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Process-driven Problem Solving with Root Cause Analysis: Adapting powerful business tools to fit the sustainability problem

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Abstract

Two of the most powerful problem-solving tools in the business world are process-driven problem solving and root cause analysis. These tools are routinely used to solve difficult problems of any type, with a track record of astounding success. However, there's a catch. The tools have only been applied to *business and technical* problems. They have never been applied to *social* problems, such as sustainability.

This paper serves as a progress report on the research results of Thwink.org, which has been attempting since 2001 to adapt these tools to fit social problems. The result is the *System Improvement Process* (SIP), a generic process designed from scratch to solve difficult large-scale social problems of any type.

At the heart of SIP lies a systematic approach for using root cause analysis to find the main root causes of a problem and the high leverage points for resolving those root causes, using subproblem decomposition, social force diagrams, and system dynamics feedback loop simulation modeling. Solution elements are then designed to push on the high leverage points. The effect is fairly predictable, since the simulation models can roughly predict, on a qualitative or quantitative bases, how the system will respond to focused efforts to push on the high leverage points.

Research results consist of SIP, a preliminary analysis, a large body of descriptive material, a paper on *Change Resistance as the Crux of the Environmental Sustainability Problem*, and just this year, preliminary studies on the effectiveness of a solution element called Truth Literacy Training.

Perhaps the most interesting aspect of this body of work is it represents a new paradigm for achieving successful earth system governance. This new way of thinking begins with the premise that “*All causal problems arise from their root causes.*” Current problem-solving approaches contain no concept of finding and resolving root causes, which appears to explain the poor results to date on solving difficult systemic problems like climate change and achieving the UN SDGs.

1. Introduction

The formal search for a workable system of earth system governance crystalized in 2007 with Biermann's seminal publication, *Earth system governance as a crosscutting theme of global change research*. (Biermann, 2007) The paper synthesized and proposed a broad, flexible research and reform agenda that, if conscientiously applied, would lead to sustainable earth system governance.

Today, twelve years later, the proposal has become a widely supported project. The inaugural issue of the Earth System Governance journal reports on the status of this project in *New directions in earth system governance research*. (Burch et al., 2019) The Introduction states that "The aim of this plan is to learn from past achievements and simultaneously take the next step in our efforts to understand emerging and existing problems and solutions related to global environmental change." (p2)

Up to this point all looks promising. A solid, well-integrated plan of attack is underway. However, Burch et al. then temper their report with reality. "Concrete mechanisms to achieve these kinds of targets, however, have generally become less specified and more uncertain.... There appears to have been a general shift away from 'hard law' frameworks towards voluntary, 'pledge-and-review' approaches." (p2) The report mainly updates and elaborates on the original proposal. Notably missing are reports of successful policy results. Instead, we see "national plans and domestic action to achieve the targets need to be implemented. ... It also remains to be seen..." (p2) Continuing this theme, the *Conclusions* section opens with "Novel approaches and innovative concepts are needed to study new and emerging as well as existing unsolved social and environmental problems." (p13)

They certainly are needed, because present approaches are simply not working:

"The near breakdown of negotiations at the 2009 climate conference in Copenhagen shows the difficulties inherent in multilateral intergovernmentalism and its prospects to stimulate much-needed reforms. [At the 2012 United Nations Conference on Sustainable Development, aka Rio +20,] the official diplomatic achievement of the conference was a nonbinding agreement, entitled 'The Future We Want.' After ten days of intense negotiations, this document had shrunk to the least common denominator that all countries could support. ... This strategy worked inasmuch as the conference document was accepted by consensus. A complete breakdown of negotiations, or a final declaration that did not find the support of all countries, was thus avoided. The price for this minimalist approach, however, was that 'The Future We Want' is largely an affirmation of the status quo." (Biermann, 2014, p204)

There's little doubt that the proposed architecture of earth system governance would work if aggressively implemented. But alas, that has not come to pass. "Progress is too slow, however, and more effort is needed." (Biermann, 2014, p213)

That's where the global environmental sustainability problem stands today. Solutions that would work are rejected by the system.

So, what can we do?

We can innovate.

2. In search of a strong diagnostic component

2.1. Identifying the gap

We take as our starting point Biermann's call for fundamental innovation when he elaborated on his original vision with a book length treatment: *Earth System Governance: World Politics in the Anthropocene*. (Biermann, 2014) The preface opened with "This book... is the result of a research trajectory... that has evolved from dissatisfaction with current concepts of environmental policy to a felt need for *new paradigms*..." That need is repeated in the first paragraph of chapter one: "A *new paradigm* in both research and policymaking is needed."

That new paradigm is earth system governance. However, it's not working, indicating something is weak, wrong, or missing. What might that be?

The theory of earth system governance consists of two main components:

"Broadly speaking, there are two ways of theorizing about earth system governance: analytically and normatively. The *analytical theory of earth system governance seeks* to explain processes and outcomes in this field. This is traditional social science. It is about the effectiveness of institutions and policies, about their inter-linkages, about the diagnostics of specific institutional and policy designs. ... The *normative theory of earth system governance*, for its part, is the critique of the current system of governance. Normative theory does not ask what is, but what should be." (Biermann, 2014, pp 25 and 27, underlining added)

Buried in that description sits the word "diagnostics." Weakness in this area, we argue, is the hidden flaw holding earth system governance back.

Here's why. When massive change resistance to adopting "much-needed reforms" was encountered at Copenhagen 2009 and Rio +20, the theory of earth system governance could not correctly diagnose why rejection occurred and what to do to prevent reform rejection the next time. Without that crucial knowledge, all proponents can do is more of the same: keep pressing hard to get the reforms adopted at the next summit or somewhere else.

Nor can the theory correctly diagnose why the Sustainable Development Goals are on track to failure, particularly the environmental goals. The latest report (UNDESA, 2019) states that: "The natural environment is deteriorating at an alarming rate. ... It is abundantly clear that a much deeper, faster and more ambitious response is needed to unleash the social and economic transformation needed to achieve our 2030 goals." Why exactly is the environment deteriorating at such an alarming rate, despite decades of effort to transition to environmental sustainability? Again, without that knowledge all proponents can do is more of the same, which history has already shown has little chance of changing the status quo. Proponents are stuck, which is where all of environmentalism stands today.

Earth system governance theory lacks a strong diagnostic component. That is the gap to fill.

2.2. Solving causal problems

Thwink.org is a small research organization established in 2001. Its mission is “To help solve the complete sustainability problem using the most efficient and effective methods available.” The Thwink researchers have a business management and consulting background, rather than an academic one. This puts them in a position to generate uncommon insights that may be useful to academia.

The Thwink research found what appears to be a sufficient starting point for the diagnostic component. The sustainability problem belongs to a class of problems known as *causal problems*. Solving problems in this class requires these general steps:

1. Define the problem.
2. Diagnose the cause (or causes) of the problem.
3. Develop a solution (aka treatment or policy) to address the cause.
4. Implement the solution and iterate as necessary.

For example, a person has pain in abdomen (step 1). A doctor runs tests, examines the patient, and diagnoses the cause as appendicitis (step 2). The standard treatment is to remove the appendix (step 3). The operation is performed and goes well (step 4).

Consider the global environmental sustainability problem, a well-known and well-defined problem (step 1). The earth system governance community diagnosed (step 2) the cause as lack of the proper governance mechanism. The starting point for the solution of earth system governance (step 3) was (Biermann, 2002). A succession of papers, meetings, and projects led to establishing the Earth System Governance Project in 2009, to implement and evolve the solution as necessary (step 4, in progress).

Now consider the problem of reform rejection (step 1), described earlier in the Introduction. What is the cause (step 2)? This is unknown, because of a weak diagnostic component. Without this knowledge it’s impossible to reliably succeed in steps 3 and 4.

Reform rejection is a form of solution failure (aka process defect). In easy causal problems, solution failure is rare because the cause is obvious and thus so is the solution. But in difficult problems solution failure is the norm, unless specialized methods are used to perform the problem-solving steps. The only known method for finding and fixing causes reliably is *root cause analysis*, which in its simplest form uses the same general steps with minor changes:

1. Define the problem.
2. Find the root cause (or causes) of the problem.
3. Develop a solution to resolve the root cause.
4. Implement the solution and iterate as necessary.

2.3. Root cause

Root cause analysis revolves around the concept of root causes. A *root cause* is the deepest cause in a causal chain that can be resolved. *Resolved* means a system’s feedback loop structure is changed such that a root cause force no longer exists or is acceptably

low. A *root cause force* is the force exerted on the connected nodes in a problem's causal chain structure by a root cause.

The key principle is that *All causal problems arise from their root causes*. An important corollary is that *If a solution fails, the reason can only be that the solution did not resolve the root causes*. Solutions to difficult causal problems usually consist of multiple solution elements.

For highly difficult causal problems, those that have defied problems solvers for 30 years or more, a more mature definition of root cause is needed. Quoting from our own work: (Harich, 2010, p57)

“A *root cause* is a portion of a system's [feedback loop] structure that ‘best’ helps to explain why the system's behavior produces a problem's symptoms. Difficult problems usually have multiple root causes. These are found by asking a succession of ‘Why is this happening?’ Kaizen-like questions until the root causes are found.

How do you know when to stop? A root cause has three identifying characteristics: [In the spirit of continuous improvement, characteristics 4 and 5 were added later.]

1. It is clearly a (or the) major cause of the symptoms.
2. It has no worthwhile deeper cause. This allows you to stop asking why at some appropriate point in root cause analysis. Otherwise you may find yourself digging to the other side of the planet.
3. It can be resolved. Sometimes it's useful to emphasize unchangeable root causes in your model for greater understanding and to avoid trying to resolve them without realizing it. These have only the first two characteristics. This definition allows numerous unproductive or pseudo root causes to be quickly eliminated.
4. Its resolution will not create bigger problems. Side effects must be considered.
5. There is no better root cause. All alternatives have been considered.

The important thing is to not stop at intermediate causes. These are plausible and easily found. Working on resolving what are in fact intermediate causes looks productive and feels productive. Intermediate cause solutions, more accurately called symptomatic solutions, may even work for a while. But until the true root causes are resolved, powerful social agents will invariably find a way to delay, circumvent, block, weaken, or even rollback these solutions, because intermediate causes are symptoms of deeper causes. One must strike at the root.”

The five characteristics form a checklist. The checklist allows numerous unproductive or pseudo root causes to be quickly eliminated.

2.4. *Root cause analysis*

If you've ever driven a car, flown in an airplane, taken a prescription drug, or used a computer, then you have used a product manufactured using root cause analysis. The industries of auto manufacturing, aircraft manufacturing, pharmaceuticals, and high-tech

electronics all use root cause analysis to keep defect rates low and quality high. Without putting root cause analysis at the very heart of their entire manufacturing process, none of these industries could produce a high-quality product. (Pande, Neuman, & Cavanagh, 2000)

Root cause analysis is the practice of using formal analysis to identify the root causes of problems or events. The practice is predicated on the belief that problems can only be solved by resolving their root causes, as opposed to merely addressing the immediately obvious symptoms and their intermediate causes. Root causes are found by starting at problem symptoms and asking WHY does this occur? This is repeated until the root causes are found. WHY questions are not answered intuitively but by rigorous inspection of the system. (Horev, 2010; Okes, 2009)

Figure 1 summarizes how root cause analysis works and shows the key terms. *The important insight is that without root causes analysis, problem solvers are limited to the superficial layer on difficult problems.*

This leads to a further insight. If it's a difficult problem, then no matter how clever superficial solutions are, or how hard

problem solvers try to get them implemented, or how hard they then try to manage the implemented solutions, superficial solutions will invariably and mysteriously fail, because they do not resolve the root causes. This can be perplexing, frustrating, and demoralizing.

By now you may have concluded, as we have, that there's a single *correctable* reason for why environmentalists of all kinds, including activists, scholars, and governments, have been unable to solve the sustainability problem and achieve sustainable earth system governance. It's because root cause analysis does not lie at the heart of their problem-solving process.

2.5. The System Improvement Process

How then can root cause analysis be applied to the sustainability problem?

This question was not easy to answer, because root cause analysis was invented by Toyoda Sakichi, father of the founder of Toyota Motor Corporation, in the early 1900s to solve *business* problems. (Ohno, 1988, p77) No version of root cause analysis suitable for *social* problems was found, so we were forced to create our own. NASA encountered the same situation: (NASA Safety Center, 2013)

“After extensive review, NASA found that none of the commercially available tools and methods would support a comprehensive root cause analysis of all the

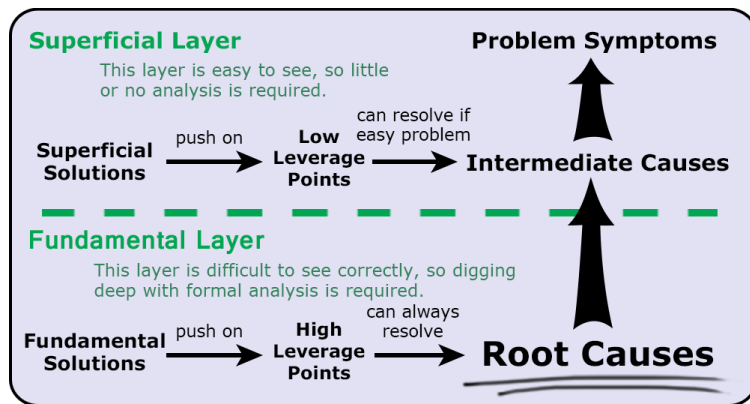


Figure 1. Causal structure map, showing the terms used in root cause analysis. The backbone of the map is the causal chain running from root causes to problem symptoms.

unique problems and environments NASA faces on the Earth, in the ocean, in the air, in space, and on moons and planetary bodies. Existing tools were designed for a specific domain (e.g., aviation), a specific type of activity, a specific type of human error (e.g., errors of omission) or had a limited set of cause codes. The NASA Root Cause Analysis Tool (RCAT), a paper-based tool with companion software (now available free to government Agencies and contractors), was designed to address the shortcomings identified in existing tools.”

Thwink.org developed the System Improvement Process (SIP) from scratch to solve difficult large-scale social problems of any kind, particularly the sustainability problem. The process provides a “fill in the blanks” framework that makes work much more focused and efficient. The process is summarized in Figure 2. Its four main steps are derived from the four general steps for solving causal problems described in section 2.2.¹

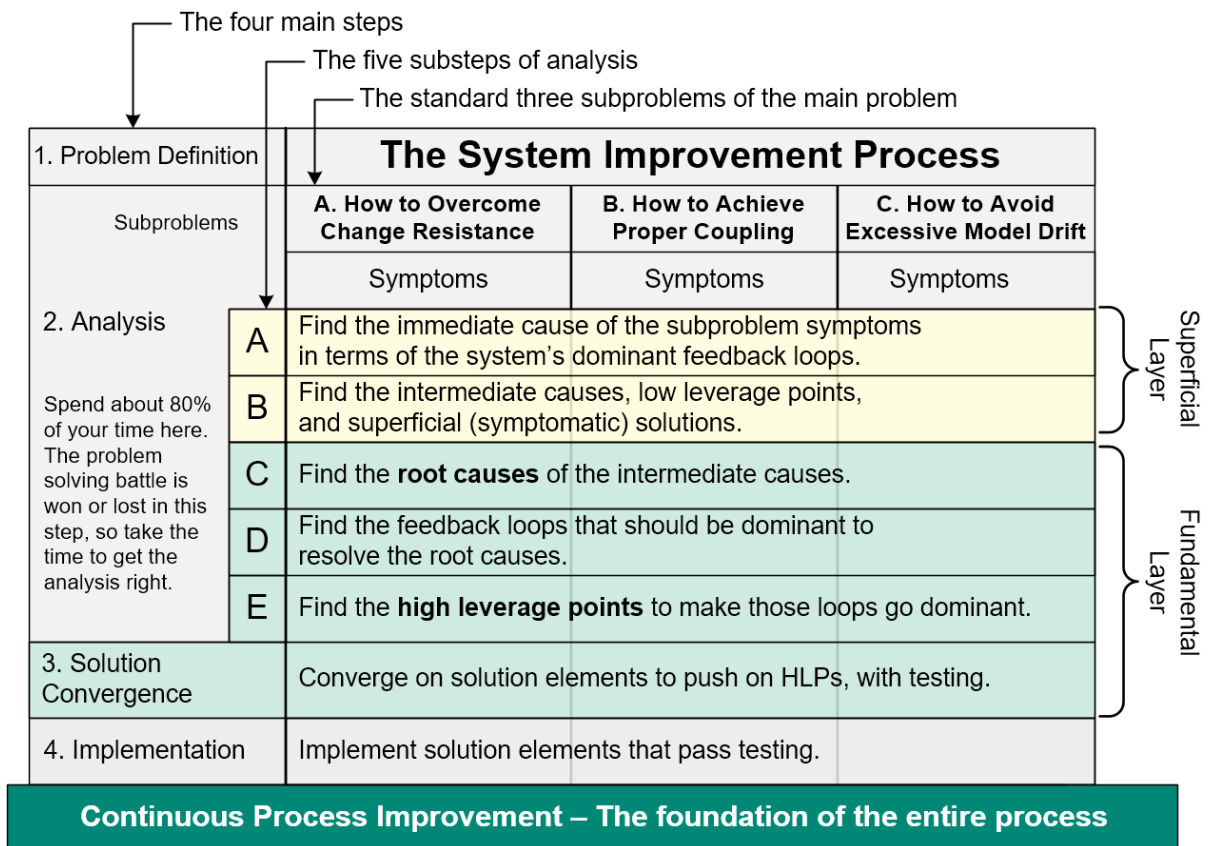


Figure 2. Summary of the System Improvement Process. The process is generic.

SIP incorporates many best practice principles. The key principle is *For difficult large-scale social problems, root causes can only be correctly identified by root cause analysis, using a process wrapper like the System Improvement Process.*

A second principle is *Complex social systems are not designed. They evolve by a long series of evolutionary changes.* Most of these are incremental nudges, while a very small number are leaps. A *nudge* consists of a solution element pushing on a high leverage point to partially resolve its connected root cause. A *leap* consists of a package of solutions

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.

elements designed to resolve one or more root causes and trigger a favorable mode change (as described later). Thereafter the system behaves in a radically different manner.

A third principle is “*Our minds have great difficulty grasping problems that cannot be visualized.*” (Dorner, 1996, p6) The SIP matrix and related tools, like social force diagrams and feedback loop simulation models, transform a nebulous cloud of problem information into a crisp, uniform visual structure that becomes the problem-solving team’s shared mental model of the problem and the many steps to its solution.

A fourth principle is “*The behavior of a system arises from its [feedback loop] structure.*” (Sterman, 2000, p107) A corollary is *All systemic problems arise from the behavior of a small number of feedback loops.* Understand these loops and night becomes day, as the essential structure of the problem moves from invisible to visible, which transforms the problem from insolvable to solvable.

The fifth principle is *Difficult complex system problems can be reliably solved only by process driven problem solving.* “At the heart of all remarkable innovations in any realm lies a rigorous routine, a disciplined methodology.” (May, 2007, p74)

The real power of SIP arises from the fifth principle.

2.6. Process driven problem solving

Process driven problem solving is the use of a formal continuously improved process as your central approach to solving problems. The main advantages are:

1. The process can much more easily be executed by a team of problem solvers. This makes the approach scalable.
2. Since the process is formally defined it can be continuously improved. Over time the process can evolve to be so powerful it's your most important asset, as it is for many of the world's largest companies like Toyota, Intel, and Exxon, and for all of science via the Scientific Method.

For those new to process driven problem solving, this may be astonishing. It’s not anyone’s personal brilliance, or heroic effort, or a grand stroke of luck, or all three that solves big hairy audacious impossible-to-solve problems, whether social, business, or scientific. It’s obsession with a process that fits the problem so well it can be used by all and continuously improved until it’s good enough to solve the problem.

The three steps of process driven problem solving are:

1. Identify the problem.
2. Choose or develop a suitable process for solving this type of problem.
3. Execute the process, which must include continuous improvement.

There are no more steps after step 3. Once you enter that step, you are always executing the process.

All large successful organizations owe their success to process driven problem solving and a collection of process that fit various classes of problems. The practice of managing and optimizing these processes goes by many names, including quality control

(Feigenbaum, 1991), process control (Pyzdek, 2003), and the quality improvement process (Tague, 2005).

2.7. Social force diagrams

A popular visual business tool for finding root causes is *cause-and-effect diagrams*, also called fishbone or Ishikawa diagrams. SIP uses a modified form called *social force diagrams*. Both diagrams are shown in Figure 3.

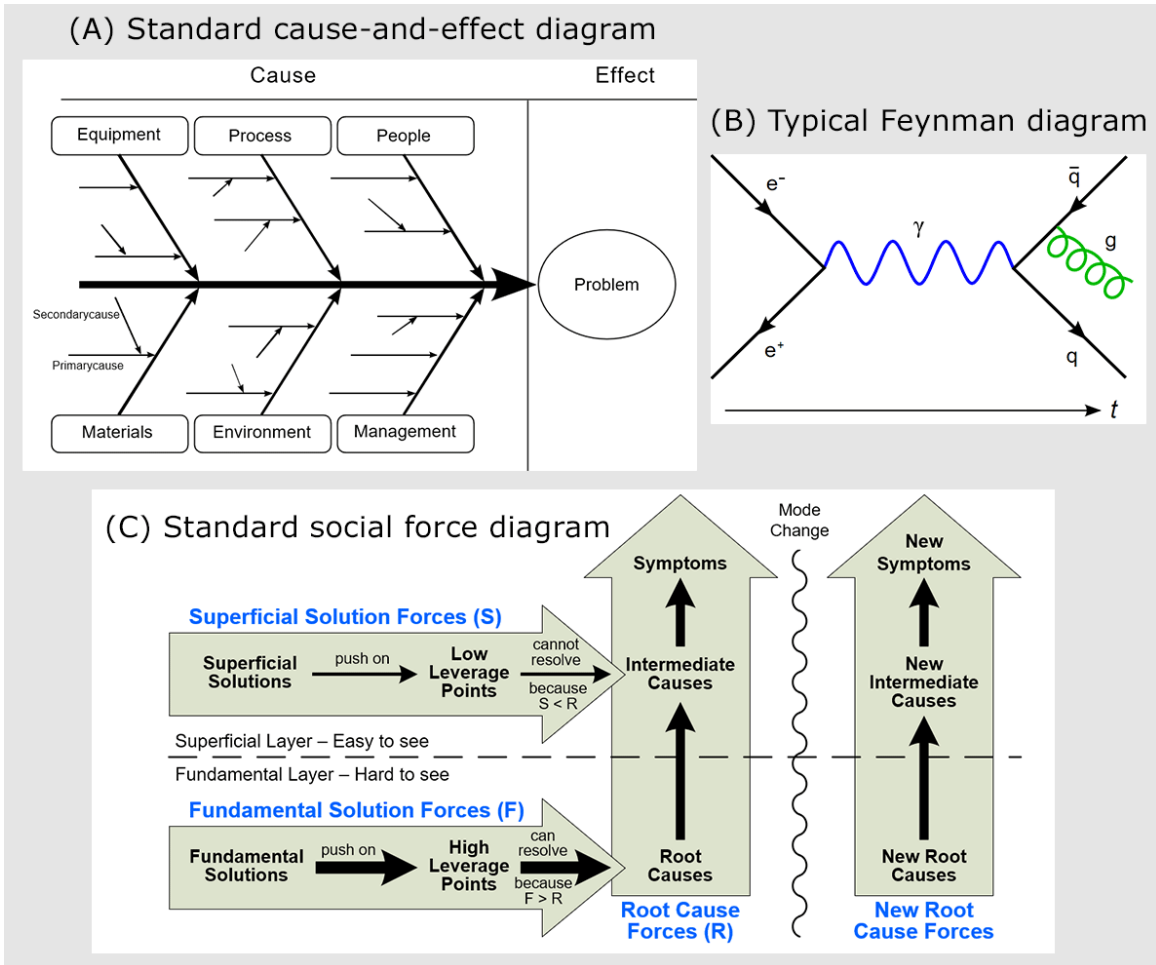


Figure 3. Three visual tools for managing problem complexity. Source for diagram A:

https://commons.wikimedia.org/wiki/File:Ishikawa_Fishbone_Diagram.svg

Source for diagram B: https://commons.wikimedia.org/wiki/File:Feynmann_Diagram_Gluon_Radiation.svg

Cause-and-effect diagrams show the causal tree leading to a problem. The six standard industrial subproblems are shown.

Social force diagrams rearrange the causal tree of cause-and-effect diagrams into a format emphasizing the superficial and fundamental layers of the problem, the three main forces (S, F, and R) that must be understood to solve the problem, and the mode change that occurs when a systemic problem is solved.

The monumental challenge of problems like sustainability is how do you cut through the overwhelming complexity? Social force diagrams reduce confusing complexity to clear simplicity by organizing the main forces involved into a standard format that, once understood, shines the light of clarity on the essential structure of the problem.

This parallels the way Feynman diagrams tamed the unmanageable complexity of quantum physics calculations by introducing a simple visual tool that made that complexity manageable:

“In the hands of a postwar generation, [Feynman diagrams were] a tool intended to lead quantum electrodynamics out of a decades-long morass. ... With the diagrams’ aid, entire new calculational vistas opened for physicists. Theorists learned to calculate things that many had barely dreamed possible before World War II. It might be said that physics can progress no faster than physicists’ ability to calculate. Thus, in the same way that computer-enabled computation might today be said to be enabling a genomic revolution, Feynman diagrams helped to transform the way physicists saw the world, and their place in it.” (Kaiser, 2005)

Social force diagrams show at a glance the relevant structure of a causal problem. In Figure 3C the line arrows represent cause-and-effect forces, with line thickness indicating relative force strength. The box arrows represent meta forces. Correct application of fundamental solution forces causes a system mode change, resulting in the new mode on the far right.

Social force diagrams simplify difficult social problems to their three main forces. The first is the *root cause forces* causing the problem. In difficult problems this systemic force is so strong it causes mode lock-in and inherently high change resistance. *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 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)

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* attempting to resolve intermediate causes. This is the second type of force.

All problems solvers can clearly see in the initial phase of solving a difficult problem is the superficial layer. But with root cause analysis problem solvers can penetrate to the fundamental layer and see the complete problem. There they will find the root causes. Once the root cause forces are known the third type of force can be employed. *Fundamental solution forces*, if properly designed, resolve the root cause by changing the feedback loop structure of the system such that a new homeostasis (aka dynamic equilibrium) becomes more attractive. Lock-in to the present mode ends, causing the system to quickly transition to the new mode. The system stays locked into the new mode due to the new root cause forces introduced by the fundamental solution forces. If the analysis (including testing) is done well, the solution force will solve the problem rapidly, efficiently, and relatively permanently.

A *leverage point* is the exact place in a social system structure a solution pushes on. SIP advocates modeling difficult problems, so the leverage point is a node in the model corresponding to points in the real world. A *low leverage point* is connected to an

intermediate cause (aka false root cause or proximate cause) in such a manner that pushing on the low leverage point will reduce, but not resolve, the intermediate cause. *Superficial solutions* (aka symptomatic solutions) push on low leverage points. A *high leverage point* is connected to a root cause such that pushing on the point with *fundamental solutions* will resolve the root cause.

2.8. Social force diagram of the Autocratic Ruler Problem

To illustrate how social force diagrams work, consider one of history’s most intractable problems: autocratic rule by countless warlords, dictators, and kings. The Autocratic Ruler Problem was eventually solved by the invention of modern democracy. This took thousands of years and much painful trial and error because the root cause was unknown. However, now it is known, allowing the retrospective social force diagram of Figure 4 to be constructed.

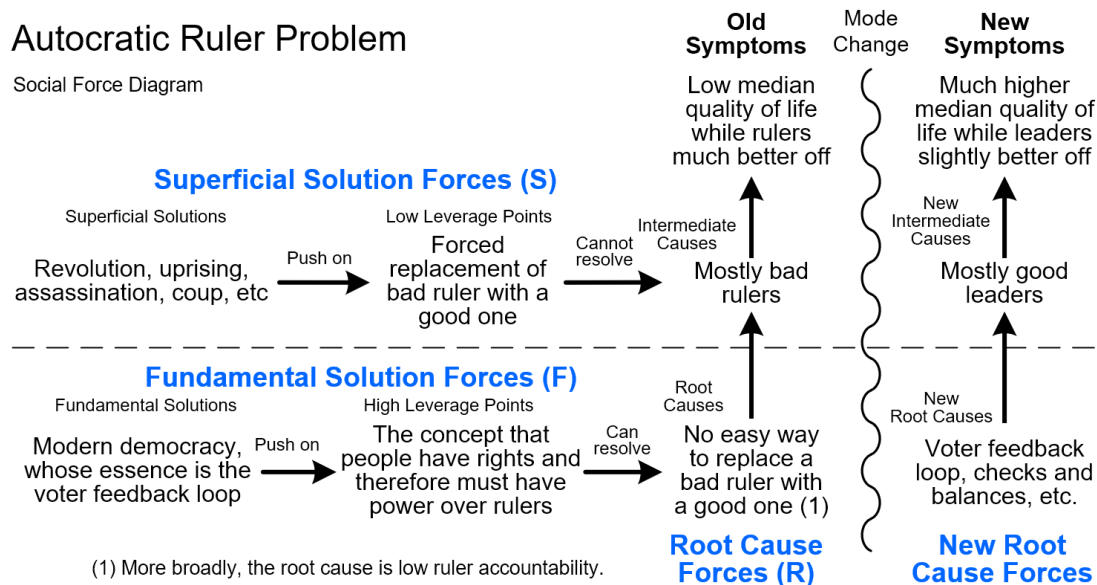


Figure 4. Social force diagram of the Autocratic Ruler Problem

The diagram shows at a glance why superficial solutions failed to solve the problem for so long (bad rulers kept reappearing once one was removed), why the fundamental solution worked (good rulers now tended to appear), and why, once the mode change occurred, the institution of democracy automatically spread (it was now much more attractive due to the new symptoms) beyond its invention nations (the United States and France). Democratic systems have tended to stay in the new mode due to the right new balancing feedback loops: voter feedback, checks and balances, government transparency, etc. If these loops become weak, the new mode will regress to the previous mode (as it threatens to do today in many nations).

The diagram is simplified. It is not the summary result of full application of SIP, which would involve a social force diagram for each subproblem, a filled in SIP matrix, and simulation models as needed.

The fundamental solution of modern democracy is usually implemented using a democratic constitution. This contains a collection of solution elements, like specifying

how voting occurs, what the branches of government are, what rights are given to citizens, and so on.²

3. Walking an analytical thread to understand the strong diagnostic component

3.1. Analytical thread

In the root cause analysis produced by SIP, a *single analytical thread* runs along the causal chain from symptoms, to an intermediate cause, to a root cause, to a high leverage point, and finally to a solution element that pushes on the high leverage point to cause a mode change from old to new symptoms.

To more fully understand the strong diagnostic component, we will walk the analytical thread for a recent experimental study.

² For a further introduction and more examples, see the glossary entry on social force diagrams at Thwink.org. For a complete description, see the section on social force diagrams in the book *Cutting Through Complexity* at Thwink.org.

3.2. Summary of Analysis of the Sustainability Problem

From 2003 to 2010 Thwink.org simultaneously analyzed the sustainability problem and iteratively developed SIP. Figure 5 summarizes the results.

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, <i>Corporatis profitis & Homo sapiens</i>	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 <i>Homo sapiens</i> .	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, <i>Corporatis publicus</i>	Politician Decision Ratings	Common Property Rights		
4. Implementation	Not yet ready for implementation because process execution is incomplete.					

Figure 5. Summary of Analysis Results. (1) to the environmental sustainability problem.

The matrix of Figure 2 was expanded in Figure 5 to show key analysis results. The one big problem of sustainability has been decomposed into four smaller (and hence much easier to solve) subproblems, A, B, C, and D. The “original” problem is subproblem D. Due to high complexity and the counterintuitive nature of complex system problems, D could not be correctly analyzed without adding the other subproblems.

The crux of a difficult social problem is usually how to overcome systemic change resistance. Once that's overcome the system will "want" to change. It will now eagerly accept the same solutions it was so vigorously resisting before. Analysis must usually begin with change resistance and give it the greatest attention of all the subproblems.

In the earth system governance problem, reform rejection is a form of change resistance. This strongly suggests that change resistance is the crux of the problem.

3.3. Social force diagram for the change resistance subproblem

As part of the Politician Truth Ratings project, Thwink.org performed a study on a solution element for helping to resolve the main root cause of systemic change resistance to solving the sustainability problem. The solution element is Truth Literacy Training, one of many solution elements for pushing on the high leverage point in Figure 6.

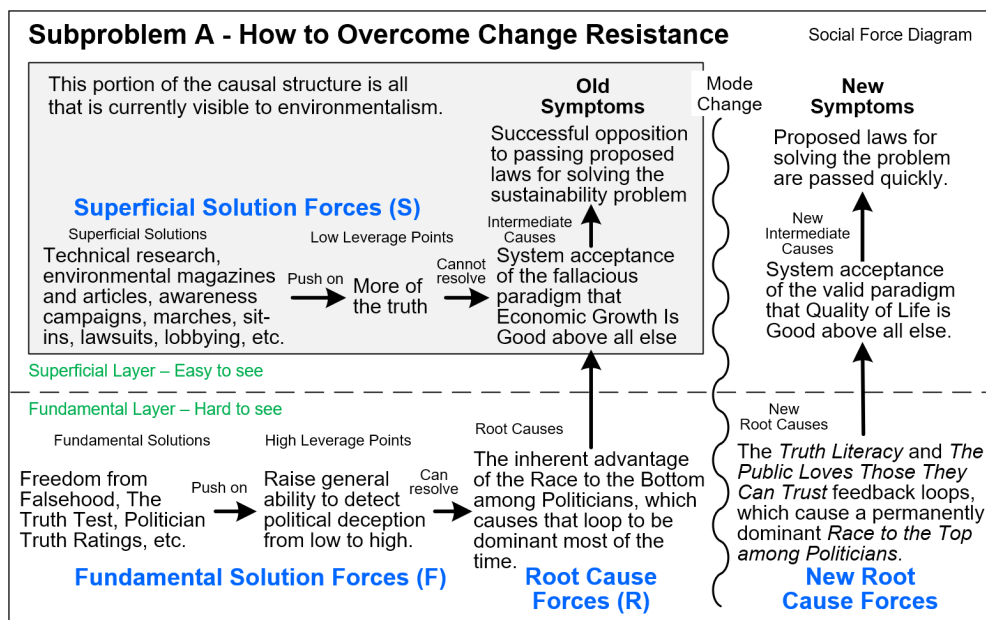


Figure 6. Social force diagram for subproblem A – How to overcome change resistance. The pre-mode change portion of the diagram was created by rearranging column A in Figure 5.

Walking the analytical thread begins at the *Old Symptoms*, which are successful opposition to passing proposed laws for solving the sustainability problem, such as the many proposals at eco summits and to national governments, including earth system governance reforms.

The main *Intermediate Cause* is system acceptance of the fallacious paradigm that economic growth is good about all else. This is widely acknowledged. 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, as quoted on p73)

Not having analyzed the problem with root cause analysis, problem solvers intuitively but erroneously sense the intermediate cause is the root cause. That cause must be countered with “more of the truth,” which is the *Low Leverage Point*. This is done with steps 2, 3, and 4 of Classic Activism: (2) find the truth in the form of the technical proper

practices needed to solve the problem, (3) promote the truth with various forms of communication and lobbying, and (4) if that doesn't work, magnify the truth with exhortation, inspiration, and bargaining, such as marches, sit-ins, and lawsuits. Because these solutions push on a low leverage point, steps 2, 3, and 4 are all *Symptomatic Solutions*.³

Substep C of SIP is "Find the root causes of the intermediate causes." By modeling the superficial solution forces with a system dynamics model called The Dueling Loops of the Political Powerplace, the analysis found the main *Root Cause* is the inherent advantage of the Race to the Bottom among Politicians feedback loop, which causes that loop to be dominant most of the time.

Figure 7 contains a high-level version of the model. The Race to the Bottom loop contains an inherent advantage that the opposing loop lacks. Because the size of falsehood (deception) and favoritism can be inflated, while the truth cannot, the Race to the Bottom has an inherent structural advantage over the Race to the Top. A politician can tell a bigger (and therefore more attractive) lie, like budget deficits don't matter. But they cannot tell a bigger truth, such as I can balance the budget twice as well as my opponent, because once a budget is balanced, it cannot be balanced any better. This inherent advantage explains why we see so much deception in political appeals to voters.

The key insight of the model is it explains why superficial solutions fail and how fundamental solutions can succeed.

The *High Leverage Point* for resolving the root cause is to raise political truth literacy (called general ability to detect political deception in the model) from low to high.

Fundamental Solutions push on high leverage points to resolve root causes. The first version of the Summary of Analysis designed nine sample fundamental solution elements for raising truth literacy. One of these is Truth Literacy Training, aka the Truth Test. However, before describing that element we need to review how the intended mode change would work.

Once the main root cause of low political truth literacy is resolved, several things happen. First loop dominance begins to shift from The Race to the Bottom to The Race to the Top Among Politicians, because now the winning strategy for politicians is to tell the truth. This leads to automatic strengthening of the Truth Literacy Promotion and The Public Loves Those They Can Trust feedback loops (not shown). The high strength of

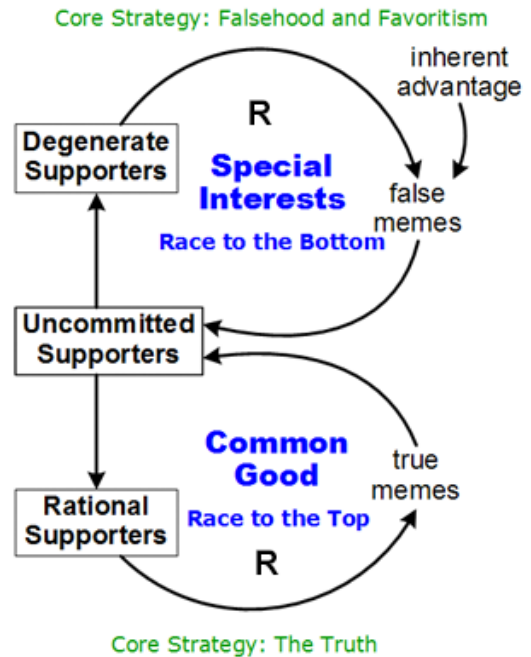


Figure 7. High-level version of The Dueling Loops of the Political Powerplace simulation model

³ For a full description of Classic Activism, including a simulation model showing why it fails to resolve the root causes, see (Harich, 2010).

these loops creates the *New Root Cause Forces*. These forces cause the Race to the Top loop to continue to grow in dominance, until the New Root Cause Forces are so strong further change occurs. The *New Intermediate Cause* becomes system acceptance of the valid paradigm that Quality of Life is Good above all else. This in turn causes the *New Symptoms* of proposed laws for solving the sustainability problem are quickly passed.

If the right fundamental solutions are applied and the main root cause of systemic change resistance is resolved, the mode change will occur and the sustainability problem is solved. The system will stay locked into the new mode for as long as the main root cause is resolved and no other root causes appear to overshadow the effects of the New Root Cause Forces.

That's the theory. Can it work? Let's examine the study.

3.4. *The Truth Literacy Training study design*

The goal of the study is *to take the first empirical steps to develop methods for measuring and raising truth literacy*, for the purpose of resolving the root cause of low political truth literacy. A few definitions must be stated:

Deception is a statement (or live action, such as in video or TV) that distorts the truth. The purpose of deception is to create false beliefs that create behavior favorable to the deceiver.

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.

Truth quotient (TQ) is a measure of a person's truth literacy in terms of their average ability to correctly process deceptive arguments in terms of how true an argument's claim is, on a scale of zero to 100%. 100% is perfect truth literacy, which is not realistically possible due to the complexity and continual evolution of real-world deception. If logic alone is used to process an argument, this is called a person's logical truth quotient (LTQ).

Democratic truth quotient (DTQ) is a measure of a person's LTQ plus how well they apply two rules of reaction to detected political deception and truth. The rules are part of Truth Literacy Training for voting. Below is the rule training material:

“Rule one is *Penalize the Deceiver*. If you discover a politician has attempted to deceive you, then when you vote or take action you should strongly oppose the politician or the source of the deception. This will have the effect of reducing attempted deception. For example, this would have a Very large impact on voting against them.

Rule two is *Reward the Truth Teller*. If you discover a politician has told the truth, then when you vote or take action you should strongly support the politician or the source of the truth. In this manner we encourage more truth tellers. For example, this would have a Very large impact on voting for them.

What if two or more politicians tell the truth in an effort to gain a person's support? Then the finer shade of discrimination is to reward the politician whose claim does the best job of optimizing the common good. How that's determined is beyond the scope of this training.”

The theory behind the study consists of four propositions:

1. TQ can be accurately measured in two ways: LTQ and DTQ.
2. LTQ and DTQ are currently low in the average voter.
3. LTQ and DTQ can be raised to high via Truth Literacy Training (TLT).
4. A certain minimum DTQ is required for a healthy sustainable democracy.

As explained earlier, the reason a certain minimum DTQ is required is the main root cause of systemic change resistance to solving large-scale common good problems is low truth literacy, and in particular, low DTQ.

These propositions apply only to democratic governments, since only democracies have the ruler accountability feedback loop, also called the voter feedback loop.

A “healthy sustainable democracy” is one able to solve its critical common good problems. These include the top problems in the three pillars of sustainability: economic, environmental, and social. In today’s world, the climate change and war (aka geo-political conflict) problems head the list. Not far behind are poverty, high inequality of wealth, systemic discrimination, recurring large recessions, and more. We refer to these as common good problems.

The fourth proposition is *the* critical insight of the study. It is not enough for citizens to have high Logical Truth Literacy (LTQ). They must be able to correctly translate that knowledge into Democratic Truth Literacy (DTQ), in order to take correct action. Correct action was measured by the vote question, described below.

The study consisted of an online questionnaire. TQ was measured by presenting typical but contrived (to reduce bias) politician statements. Each statement contained a claim and was followed by three questions:

1. The politician said (the claim.) How *true* do you feel that claim is?
False, Mostly false, Half true, Mostly true, True, Cannot decide
2. What is the main reason for your decision in the above question? (Text box)
3. 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? [Answer option numbers are included.]
 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.

Question 1 is the “truth” question. The claim varies depending on the statement. The correct answer to the truth question is determined by inspection of the statement and application of what a person knows about truth literacy.

Question 2 is the “probe” question. We found this question improved answer quality and provided essential feedback for iterative improvement of questions during study development. The probe answers also provide a revealing look at how people think, how that thinking varies across participants, and clues for improving future measurement and training.

Question 3 is the “vote” question. The correct answer to the vote question is determined by the Penalize the Deceiver and Reward the Truth Teller rules.

Participants were randomly assigned to one of three treatment groups. Group 1 received training on a neutral topic. Group 2 received training on how to tell if a claim is true or false. Group 3 received the same training as group 2 plus vote training on the rules of reaction to detected political deception and truth. After the training, all groups were presented with 17 statements and their questions. 4 statements contained true claims. The other 13 statements contained false claims, using various fallacies common to deceptive statements designed to win political support among voters. The fallacies were cherry picking, flawed application of the Strong Evidence Rule, ad hominem attack, appeal to emotion, strawman, false dilemma, and false fact lie.

3.5. *Study results*

The study was run on Wednesday evening, October 2, 2019 using a Prolific online panel and our own software for the online questionnaire. Subjects were United States residents. Average age was 31 years old, with a range of 22 to 51. Average completion time was 85 minutes, including a 5 minute break half way through. Number of participants in the three groups was 30, 30, and 33.

Proposition 4 says “*A certain minimum DTQ is required for a healthy sustainable democracy.*” What would a starting estimate for minimum DTQ be, before additional research?

We estimate minimum TQ should be enough to spot typical political deception 50% of the time or more (as measured by the truth question) and take correct action 50% of the time or more (as measured by the vote question). Minimum DTQ is about 50%.

This is a vitally important system target. What minimum DTQ actually should be can eventually be determined by real-world measurement. We expect minimum DTQ varies per political system due to various factors.

Figure 8 contains key study results. Treatment groups 1, 2, 3 are labeled T1, T2, T3. Guessing would give 17% correct for truth scores and 11% correct for vote scores. The estimated minimum TQ for a healthy sustainable democracy is 50%.

The first three propositions were three of the hypotheses to be tested by the study.

Proposition 1 is *TQ can be accurately measured in two ways: LTQ and DTQ.*

Proposition 1 was weakly supported for those not receiving Truth Literacy Training. Cronbach's alpha was .38 and .44 for T1, the neutral training topic group. We theorize this is low because since these participants are untrained, they are forced to guess a lot. Guesses have low internal consistency.

Proposition 1 was almost supported for those receiving only claim training, with alphas of .67 and .68 for T2. These alphas were much lower than those for T3. We attribute this to the confusion induced by not being training on the vote question, but being asked that question and forced to guess. This causes confusion on the truth question and reduces internal consistency.

Proposition 1 was well supported for those receiving full Truth Literacy Training, with alphas of .82 and .92 for T3.

Proposition 2 is *LTQ and DTQ are currently low in the average voter.* This proposition was well supported. The average voter has never received the equivalent of Truth Literacy Training. Their LTQ and DTQ were very low, about 8% and 2%.

Proposition 3 is *LTQ and DTQ can be raised to high via Truth Literacy Training.* This proposition was well supported.

The findings for propositions 1, 2, and 3 are excellent news, since they suggest the solution element is needed (the root cause of low truth literacy exists) and can work (the root cause can be resolved).

Hypothesis 4. *Truth Literacy Training on only determining the truth of claims is insufficient to raise DTQ to above the minimum DTQ for a healthy sustainable democracy.* This hypothesis is why the second treatment group, training on claims alone, exists.

Hypothesis 4 was well supported. The average vote score for those receiving claim training alone was 6%. This shot up to 67% for the group receiving claim and vote training.

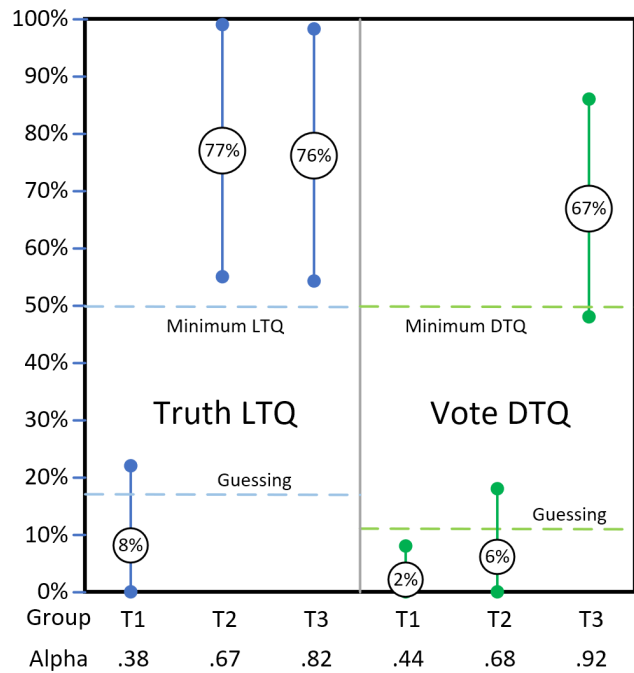


Figure 8. Average scores and 95% confidence intervals for answers to deceptive statements. Treatment groups were:
 T1 – Training on neutral topic
 T2 – Training on claims
 T3 – Training on claims and vote

We found this astonishing. *Even if a person has been trained on how to tell whether a political claim is true or false, they are unable to translate the truth or falsity of a claim into correct action.* Instead, they choose all sorts of answers for the vote question. From our point of view this doesn't make sense. In a time when political deception is so rampant and the truth is so rare, why would anyone NOT want to strongly penalize deceivers? Why would anyone NOT want to strongly reward truth tellers? Isn't that what's required if we want democratic governments to work for the best interests of voters? We suspect the reason for this behavior is hardly anyone has received the equivalent of Truth Literacy Training.

Hypothesis 5. Truth Literacy Training persists over time, but gradually falls enough to require continual refreshing. The level of truth literacy can be boosted to original levels with small amounts of refresh training.

To test this hypothesis a second questionnaire was run 26 days later, with a dropout rate of 20%. Different statements were 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 the original 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, this is a decline of only 11 and 10 points, a surprisingly 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. It also suggests there was more than the 11 and 10 point drops 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 and second questionnaires. During this work the refresh training could be improved as needed. Despite this problem hypothesis 5 was well supported.

We were especially pleased to see that the training effect did not drop abruptly, but slowly. We also found that basic training (as opposed to full training in a larger number of fallacies and other areas) requires only one hour of online instruction. This suggests that a mature approach to truth literacy training, integrated into a society's educational, news, and other systems, can be accomplished with a relatively low amount of effort, much less than that required for reading, writing, math, and other forms of literacy.

3.6. Interpretation of the distribution of raw vote answers

Findings like these require deeper scrutiny. Figure 9 contains distributions of the raw vote answers. See section 3.4 for a list of the answer option numbers.

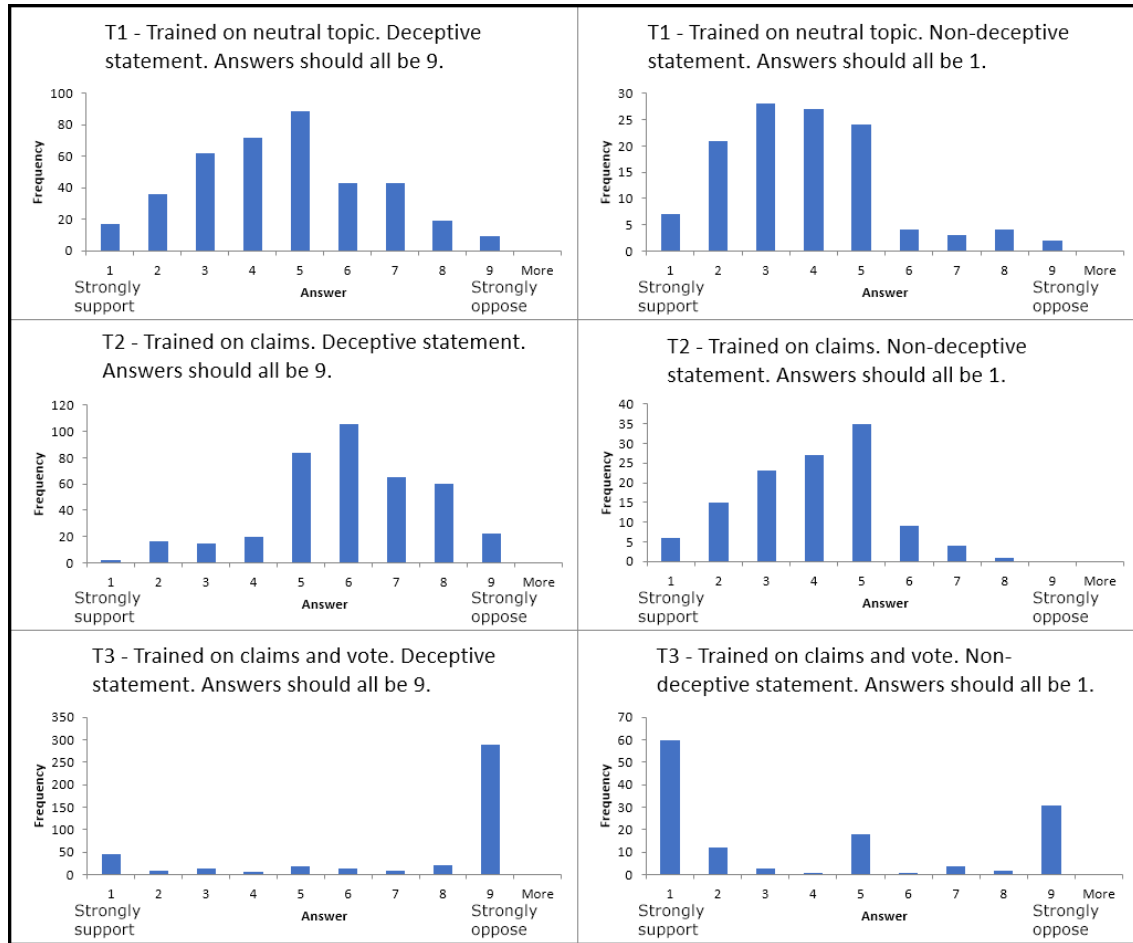


Figure 9. Distributions of the raw vote answers. Answer 5 is “It would make no difference.”

T1. Training on neutral topic – While the effect probably varies across political units and study samples, we expect that the first row of Figure 9 approximates how citizens in democracies behave today. *There’s little difference in voting behavior related to whether a political claim that may contain clever deception is true or false.* There’s a small difference. But voters are not wise enough to translate claim truth knowledge into how to vote correctly. The result is successful deception goes largely unpenalized. This has not gone unnoticed by politicians willing to engage in deception.

T2. Training 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 the right direction on vote answers. But very few choose the correct answers, which are 9 or 1. A surprising percentage choose answer 5, “It would make no difference.”

T3. Training on claims and vote – The third row, if we could get enough voters there, would easily resolve the root cause of low political truth literacy. Participants exhibited some confusion on non-deceptive statements, indicating training material needs improvement in this area.

We have not tested proposition 4, *a certain minimum DTQ is required for a healthy sustainable democracy*. That is a difficult hypothesis to test. We expect it holds, however, since the designers of democratic institutions strongly assume that voters will be sufficiently wise and informed enough to elect leaders who will work for the common good, instead of the uncommon good of themselves and powerful special interests.

3.7. *Strength of the solution element*

The strength of a solution element is how much its application contributes to achieving the new symptoms state. For the change resistance subproblem, the symptoms state is *the probability proposed laws for solving the sustainability problem will be passed quickly*. Currently symptoms state is low. We want it to be high, ideally 100%.

Symptoms state can be calculated using the democratic truth quotient (DTQ). DTQ is the logical truth plus following the rules of Penalize the Deceiver and Reward the Truth Teller, as described in section 3.4.

We estimate that once DTQ reaches 50%, enough political deception will be detected that the winning strategy will be for politicians to tell the truth all the time. When DTQ reaches 50%, symptoms state reaches 100%. Thus, symptoms state equals measured DTQ / minimum DTQ. If measured DTQ exceeds the minimum DTQ, then symptoms state equals 100%.

We can now calculate the old and new symptoms state.

For old symptoms state, DTQ for T1 and T2 on the vote question equals 2% and 6%. 2% and 6% / 50% equals 4% and 12%. Taking the average of 4% and 12%, the old symptoms state equals 8%. The probability proposed laws for solving the sustainability problem will be passed quickly is 8%. This is low.

For new symptoms state, DTQ for T3 on the vote question equals 67%. This exceeds the minimum DTQ of 50%, so new symptoms state equals 100%. In the study, the Truth Literacy Training solution element fully achieved the new symptoms state, *so solution element strength is high, about 100%*.

These are very preliminary findings, however. We don't yet know how they generalize to real elections. We don't know how the training effect persists over time, and how much continual refresh training will be required, or even the best ways to do that. The minimum DTQ is estimated. The confidence intervals need to decrease so we can make more reliable solution convergence and implementation decisions. Much further research will be required to refine and test the solution element to the point of working well in the real world over long periods of time, as well as to integrate this solution element with others.

4. **Conclusions and a proposal**

We do not yet know if the Truth Literacy Training solution element alone can solve the change resistance subproblem. However, it can make a strong contribution. If it works extremely well, which is realistically possible with continuous improvement of the solution element and the process driving its creation, it appears fully capable of initiating

the desired mode change. Better, however, would be a multi-pronged attack using multiple solution elements.

Our most important conclusion is that the System Improvement Process (SIP) can provide the starting version of the needed strong diagnostic component and can serve as a comprehensive problem solving process. SIP behaves quite differently from the five research lenses described in Burch et al, whose purpose is to “offer analytical power.” We therefore propose a sixth lens, Problem Solving Processes, using best practice principles such as those in section 2.5 and exemplars such as SIP as described in this report.

The goal of this report was twofold. First, to describe how two of the most powerful problem-solving tools in the business world, *process-driven problem solving* and *root cause analysis*, can be applied to the sustainability problem in a manner that changes the problem from insolvable to solvable, and makes successful earth system governance possible. Second, to illustrate in some detail how the sixth lens of Problem Solving Processes could work, including preliminary empirical data.

To achieve that goal, we strived to clearly show how these tools can be applied to the sustainability problem, and how that can lead to vastly different insights on solution strategies. These strategies differ so much from popular solutions that we came to an unexpected but welcome conclusion. *None of the four high leverage points identified in the analysis of Figure 5 have ever been pushed on before with large-scale solution elements.* This suggests that that if the high leverage points are anywhere close to correct, and we can make the hypothesized mode changes happen, then the sustainability problem can be rapidly solved. This is good news.

We offer further good news. *The four main root causes found by the analysis are so interlocked that resolving any one root cause resolves them all.* This means problem solvers can concentrate solution effort on the easiest root cause to resolve. From what we’ve seen, this is probably the root cause of change resistance. That’s why we picked the study we did.

If the root cause of change resistance is resolved, that also leads to resolving the other three root causes, because now systemic change resistance to solving common good problems is low. The other three subproblem mode changes would also occur, solving the environmental sustainability problem even more rapidly. This is exceptionally good news, especially for the climate change crisis and its looming tipping points. ⁴

There’s even more good news. The most extraordinary data in Figure 9 is the left chart in row one. When a politician makes a deceptive statement to gain support, it works more often than not, even in a country (the US) where voters are well educated. The average education level in the study for 93 participants was 3.8, where 3 is high school, 4 is an undergraduate degree, 5 is a master’s degree, and 6 is a PhD. (None had a PhD.)

There’s a deeply productive insight here. *The data in row one directly explains why earth system governance reform rejection is the norm.* If voters cannot tell truth from deception, they are easily deceived into supporting politicians working for the uncommon

⁴ For a complete 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.

good of powerful special interests, notably large for-profit corporations and the rich, whose goal is maximizing *short-term* gains (profits for corporations, income and wealth for the rich). This causes systemic change resistance to solving *long-term* common good problems like environmental sustainability.

In the context of the earth system governance research framework, the analysis found a solution strategy for making democratic governments sufficiently accountable. “A particular focus of [the research lens of democracy and power] is how to secure more accountable state, non-state, and hybrid governance arrangements....” (Burch et al., 2019, p8) Low truth literacy causes low accountability, since voters cannot tell truth telling politicians from deceptive ones.

The data in Figure 9 confirms that the hypothesized high leverage point of raising political truth literacy exists. Instead of educating citizens about the truth of the severity of the sustainability problem (a strategy of more of the truth, aka “speaking truth to power,” a low leverage point), citizens need to be educated about how to tell truth from deception (a strategy of raise truth literacy, a high leverage point).

Good data, even if it’s preliminary, doesn’t lie. Process driven problem solving, when combined with root cause analysis and feedback loop modeling of the problem structure, produces high-quality data pointing precisely to where an intervention can produce the largest effect for the least effort. This data points to the conceptual big green button in Figure 10.

We therefore end this report on a note of empirical optimism.



Figure 10. A conceptual pushbutton. This encapsulates the strategy of using the right tools to rigorously identify the system’s high leverage points. Once that’s done, solution elements may be designed to push on the high leverage points and thereby solve the problem with maximum speed, efficiency, and reliability. This is social system engineering at its finest.

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