth Literacy Training can push on the high leverage point, on October 2, 2019 we ran a study on 93 US subjects aged 22 to 51 using three randomly assigned treatment groups, a Prolific online panel, and our own software. Number of participants in the three groups was 30, 30, and 33. Average completion time was 85 minutes, including a 5-minute break half way through.

Group 1 received training on a neutral topic. Group 2 received training on how to tell if a political claim was true or false, by spotting the pattern of fallacy or non-fallacy used. Group 3 received the same training as group 2 plus training on how to vote correctly, given whether a claim made by a politician was true or false. This consisted of applying the Penalize the Deceiver rule if a claim was false and the Reward the Truth Teller rule if a claim was true.

The claims were embedded in non-hot, typical but fictional statements averaging 124 words. The false statements employed seven fallacies we found common in political appeals: cherry picking, flawed application of the Strong Evidence Rule, ad hominem attack, appeal to emotion, strawman, false dilemma, and false fact lie.

Here's why the spot-the-pattern of deception form of training can be so effective. *It can potentially nullify the deceptive power of goal-oriented motivated reasoning*, a theory explaining how political decision-making works. "In short, citizens are often *partisan* in their political information processing, motivated more by their desire to maintain prior beliefs and feelings than by their desire to make 'accurate' or otherwise optimal decisions." (Lodge & Taber, 2013, p149-150) When a prior belief is false, such as racism or climate change denial, deception has occurred. Here partisan means strong adherence to a party, cause, person, idea, etc.

The purpose of deception is to create a false belief that benefits the deceiver at the expense of the deceived. False beliefs are created and strengthened by fallacious arguments, which work when someone fails to spot a fallacy. Deceivers use fallacies like the seven listed above to implement deception strategies like identity politics, backlash politics, wrong priorities, the big lie, false enemies, and personality cult leader. These strategies create false beliefs, which become a person's false goals. The strategies work because they exploit the power of goal-directed motivated reasoning to cause people to avoid and rationalize away anything that disagrees with a false goal, and to seek out and accept anything that agrees. But once a person learns how to spot a fallacy pattern, they are inoculated. That fallacy can no longer be used to fool them into a false goal, so they never believe the false goal in the first place or they question a false goal already held.

Statements were presented in random order. Each statement was followed by three questions: the *truth question* (How true to you feel that claim is?), the *probe question* (What is the main reason for your decision in the above question?), and finally the *vote question* (described later).

Study results (Figure 5) confirmed a number of hypotheses that hold for US voters and probably most other democracies. Logical truth quotient (LTQ), the ability to tell if a deceptive claim is true or false, was measured by the truth question. LTQ is naturally low, about 8% for group 1. Voters not trained in truth literacy can spot a fallacy in a false political statement an average of only 8% of the time.

Democratic truth quotient (DTQ), the ability to vote correctly given a deceptive claim made by a politician, was measured by the vote question. DTQ is also naturally low, at 2% for group 1. *This is a crucial finding and explains why change resistance to solving common good problems, achieving the SDGs, and adopting reforms like ESG is so stubbornly high.*

Because truth literacy is naturally low, voters are easily fooled into voting for candidates who do not work for the common good, but instead work
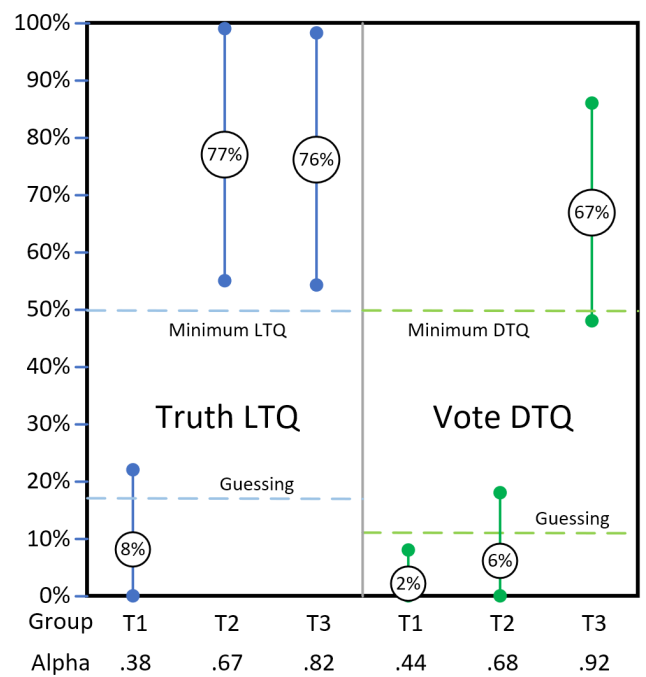

Figure 5. Average scores and 95% confidence intervals for answers to deceptive statements. Treatment groups were:
T1 – Trained on neutral topic
T2 – Trained on claims
T3 – Trained on claims and vote

for the uncommon good of powerful special interests (notably large for-profit corporations and the rich) or themselves. The latter includes the current rise of authoritarians, like Putin, Trump, Turkey's Erdogan, and Hungary's Orban (Synder, 2018). "The transition from democracy to personality cult [aka authoritarianism] begins with a leader who is willing to lie all the time, in order to discredit the truth as such. The transition is complete when people can no longer distinguish between truth and feeling." (ibid) "The ideal subject of totalitarian rule is not the convinced Nazi or Communist, but people for whom the distinction between fact and fiction, and the distinction between true and false, no longer exist." (Kakutani, 2018, p11)

DTQ for group 2 was 6%, a deeply counterintuitive discovery. We expected it to be low, but not that low. The 6% means that even if voters have been trained on how to tell if a deceptive claim made by a politician is true or false, they are unable to correctly translate that knowledge into how to vote correctly. Group 2, which received claim training but not vote training, averaged spotting falsehood 77% of the time, but could translate that knowledge into voting correctly only 6% of the time. The claim training made almost no difference on voting correctly.

The key data is DTQ for groups 1 and 3. The large increase, from 2% to 67%, a 65-point rise, is extremely good news. *The increase suggests the solution element may be capable of resolving the root cause of low political truth literacy.* Group 3 training took only about one hour, suggesting that Truth Literacy Training, such as in education systems and online self-training, will not require that much of a person's time.

4.3. Drilling down into the raw data

The vote question was "If the election were held today and this was all the information you had, how much impact would what the politician claimed have on your decision to vote for or against the politician?" The answer used a nine-point Likert scale:

1. Very large increase in support.
2. Large increase in support.
3. Medium increase in support.
4. Small increase in support.
5. It would make no difference.
6. Small increase in opposition.
7. Medium increase in opposition.
8. Large increase in opposition.
9. Very large increase in opposition.

Figure 6 contains distributions of the vote question answers. The correct answer is 9 for deceptive and 1 for non-deceptive statements. Any deviation from correct answers for deceptive statements means a person has been partially deceived, and that adds up. Deviations from correct answers for non-deceptive statements means a person doesn't understand how to best support those politicians who speak the truth (instead of falsehoods) about what's best for their constituents. Let's examine the three rows for the treatment groups.
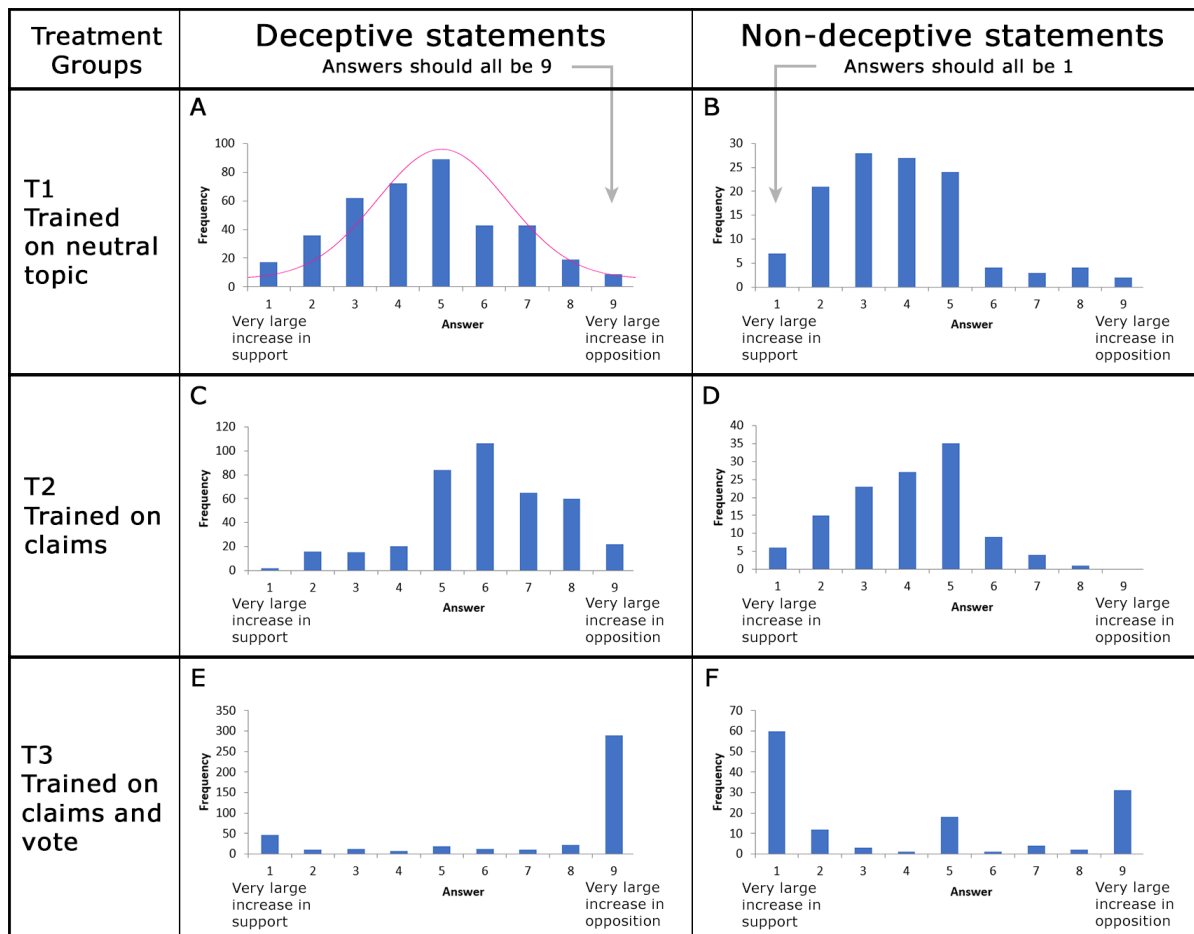
Figure 6. Distributions of vote question answers. A normal distribution curve has been added to one chart for discussion.

T1. Trained on neutral topic – While the effect probably varies across political units and study samples, we expect that *the first row approximates how voters in democracies behave today*. Looking at chart A, there's more support than opposition in response to a deceptive political claim. This has not gone unnoticed by politicians willing to engage in deception. Also notice how close the data comes to a normal distribution centered on the midpoint. *This indicates a person's level of truth literacy is largely due to random factors,* i.e., environmental and genetic chance, rather than the formal education seen in charts C and E.

T2. Trained on claims – The second row offers slightly more comforting results. Citizens trained on how to determine the truth of claims but not trained in how to vote, intuitively lean in the correct directions on vote answers. But very few choose the correct answers, which are 9 or 1. A surprising percentage chose answer 5, "It would make no difference." That's like saying "It doesn't matter to me at all if a politician tells the truth or not." But yet it must, if democracy is to thrive. This is why the vote training in T3 is required.

Similar observations apply to the other incorrect answers. For example, answers 4 and 6 are like saying "It barely matters to me if a politician tells the truth or not."

T3. Trained on claims and vote – The third row, if we could get enough voters there, would resolve the root cause of low political truth literacy. For the solution element to work, we estimate only 5% to 15% of an electorate needs effective training since most elections are close. The biggest training impact would be on uncommitted young and swing voters. Voters already strongly committed to a false ideology (corrupt supporters in Figure 4) would tend to resist change due to the deceptive power of goal-oriented motivated reasoning, though it's possible the training could nullify that effect on some. The training is not needed for voters already supporting truth telling politicians (virtuous supporters). This suggests that initially, training should target those who would benefit the most. In the long-term, all citizens should be trained.

On chart F, participants exhibited significant confusion (seen in the spikes on answers 2, 5, and 9, which should be near zero), indicating training material needs improvement in this area.

4.4. Follow up study results

A follow up study was run 26 days later, with a 20% dropout rate. A second set of statements was used to avoid memory effects. The second questionnaire consisted of three parts: pre-refresh statements, refresh training, and post-refresh statements. The refresh training involved reading the same reference material from the first questionnaire and answering 4 short questions instead of the twenty some much longer questions in the first questionnaire. Refresh training was about 30 minutes, versus about 60 minutes for initial training.

Pre-refresh scores for treatment groups T2 and T3 for the truth questions were 67% and 66%. Compared to scores of 77% and 76% in the first questionnaire, t*his is a decline of only 11 and 10 points, a very favorable result.* Post-refresh scores were 69% and 75%, indicating a small amount of refresh training can boost truth literacy back to about its original level, at least for T3 which is complete training. Vote questions behaved in a similar manner.

However, truth scores for treatment group T1 were 22% and 20% for the pre-refresh and post-refresh statements, versus 8% for the first questionnaire. This indicates that spotting deception was substantially easier in the second questionnaire statements. This also suggests

there was more than the 11 and 10 point declines noted above. A more accurate measure of training persistence would require further statement testing/development and rerunning the study using balanced statements of equal difficulty in the first, second, and even later questionnaires.[3] During this work the training could be improved as needed.

As expected, the data shows that regular refresh training of some type will be continually required. This need not come only from traditional forms of continuing education, but can also come from regular exposure to the training concepts via other forms, such as fact check articles on deception in political statements and use of the training concepts in news shows and publications. Truth literacy education (initial and continuing) can also come from general exposure to *a truth-literacy-oriented culture*, *where political truth literacy is deemed to be the most important literacy of them all,* if democracy is to function as designed. Only then can sustainable governance be achieved.

Peering into the future, what might a truth-literacy-oriented culture look like in a political powerplace where politicians and parties market themselves and the best deceiver wins, unless that deception is thwarted? The key cultural trait might be something like "Marketplace Deception Protection Skills…. A person who is skilled in deception protection will have well-learned mental procedures designed to detect, neutralize, resist, correct for, and penalize deception attempts…. More broadly, consumers adept at deception self-protection will learn to warn and protect friends, kin, and loved ones…. Most broadly, consumers must learn to adopt a deception protection goal as their default…." (Boush, Friestad, & Wright, 2009, p123-124)

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[3] The second set of statements was developed after the first questionnaire was run. Without realizing it, we structured them slightly differently and frequently omitted stating how strongly supported the premises were. This caused the second set to be substantially easier than the first set, as it made fallacies easier to spot. This problem is easily corrected.

4.5. *Social force diagrams and the desired mode change*

SIP employs Social Force Diagrams (SFDs) as a problem analysis tool. SFDs show at a glance the high-level causal structure of a problem and the desired mode change. Analysis begins with the standard format of Figure 7A. Figure 7B shows the completed SFD for sub-problem A.[4]

Social force diagrams simplify difficult social problems to their three main forces. The first is the *root cause forces* (force R) causing the problem. In difficult problems this systemic force is so strong it causes current mode lock-in and inherent high resistance to mode change. *Systemic* means "originating from the system in such a manner as to affect the behavior of most or all social agents of certain types, as opposed to originating from individual agents." (Harich, 2010) The central role of lock-in in the environmental sustainability
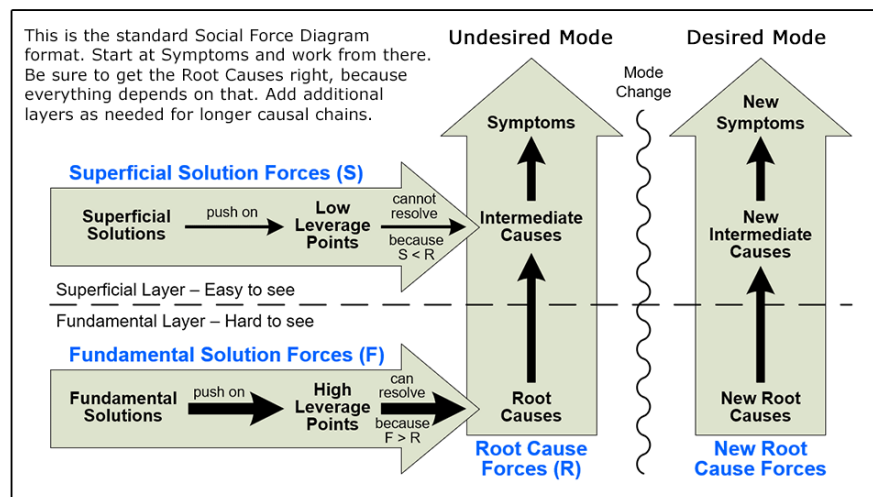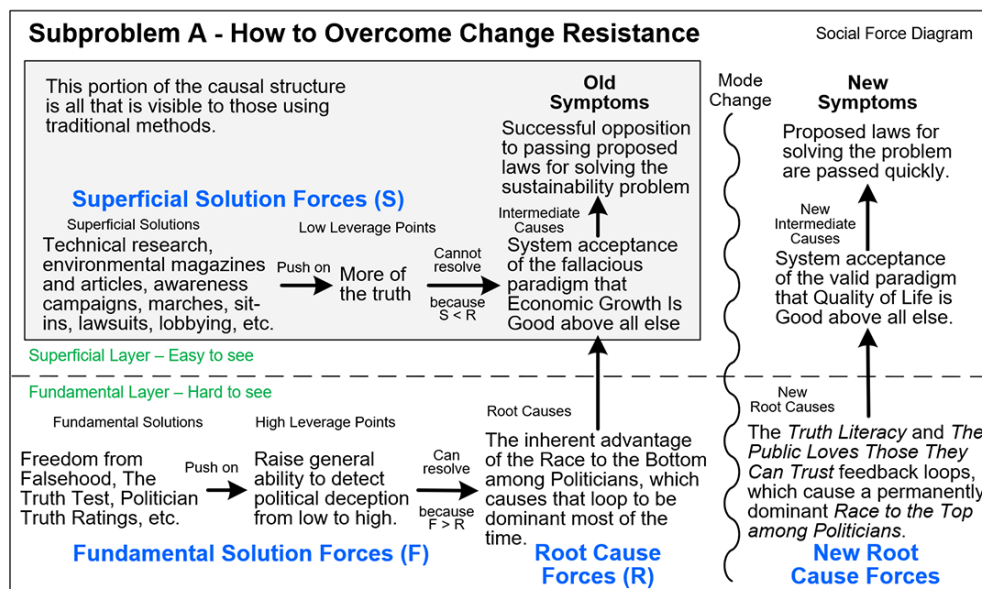
Figure 7. Standard and Subproblem A SFDs. The pre-mode change portion of the lower diagram was created by rearranging column A in Figure 3.

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[4] For more on SFDs and several examples, see the glossary entry on Social Force Diagrams at Thwink.org.

problem has long been noted, such as by Hardin in *The Tragedy of the Commons*: "Each man is locked into a system that compels him to increase his herd without limit—in a world that is limited." (Hardin, 1968) The system dynamics literature calls lock-in "policy resistance, the tendency for interventions to be delayed, diluted, or defeated by the response of the system to the intervention itself." (Sterman, 2000, p5) Lock-in occurs in all difficult systemic social problems.

Working backward from the symptoms, problem solvers identify what they believe are the causes and develop solutions based on that assumption. If it's a difficult problem the solutions fail at first because they are *superficial solution forces* (force S) attempting (in vain) to resolve intermediate causes. This is the second type of force.

Using traditional methods, all problems solvers can see is what's in the gray box on the superficial layer (Figure 7B). But with root cause analysis, problem solvers can penetrate to the fundamental layer and see the complete causal structure of problem, which contains the root causes and their high leverage points.

Once the root causes are known the third type of force can be employed. *Fundamental solution forces* (force F), if properly designed, resolve the root causes by changing the feedback loop structure of the system such that a new homeostasis (dynamic equilibrium) becomes more attractive. Lock-in to the present mode ends, causing the system to quickly transition to the desired new mode. The system stays locked into the new mode due to the new root cause forces introduced by the fundamental solution forces. If analysis and solution convergence testing are done well, the solution force will solve the problem rapidly and relatively permanently.

The analytical power and scientific rationale of SFDs arises from what SIP calls The Six Laws of Root Cause Analysis. The laws are:

1. *All causal problems arise from their root causes*. Therefore, solving causal problems requires correct understanding of their causal structure.

2. *Superficial solutions fail because S < R,* since force S is directed at an intermediate cause. Force S is always less than force R, because root causes exert much more force on intermediate causes than superficial solutions ever can. This explains why low leverage points exist.

3. *Fundamental solutions can succeed because they can be designed such that F > R,* since force F is directed at a root cause. This explains why high leverage points exist.

4. *If analysis shows no F > R exists, the problem is insolvable.* When this is encountered the problem should be redefined such that at least one $F > R$ exists, and analysis should start over with the new equation(s) in mind. Or solution should not be attempted and the problem declared insolvable. But now you know exactly *why* it cannot be solved and will not waste any more effort on solving it.

5. *Difficult large-scale problems have multiple root causes.* This is why SIP decomposes the one big problem into smaller subproblems, each of which has one or more root causes. Without this decomposition correct analysis is impossible. Analysis uses one SFD per subproblem.

6. *Due to lock-in, difficult systemic problems can be solved only by correctly engineered mode changes.* Lock-in occurs due to the unrelenting strength of a system's dominant feedback loops. The desired mode change requires reengineering the system's structure such that when force F is applied, a new force R is created, and the system's current dominant feedback loops are replaced by new ones, causing the mode change to occur.

Study data demonstrates the Truth Literacy Training solution element can push on the high leverage point and, if study results generalize to real voters and elections, initiate the desired mode change. The push first activates and strengthens the *Truth Literacy Promotion* and *The Public Loves Those They Can Trust* feedback loops (not shown). These loops create the *New Root Cause Forces* driving the mode change, and strengthen the *You Can't Fool All of the People All of the Time* loop (shown on Figure 4).

The mode change begins. (Figure 8) The higher strength of the *You Can't Fool* loop increases *detected false memes*, which weakens *The Race to the Bottom* and strengthens *The Race to the Top*. This causes *The Race to the Top* loop to grow in dominance and (in order to optimize the common good) feeds back to stronger pushing on the high leverage point, which in turn strengthens the *New Root Cause Forces*. This feedback continues until the winning strategy for politicians becomes telling the truth. Soon the *New Intermediate Causes* become "System acceptance of the valid paradigm that Quality of Life is Good above all else." This in turn causes the *New Symptoms* to become "Proposed laws for solving the sustainability problem are quickly passed." The mode change completes and the problem is solved.
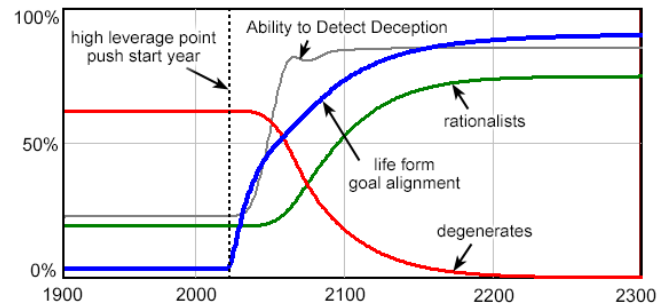

Figure 8. A scenario showing how raising political truth literacy can lead to a dominant Race to the Top. Note how long the mode change takes. Other scenarios improve on this by pushing on additional high leverage points. Life form goal alignment refers to the high leverage point of subproblem B.

4.6. Study implications

It thus appears there's a relatively easy way to successfully push on the high leverage point and thereby raise a population's political truth literacy from low to high. *Doing so has the clear potential to greatly reduce change resistance and thereby rapidly lead to solution of most or all of the sustainability problem, depending on how well study results generalize to real voters and elections.* We realize this is an extraordinary claim, but let's remember that solutions based on the three tools have never been applied to the sustainability problem before. We should therefore expect the same astonishing surprises and successes that occur when business and engineering apply forms of the same three tools to their own biggest problems.[5]

Using SIP, section 4 walked an analytical thread in a single subproblem, from symptoms to a solution element. We wish to draw your attention to these results:

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[5] Better than pushing on the high leverage point with a single solution element would be a multi-pronged attack using multiple solution elements. The solution convergence step designed nine sample solution elements for doing this. But the central claim remains the same: there's a relatively easy way to successfully push on the high leverage point.

1. Like a telescope that brings what you're looking at into sharp focus, the process let us see the full causal structure of the problem, which led right to an innovative, very promising high leverage point that tested well the first time. This demonstrates high process efficiency.

2. The process produced an extraordinary and plausible claim for solving the entire problem, which demonstrates the power of the tool to quickly lead to high process maturity, though tool improvement will be needed since SIP is essentially version 1.0.

3. The process identified a large critical gap in the literature: the role of political truth literacy in voting behavior and the health of democracy. The process clearly identified the gap, demonstrated that filling the gap can have highly beneficial impact, and showed how to get started experimentally.

4. The process is simple to learn and straightforward to apply, though much thoughtful work is required. Other than system dynamics simulation modeling, there are no difficult new skills to master. Only one good modeler is needed on a small team.

These results serve to support the conclusions that follow.

5. Conclusions

First, as concluded in section 3, "Instead of coordinating research using the contextual conditions and research lenses matrix, the ESG plan needs to coordinate research using a standard problem-solving process incorporating the three tools."

Second, use of all three tools in an integrated process like SIP appears to provide the quantified analytical rigor needed for social science to begin the transformation from a soft to a hard science.

Third, after long development and our first experimental study, the System Improvement Process (SIP) appears ready for general use, though we admit ignorance on where it will need improvement next. The analytical thread described in this article demonstrates the process is theoretically capable of solving the environmental sustainability problem by resolving its root causes reliably, efficiently, and rigorously, with a modest amount of empirical confirmation from the study. No other process we are aware of can do this.

Fourth, a lofty mountain of evidence from the business and engineering world demonstrates that tools 1 and 2 are required to reliably and efficiently solve difficult large-scale *technical* problems. From this we infer the same tools are required to reliably and efficiently solve difficult large-scale *social* problems. In addition, tool 3, model driven analysis, is required because solving the environmental sustainability problem requires a comprehensive mode change plan, using solution elements and strategies that were developed with the deep explanatory and predictive knowledge that only a feedback loop simulation model of the analysis can provide.

6. A proposal

Given these conclusions, we propose that the ESG community consider modifying the ESG Science and Implementation Plan, by adding a component centered on the main

problem-solving process to be used. *The component's goal would be "to coordinate research using a standard problem-solving process incorporating the three tools."*

In order to introduce the reliability, efficiency, and rigor required to achieve the ESG vision and the "urgent transformations" (theme of the 2019 ESG conference) required, this goal would replace the present plan policy of "By no means are these methods prescriptive and indicative of what method should be used for addressing the analytical problems and research questions introduced in the earlier sections." (p79) While other methods can be used for various aspects of the analysis, *the main analysis must use the process specified in the component.* A single standard process followed by all must lie at the core of the plan. This mimics the way countless business project plans, contracts, and operations standards strictly specify the procedures (or procedure requirements) to be used for certain tasks.

We acknowledge this is such a large and sudden paradigm change that there may be hesitation or pushback, especially considering how much work went into developing the present plan. However, we see no alternative, no slower or more cautious step forward that would work in time, though there may be one. Such a change would require considerable evaluation and planning. We are thus careful to sketch only the high-level aspects of the proposal. We look forward to critical debate, though with rapid closure since the clock is running out on the climate change crisis.

The component would include a list of best practice process principles, such as these:

1. *Solving difficult large-scale social problems reliably, efficiently, and rigorously requires process-driven problem solving, root cause analysis, and model driven analysis.* These are known as the three tools.

2. *The most important of the three tools is process-driven problem solving.* This is why Toyota Motor Company (inventor of root causes analysis and process driven problem solving in manufacturing using root cause analysis) stresses over and over that "The right process will produce the right results." (Liker, 2004. p85)

3. *Most or all of the behavior of interest in a social system problem is driven by a small number of root cause forces.* We estimate small to mean 1 to 5. For example, the SIP analysis of the environmental sustainability problem found 4 main root causes, one for each subproblem. Since resolving any one root cause resolves them all, the problem is driven by the equivalent of a single root cause.[6]

4. *Complex social systems cannot be designed and built all at once. Instead, they evolve by a long series of evolutionary changes.* Most of these are incremental nudges, while a very small number are leaps. The reason complex social systems cannot be designed and built all at once (as normally happens to hard science systems, like machinery and buildings) is that due to extreme dynamic complexity, sensitive starting conditions prevent accurate prediction of completed system behavior. Sensitive starting conditions (the butterfly effect) occurs when small changes in initial conditions produce large changes in long-term behavior.

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[6] For description of how resolving any of the four main root causes resolves them all, see the chapter on *Overview of Analysis Results*, in *Cutting Through Complexity* at Thwink.org.

An *evolutionary nudge* consists of a solution element pushing on a high leverage point to partially resolve its main root cause, or to fully resolve a minor root cause. An *evolutionary leap* consists of a package of solutions elements designed to resolve one or more major root causes and thereby trigger a favorable mode change. Thereafter the system behaves in a radically different manner. The foremost recent example of a social system leap was invention of modern democracy.[7]

5. *Difficult large-scale social problems can be reliably and efficiently solved by understanding their root cause forces and high leverage points, followed by use of that knowledge to design the appropriate evolutionary nudges and leaps.* This provides the basis for reliable and efficient Social System Engineering (SSE), which is essentially what the ESG community is trying to discover how to do at the global level *and is the real problem they are solving.*

The literature reports the field of SSE is still in Thomas Kuhn's pre-science stage. "There is an urgent demand for the development of SSE. …it is evident that the theoretical foundations for SSE are still being explored." (Wang & Li, 2018, pp19, 21) This gap can be filled. *The research reported on in this article, combined with further research and application by the ESG project, can speedily create the first correct version of the theoretical foundation.* This is a second extraordinary claim. We justify it using the same rationale as before in section 4.6.

The standard process must highly support the process principles.

Lastly, the component would include a seed process for getting started, such as SIP. Driven by relentless continuous improvement, from that gently planted seed will grow the process maturity that will ultimately realize the vision of the ESG Project, modern democracy, and the SDGs.

7.   An example of changing to a newly created core process

To familiarize readers with how other fields have seized an opportunity to replace their core process and done so rapidly and successfully, let's examine a recent case.

Changing to a more productive core process is common in business, where the benefits can be immense. A relevant example is Lean production, a generic version of the Toyota Production System that's become a world standard for process improvement in manufacturing and services. Anyone can learn Lean and expect to regularly make large improvements to their main production processes, which explains Lean's rapid global adoption.

Compared to traditional business production processes, Lean is radical change. Lean centers on eliminating waste by finding its root causes and implementing countermeasures to reduce waste to zero or near zero. Waste is anything that absorbs resources but doesn't add customer value. Types of waste are delays, excess product in work flow or finished inventory, defective products that must be reworked or discarded, customer dissatisfaction

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[7] Evolutionary nudges differ from behavioral psychology nudges, where "A 'nudge' is essentially a means of encouraging or guiding behavior, but without mandating or instructing, and ideally without the need for heavy financial incentives or sanction." (Halpern, 2015) Resolving a minor root cause does not cause a very noticeable systemwide mode change, while resolving a major one does. Typically, a minor root cause relates to a minor problem, while a major root cause relates to a major problem. A major problem can have minor and major root causes.

resulting in lost sales or fewer referrals, unnecessary process steps, and so on. All of these types of waste occur in university research, a service industry.

Lean was created in the late 1980s by a program at the Center for Technology, Policy, and Industrial Development at MIT. The program "spent five years exploring the differences between mass production and lean production in one enormous industry [auto manufacturing]. … In this process we've become convinced that the principles of lean production can be applied equally in *virtually every industry* across the globe…." (Womack et al., 1990, pp7-8) In 1990 three directors of the program published the results in the bestseller *The Machine that Changed the World: The Story of Lean Production*. The book launched the Lean revolution in Western industry.

As one example, Art Byrne mastered Lean and then personally applied it to "more than 30 different companies (or subsidiaries) spanning 14 different countries. …my approach [to implementing Lean] has always produced exceptional results for all stakeholders. … Applied correctly, it has the potential to change everything… [Lean] is easy to explain but hard to do. That's why you need a game plan that is simple, repeatable, and works in any type of business." (Byrne, 2013, p xii-xiii)

"In order to help you turn your company around, I have to be able to get you to see things differently. You have to develop '*Lean eyes'* so that you can see the waste that is clogging up your value-added activities. If, for example, I walked around your factory or office with you, I would see opportunities everywhere that you can't see. Don't worry. You won't be able to change your vision overnight, but if you follow the approach I have laid out, you will get there fairly quickly." (ibid, p xv) Like the causal telescope of SIP, Lean allows you to see things you could never see before.

Lean makes extraordinary claims about potential gains similar to those we've made in this article. And it delivers on those claims. For example:

"Several years ago [on a group educational trip to Japan] we had just finished a tour of a Toyota supplier [who practiced Lean]. In the Q&A session… we learned that it had only two days of total inventory [raw inventory, work in progress, and finished goods]. When I stood up to thank them in my closing comments, I mentioned that the four companies represented in our group had between 70 and 80 days of inventory. Once this was translated, it set off a lot of chattering and looks of disbelief among our hosts. They couldn't believe that anyone could possibly have that much inventory." (ibid, p xviii)

Back in the US at one of Art Byrne's companies, "This explosion of activity [lots of quick decisions to eliminate waste as part of conversion to Lean] was quite a shock for our people. So were the expectations. When we did our first rolling mill setup reduction *kaizen*, everyone on the team thought I was out of my mind when I said we were going to reduce the 14-hour rolling mill setup time to less than ten minutes. …several months later, when the setup time was down to 6 minutes, I was no longer crazy, and I had a new crop of energized believers." (ibid, p12) This is a typical example of rapid large improvement due to conversion and total commitment to a radical new process.

Summarizing, the MIT program studied an existing successful process (the Toyota Production System), identified its key principles and practices, and created a new process, Lean, that can be applied by anyone in any production industry. The results were so productive that 13 years later in 2003, in the sequel to *The Machine that Changed the World*, the authors

had the data to conclude that "*Lean Thinking* is the single most powerful tool available for creating value while eliminating waste in any organization." (Womack & Jones, 2003, p6, see also chapter 14)

We sincerely hope the results of studying the three tools and creating a new process for solving difficult large-scale social problems will be just as productive, because "The pace of change required in our societies, particularly to achieve the 1.5°C or 2°C degree targets, is stunning." (Earth System Governance Project, 2018, p12)

8. Thoughts on governance

What forms of sustainable governance would work best after the main root cause of systemic change resistance to solving common good problems is resolved and the human system enters the desired new mode, where needed reforms are no longer rejected and "the pace of change required" to achieve critical sustainability targets in time can begin? We really cannot say specifically and apologize for being neutral on this vital question.

But we can say that once that mode begins, *the human system will rapidly self-evolve in the proper direction* because the system now "wants" to self-govern itself as effectively as possible, as defined by jointly set goals. What exactly the emergent result would look like we cannot predict, just as no one could have reliably predicted (in any detail) the consequences of the cascading Scientific, Industrial, and Information Revolutions.

We can predict, however, that if tools like SIP work as well as the three tools have on business and engineering problems, then various social problems will be defined, analyzed, and solved at a rapid pace. This will start at the top, where each of the SDGs is a well-defined problem to solve. Priorities will be required.

Once the tools mature, that will allow precise Social System Engineering of specific aspects of local, national, regional, and global governance systems. After several decades this would become one more routine form of engineering, complete with licensed social system engineers, though this now seems like an impossible dream. Dreaming a little ourselves, historians will then declare we have entered the Social System Engineering Revolution and that the crisis of the Anthropocene is over, at least for now.

For example, if engineers/managers discover a governance system is deficient in a particular characteristic, like high income inequality, too many cases of injustice, or a flaw in the governance system itself, that will be defined as a problem to solve. It can then be rapidly solved to a high level of quality, because the system now "wants" to solve common good problems and has the tools to do so. A continual series of such incremental nudges to the system will always be needed, just as a skipper constantly keeps a hand on the tiller to steer in the preferred direction.

This leads to *a brief conceptual scenario* for how the ESG problem can be strategically solved: Once well tested solution elements like Truth Literacy Training are implemented in one nation and are used to raise political truth literacy from low to high, the main root cause of systemic resistance to solving common good problems will be resolved in that nation. It will then leap to the *local right mode* and suddenly become able to *rapidly* solve common good problems that were previously insolvable due to change resistance.[8]

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[8] How rapidly a society can change to directing all resources possible to a critical problem to solve, once that society has made the mode change to wanting to do that, can be seen in the case of industrial mobilization during World War Two. In

The solution will then quickly spread to other nations due to the tremendous benefits achieved, just as democracy itself spread long ago. At a certain point, global lock-in to the present wrong mode will end and the human system will undergo a mode change leap to the *global right mode*. Thereafter the system's new homeostasis will continually steer (self-manage) the system towards its preferred common good goals, where reasonably optimum (and unpredictable) forms of governance will automatically evolve.

According to the analysis, the dominant feedback loop in political systems will now be *The Race to the Top Among Politicians*. Because politicians will be competing to see who can tell the most attractive truths about what they can do to optimize the long-term common good for their constituents, state support for cooperatively setting, monitoring, and achieving joint common good goals (including the SDGs) will be systemically high, which has never happened before. Global governance institutions, including the United Nations, will reach entirely new levels of mutual trust, cooperation, financial support, and performance results, and the ESG problem is solved.

The scenario omits non-democracies, particularly China. We expect that once the world's democracies move to the right mode, getting China to do the same will be a solvable problem, especially considering China's trade dependencies with democracies and its heavy reliance on propaganda.[9] This is one more problem the self-managing system will solve.

Let's put all this together. System self-management means automatically detecting and solving problems of any kind (such as governance problems of any kind, if speaking of a governance system), if they are solvable, in order to achieve the system's goals. The scenario's mode changes are required, because no approach to sustainable governance will work unless the system it governs is in the right mode, where it has an inherent causal bias toward achieving the common good. It follows that designing a sustainable governance model that works when a system is not in the right mode, as the global system is now, is an impossible problem to solve. *The essence of the proper governance model then, is one that is eternally self-managing and governs a system in the right mode.*

9. Further research

The material presented here suggests further areas of research. Can study results be replicated? Can they be improved? What further work is necessary on Truth Literacy Training for it to be introduced to actual populations? What additional solution elements are necessary to raise political truth literacy from low to high? What unexpected insights can be found by intense study of the research gap on political truth literacy and its role in the health of democracy? How can the SIP analysis of subproblems B, C, and D be improved and applied, in order to accelerate and strengthen the overall solution?

Social scientists need to become social engineers, who don't just do research. They solve problems. This leads to the most important question of all. *How can the work presented in this report, combined with other work, create the first version of a successful theoretical*

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only two years, GDP devoted to military production in the UK rose from 15% to 53%, in the USSR from 17% to 61%, and in the US from 11% to 42%. (Harrison, 1998, p34)

[9] Solutions like Truth Literacy Training will allow citizens of authoritarian governments to see through the endless stream of lies and propaganda those governments rely on for submission, cooperation, and support from their citizens. If that bubble of deception no longer works, how long can those governments last?

foundation for Social System Engineering? That is the real problem the ESG community is trying to solve.

10. Acknowledgements

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