Chapter 7

An Assessment of Problem Difficulty

THE MORE DIFFICULT THE PROBLEM, THE MORE MATURE THE PROCESS USED TO SOLVE IT MUST BE. This chapter explores the ramifications of this key principle.

The Two Right Questions

All it takes is two simple questions to determine if someone is on track to solving a problem. The questions are:

1. **What process are you using?**
2. **Why are you so sure that process will lead to a successful solution?**

If the problem is the global environmental sustainability problem, then you will make an astounding discovery: *Most people and organizations have no formally defined process for solving the problem.* The very few that do have no way of proving that their process is highly likely to lead to a solution that works.

For example, what process have you or your organization been using, not to run your business but to actually solve the problem? What about those other environmentalists and other organizations that you are familiar with?

I have asked these questions and have never found a good answer. The only exception is those organizations that are working on a sustainability subproblem that is so easy that the process they are using is bound to work, such as the way the Nature Conservancy applies its Conservation by Design process to its mission of preserving "the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive." But such processes cannot be scaled up to solve the complete sustainability problem, though they do have some of the required elements.

Now suppose you could answer yes to the first question and provide strong proof for the second. Wouldn't that put you on the road to solving the problem?

The remainder of this chapter will allow you to do exactly that.

The Top 11 Environmental Problems

The most practical place to start in solving a problem is to learn enough about the problem so that you can take the right strategic approach. Mountain climbers first study a mountain and its surroundings to see which face offers the best prospects for a successful climb. Tournament bass fisherman first study a lake to see where the potential big spots are. Only after that do they begin to develop a fishing plan. Settlers immigrating to the new world first surveyed a broad area (by word of mouth) to see where the most promising settlements might be before they begin to make more detailed inquires and visits. In all cases, it is always the very first strategic decisions that made the biggest difference.

Our first strategic decision is to decompose one big problem into many little ones. This will allow us to more easily analyze the little ones, and from that determine why the big problem is so difficult to solve.

The decomposition we have chosen is from the Scientific Committee on Problems of the Environment study (SCOPE), whose results were summarized in the UNEP's *Global Environment Outlook 2000* on page 339. The highlight of the study was a list of "major emerging issues." Some of these are social issues, such as "poor governance." Others are contributors (proximate causes) to other issues, such as "population growth and movement." Extraneous issues like this were removed, so as to leave only bona fide environmental problems. The top eleven of these are listed below:

1. Climate change, 51%
2. Freshwater scarcity, 29%
3. Deforestation and desertification, 28%
4. Freshwater pollution, 28%
5. Loss of biodiversity, 23%
6. Air pollution, 20%
7. Soil deterioration, 18%
8. Ecosystem functioning, 17%
9. Chemical pollution, 16%
10. Stratospheric ozone depletion, 15%
11. Natural resource depletion, 11%

The percents are the percentage of SCOPE study respondents mentioning the issue. There were 200 environmental experts in more than 50 countries who contributed to the study. For example, 51% of all respondents mentioned climate change as a major emerging issue. All in all, this study was the best ranked source I could find for the world's top environmental problems. Note that the problems are ranked by urgency, not difficulty.

What Are the Factors That Make the Sustainability Problem So Difficult?

Our second strategic decision is to perform a second decomposition. The top environmental problems are top issues because they urgently need solving. But despite the fact they should have been solved long ago, they have not. What is it about these problems that makes them so difficult to solve? To answer that question we decompose difficulty into the key factors we suspect can be used to differentiate easy and difficult problems.

Every situation is driven by a small number of factors. Thus it is safe to assume that only a small number of factors account for why some problems are easy to solve and some are difficult.

When we start to examine the sustainability problem for difficulty factors, a few jump right out because they are nearly unique to the problem. The first of these is:

Factor 1 – High displacement in space – Displacement is distance from cause to effect. Displacement in space is how geographically close to a problem source its symptoms are.

Let's look at three examples: (1) A tanker oil spill mostly pollutes the sea around it and the shores it lands on, which tend to be nearby. This is a low to medium displacement in space. (2) The acid rain pollution emitted by a coal fired power plant has a medium displacement in space, because the effects occur hundreds of miles away, especially as the use of tall smokestacks to reduce local pollution has grown. (3) The greenhouse gases emitted by fossil fuel burning cause the effects of climate change all over the world, which is a high displacement in space.

Thus oil spills have a low displacement in space, while the acid rain problem has a medium displacement and greenhouse gas emissions have a high displacement. Which has been historically easier to solve? This varies directly with displacement in space. Oils spills have been the easiest to solve, and occur at a very low rate, considering the large number of annual tanker trips. The problem of acid rain has been moderately reduced, through the use of low sulfur coal, cleaner coal burning technologies, and the use of natural gas instead of coal. But the problem of greenhouse gas emissions from fossil fuel burning has not been solved at all, and has in fact grown worse every year for decades.

There is an easily discernable, fairly widespread correlation between displacement in space and problem difficulty. This makes this an important factor.

Next, let's meet this factor's twin sister:

Factor 2 – High displacement in time – Another type of displacement is displacement in time. This occurs when the problem event and the appearance of problem symptoms are separated by a delay in time.

We can reuse the same examples from above. An oil spill has a low displacement in time, since the effect shows up immediately as an oil slick and a few days later as the slick washes up on shorelines. Acid ran has a medium displacement in time. It takes days to weeks or even months before rain, snow, or sleet causes the water droplets in the air containing sulfur dioxide and nitrogen oxides to transfer to the ground. Greenhouse gas emission have a very long displacement in time of decades or centuries, because of the very long delay of the time it takes for temperatures to rise and weather patterns to change.

Again, there is an excellent correlation between displacement in time and problem difficulty. The higher the displacement in time, the more difficult the problem is to solve.

Let's pause to apply the first two factors to the list of environmental problems. If the factors are useful then what we should see is a medium to high displacement in space and time in most of the problems.

Below is a table of difficulty ratings for the first two factors. The ratings are on a scale of 0 to 5, where 0 is infinitely low, 1 is very low, 2 is low, 3 is medium, 4 is high, and 5 is very high. Rather than an exhaustive scholarly analysis for each rating I have used my own best judgment. This should suffice, since the prime purpose of the table is to open up a new dimension of understanding.

The Top Eleven Environmental Problems With difficulty ratings on a scale of 0 to 5	**Displacement**	
	In Space	**In Time**
1. Climate Change	5	5
2. Freshwater scarcity	1	4
3. Deforestation and desertification	1	3
4. Freshwater pollution	3	3
5. Loss of biodiversity	1	4
6. Air pollution (excluding climate chg)	2	2
7. Soil deterioration	1	3
8. Ecosystem functioning	2	3
9. Chemical pollution	4	3
10. Stratospheric ozone depletion	5	5
11. Natural resource depletion	1	5
Average Difficulty Rating	2.4	3.9

Every problem has at least one factor with a rating of medium (3) or above except air pollution, so the factors correlate well with problem difficulty.

There are two patterns of interest. One is it does not appear that the higher the rating, the higher the problem appears in the ranking. This is because these were selected as the top environmental problems due to their urgency, not their difficulty.

The other pattern is that displacement in time averages much more than displacement in space. This can be explained by the principle that the top strategy for competitive agents is to maximize the net present value of their competitive advantage. All other behavior follows from that. This causes social agents, given a choice between working on a displacement in space or time problem, to choose the displacement in space problem first. While the truism "Out of sight, out of mind" often determines decisions, the rules of "This is not going to cause a problem any time soon" and "We must maximize value to today's stockholders" hold priority and determine even more. It is deeply embedded cultural norms like these that determine aggregate agent behavior, not the ones we might like them to follow, such as the precautionary principle.

Next let's return to identifying the main factors that cause one environmental problem to be more difficult to solve than another. These will not be nearly as obvious as the first two.

Factor 3 – Weak perceived proof of cause and effect – If perceived proof of cause and effect is weak, then a problem is difficult to solve, because it is difficult to convince people that is should be solved.

Notice the word "perceived." Suppose physical proof of cause and effect is low, as it was for global warming until the last ten years or so. Add to this the fact that logical proof that the phenomenon of global warming is true has been around for a long time, and you have the ingredients for differences of opinion. Some people (those who are accustomed to logically proving things) will perceive that proof of cause and effect is high. Others (those who need conclusive evidence) will perceive that proof of cause and effect is low. Still others will be caught in the middle and not know what to believe, causing them to be susceptible to pleas from either side to see it their way. This frequently causes them to fall victim to fallacious appeals based on FUD (fear, uncertainty, and doubt) that argue that there is just not enough evidence to justify strong action. Or they may be persuaded by the fallacious emotional appeals of environmental classic activists to see things their way.

When this situation appears in the business world or science, cool calm logic and standard analytical practices are used to determine what to do. But most of the public, environmentalists, and politicians are not trained to think like business managers or scientists. This causes them to be highly susceptible to fallacious appeals as described above.

There is, however, an alternative: teach the public to think like business managers and scientists. This is starting to be done with rules of thumb, also known as principles. Of these the precautionary principle is an outstanding example. While this principle has long been used in business, science, and academia, it is new to the environmental debate. Essentially the **precautionary principle** says that if physical proof that a practice is harmful is low, but logical proof that it may be high is present, then decision tree analysis should be followed, which will usually indicate that the practice should be avoided until further and more conclusive evidence becomes available.

Factor 4 – Caused by many types of agent behavior – A problem is easiest to solve if it is caused primarily by one type of agent behavior. Usually the more types of agent behavior that cause a problem, the more difficult it will be to solve the problem.

Examples of one type of behavior and easy problems are the way acid rain is caused mostly by the burning of sulfur-containing coal, or the way a river may be polluted mostly by a single source of pollution, such as agricultural runoff or factory waste dumping.

Each type of agent behavior is a problem source. The more different types of sources there are the more difficult the problem becomes, because each unique type of source generally requires a custom solution and/or is a source of change resistance. If there are many types of agent behavior causing the problem, then there are probably going to be many special interest groups battling to be allowed to continue their behavior. Thus the higher the number of sources, the greater the change resistance will probably be.

Factor 5 – Caused by a high percentage of agents – The higher the percentage of agents whose behavior is causing a problem, the more difficult it will be to solve the problem.

For example, consider the climate change problem versus the soil deterioration problem. In industralized countries, over 90% of the population directly causes climate change through the burning of fossil fuels as they drive or consume energy. But less than 10% are responsible for soil deterioration, because such a small percentage are farmers. This factor helps to explain why, in industrialized countries, climate change is so much more difficult to solve than soil deterioration. In the unindustrialized countries the percentages are approximated reversed, which explains why they find that soil deterioration is a harder problem to solve than climate change.

Factor 6 – High solution cost – The more a solution costs, the more difficult it will be to fund. Expensive solutions tend to be postponed, driven by hopes there is a cheaper way or that the problem will just go away. Very high solution costs can make a problem appear unsolvable if a society cannot afford the expense, or if there are competing problems vying for investment.

If a society is faced with a multitude of problems, many of which are expensive, it will be forced to solve some and not others, or to go with partial solutions. In the case of the sustainability problem this is the equivalent saying the problem has reached the point of insolvability.

Factor 7 – High influence of agents who perceive they will be made worse off by the solution – Finally we come to what is probably the biggest factor of them all. If the agents who perceive they will be made worse off by the solution have high influence, then they can usually block progress on solving the problem until a "wakeup call catastrophe" occurs. This is a catastrophe so large, and with such an obvious cause, that enough agents in the system are galvanized into taking critical action immediately. Or it may take a series of wakeup calls.

There is no doubt this is a key factor. Leading the charge against taking action on the sustainability problem are large for-profit corporations and their proxies, which include the United States, innumerable politicians, lobbyists, other countries, and so on. This source of change resistance was identified earlier on page 32 as the New Dominant Life Form. This section argued that the modern corporation and its allies is now the dominant life form on Earth. Because its top goal is to maximize the net present value of profits, it correctly perceives that it will be made worse off (in the short term) by the solution. This will happen, because the largest reductions in environmental degradation will come from reductions in population and consumption per person, not from changes in technology. This fact is often glossed over by environmentalists so as to soft pedal a harsh truth, and thereby win over corporate minds to their cause. But in an objective analysis it cannot be glossed over as easily. It is as real as the moon.

This completes the identification of the main factors that make solving the sustainability problem so difficult.

The Problem Difficulty Table

On the next page is the table of problem difficulty ratings for a list of problems. How the ratings are calculated will take some explanation.

The first thing to realize is the rating system is generic. It applies to all complex social system problems, not just sustainability. This is important, because *the power of an abstraction increases exponentially with its universality*.

All complex social system problems are different. Each has its own unique challenges. But underneath the veneer of a social problem's outward appearance lies a pattern that can be used to calculate the problem's difficulty. The pattern consists of the problem difficulty factors. While there are many more than the seven factors listed, these appear to be enough to roughly determine a problem's difficulty on a relative basis.

The table is not meant to be definitive. The raw scores are estimated. So are the weightings. Selection of the factors and weights is my own first pass educated guess, rather than one based on expert opinions and studies. The purpose of the table is to illustrate the concept of problem difficulty factors, and to encourage that concept to grow into the realization of the need for a problem solving process that can handle such factors.

As we discuss the table it is vital to remember that *the factors are only superficial*. They are only proximate (immediate or direct) causes. They are *not* the underlying causes of why a problem is difficult to solve. However the factors are very useful for designing the proper process to solve the problem and as clues on where to focus one's analysis.

How the Ratings Are Calculated

How much of each of the factors is present in a problem determines that problem's difficulty rating. Because some factors are more influential than others, a weighting system is used.

An example is factor 1, high displacement in space. This receives only a weight of 1 because it is much less important than factor 2, displacement in time, which gets a 3. Looking at the climate change problem, we see a raw score of 5 and 5 for factors 1 and 2. But after these are multiplied by their weights, the weighted scores are 5 and 15. The raw scores are first and the weighted ones are second for each factor.

The maximum weighted scores are designed to add up to 100. This gives a total weighted difficulty rating ranging from 0 to 100. This is squared to get the final score, the relative difficulty rating, which ranges from 0 to 10,000. Squaring is necessary because problem difficulty rises approximately exponentially as the weighted score goes up. A counterpart is how in school grades 1 to 12, the ability of a student in grade 12 is not double that of one in grade 6. It is much, much more. There are something like a dozen times as many types of problems the twelfth grader can solve as the sixth grader. The

Difficulty Ratings for Complex Social System Problems

The higher the difficulty rating, the greater the change resistance will tend to be.

The problem difficulty factors receive scores ranging from 0 to 5, which is the easy-to-difficult problem difficulty spectrum. Raw scores for each factor are assigned using these criteria: 0 – Factor is infinitely low (such as zero) 1 – Factor is very low (very easy) 2 – Factor is low 3 – Factor is medium 4 – Factor is high 5 – Factor is very high (very difficult)		Problem Difficulty Factors							Rating		
		1. High displacement in space	2. High displacement in time	3. weak perceived proof of cause and effect	4. Caused by many types of agent behavior	5. Caused by a high percentage of agents	6. High solution cost	7. High influence of agents who perceive they will be made worse off by the solution	Total weighted difficulty rating on a scale of 0 to 100	Relative Difficulty Rating = Weighted Rating Squared	Success in solving the problem
Factor Weight		1	3	2	2	2	4	6			
Maximum Weighted Score		5	15	10	10	10	20	30	100	10,000	
Environmental Problems	SCOPE Study										
1. Climate change	51%	5 5	5 15	4 8	5 10	5 10	5 20	5 30	98	9,604	Low
2. Freshwater scarcity	29%	1 1	4 12	1 2	4 8	3 6	3 12	4 24	65	4,225	Low
3. Deforestation and desertification	28%	1 1	3 9	1 2	5 10	4 8	4 16	4 24	70	4,900	Low
4. Freshwater pollution	28%	3 3	3 9	1 2	2 4	2 4	2 8	3 18	48	2,304	Medium
5. Loss of biodiversity	23%	1 1	4 12	1 2	5 10	5 10	4 16	4 24	75	5,625	Low
6. Air pollution (excluding climate chg)	20%	2 2	2 6	1 2	3 6	3 6	3 12	3 18	52	2,704	Medium
7. Soil deterioration	18%	1 1	3 9	3 6	2 4	2 4	5 20	4 24	68	4,624	Low
8. Ecosystem functioning	17%	2 2	3 9	4 8	5 10	5 10	4 16	5 30	85	7,225	Low
9. Chemical pollution	16%	4 4	3 9	2 4	4 8	3 6	3 12	3 18	61	3,721	Medium
10. Stratospheric ozone depletion	15%	5 5	5 15	1 2	1 2	1 2	1 4	1 6	36	1,296	High
11. Natural resource depletion	11%	1 1	5 15	1 2	5 10	5 10	4 16	5 30	84	7,056	Low
Non-environmental Problems											
Urban decay		1 2	3 9	5 10	2 4	5 10	4 16	5 30	80	6,400	Medium
Civil rights		1 1	1 3	1 2	2 4	3 6	1 4	3 18	38	1,444	High
Women's suffrage		1 1	1 3	1 2	2 4	4 8	1 4	3 18	40	1,600	High

twelfth grader can also solve problems that are a dozen times as hard as anything the sixth grader can solve. The same phenomenon occurs in chess rankings. A rated player with a rating 10% higher than another player does not win just 10% more games. They win nearly all of them.

The analytical power of the table comes from the way it can compare one problem to another, and explain why one problem is easy to solve and another one is not, at the immediate factor level. For example, we now have proof positive that the climate change problem is very difficult to solve, because civilization has been woefully unable to solve it for decades and the problem continues grow dramatically worse. The table shows exactly why, *at the immediate factor level*, in a manner that is easy to discuss and hard to refute. Similarly, we also have proof the stratospheric ozone depletion problem is an easy problem, because it's been solved. Again, the table shows why. By studying the relationship patterns in the table we can start to look deeper into the system and see why it exhibits such strong change resistance for some problems at the factor level.

The Factor Weights

The weights vary from 1 to 6 as shown in the list below. They have been very approximately estimated. Their exact values are unimportant. Only their rough relative values are.

Difficulty Factor	Weight
1. High displacement in space	1
2. High displacement in time	3
3. Weak perceived proof of cause and effect	2
4. Caused by many types of agent behavior	2
5. Caused by a high percentage of agents	2
6. High solution cost	4
7. High influence of agents who perceive they will be made worse off by the solution	6

Here's how the weights were selected:

The first factor, **high displacement in space**, has a weight of 1. This is arbitrarily chosen as the *reference weight*. All other weights are multiples of the reference weight.

The second factor, **high displacement in time**, has a weight of 3. This factor is estimated to be three times as influential as the reference weight, due to the way social agents heavily discount the future. That is, a bird in the hand is worth two in the bush. Or there's the golden rule of for-profit corporations: Maximize the net present value of profits above all else, because if you don't your competitors will and you will be their lunch tomorrow. The first and second factor weights give us a *reference range* on which to place the remaining weights. All other weights are assigned as relative to the reference range.

The third factor, **weak perceived proof of cause and effect**, carries a weight of 2. Weak perceived proof is about the same as weak physical proof, since most people depend on physical rather than logical proof to make up their minds about new problems. This factor is less influential on agent behavior than displacement in time, but more influential than displacement in space.

This factor is not as influential as high displacement in time because if you compare "I'm not sure" to "This won't happen for 50 years," the latter has more influence on decision making. This is because very few people are accustomed to thinking that long term. Almost no one does in the normal course of their job or in their everyday life.

But this factor is more influential than displacement in space, because when you compare "I'm not sure" to "This is not causing a problem here," the uncertainty of "I'm not sure" makes that take precedence over "This is not causing a problem here." The more uncertain you are, the less you want to take action.

The fourth and fifth factors, **caused by many types of agent behavior** and **caused by a high percentage of agents**, also have a weight of 2 for about the same reasons that the third factor does.

But the sixth factor, **high solution cost**, is another story entirely. It carries a weight of 4. This is 1 more than the weight for high displacement in time, because "This is going to be expensive to solve" is a bigger impediment to taking solution action than "This won't happen for 50 years." The reason is the way maximization of corporate profit, as well as the accumulation of money and other forms of wealth by individuals, rulers, and governments, is the top driver in most agent decisions.

The last factor, **high influence of agents who perceive they will be made worse off by the solution**, starts to go off the chart. In solving a social problem there is no factor that comes even close to how difficult the problem is to solve if those who will be made worse off are in a position to block the solution. Thus this factor has a weight of 6.

These weights are all estimated. Another way to set them would be with a simple measurement poll. It could ask respondents how they would weight or rank the seven factors, which could be represented by the following list of phrases:

1. This is not causing a problem here.
2. This won't happen for 50 years.
3. I'm not sure.
4. Many of types of behavior cause this problem.
5. Many different types of agents, such as different groups of people or different industries, are causing this problem.
6. This is going to be expensive to solve.
7. There are a lot of very influential parties who don't want to see this problem solved.

A poll would undoubtedly find a different set of weights than those estimated above. But it would also find that the weights are not all the same, and therefore there are specific, measurable reasons why some problems are more difficult to solve than others. That is the key insight here.

The Two Levels of Change Resistance

Looking over the seven factors, we see that each of them increases the tendency of the system to resist change. The higher the rating for a factor, the more that factor increases change resistance. The higher the total rating or the relative rating for a problem, the higher the change resistance associated with that problem. *More than anything else, the ratings are a measure of change resistance.*

This is exactly what we would expect, because the more difficult a problem is to solve, the more the system is resisting change. But change resistance at the agent level means the refusal of a person or organization to fully support or adopt new behavior. At the system level change resistance is the tendency for a system to resist change even when a surprisingly large amount of force is applied. Thus there are two levels of change resistance at play here: **system change resistance** and **agent change resistance**.

When we are thinking about a problem and the system that contains it, change resistance is the tendency for the system to resist change. But when we analyze the system for the sources of change resistance and start to think in terms of types of agents, change resistance is the refusal of those agents to support or adopt new behavior. *It is only by thinking at the deeper level of* **agent type change resistance** *that we can begin to see the social structures that are the fundamental causes of a problem.*

This is a critical insight, because the change resistance side of the problem is the crux.

The Environmental Problems

The table below lists the top 11 environmental problems identified by the SCOPE study. Each problem has been rated. As shown in the sorted table, the higher the difficulty rating the lower the success in solving the problem. Thus it appears that the difficulty ratings do indeed explain why some problems are difficult and some are easy, at the factor level.

Environmental Problems Sorted by Difficulty	Relative Difficulty Rating	Success in solving the problem
10. Stratospheric ozone depletion	1,296	High
4. Freshwater pollution	2,304	Medium
6. Air pollution (excl climate chg)	2,704	Medium
9. Chemical pollution	3,721	Medium
2. Freshwater scarcity	4,225	Low
7. Soil deterioration	4,624	Low
3. Deforestation and desertification	4,900	Low
5. Loss of biodiversity	5,625	Low
11. Natural resource depletion	7,056	Low
8. Ecosystem functioning	7,225	Low
1. Climate Change	9,604	Low

A very high difficulty rating does not mean a problem is impossible to solve. It only means there is going to be a high level of change resistance. If the process used in solving the problem takes change resistance into account, then problem solvers will be able to routinely sail right through problems like the ones on the list above.

Let's compare the problems at the top and bottom of the table, to see why one was so easy to solve and why the other remains unsolved. These are stratospheric ozone depletion and climate change.

As soon as the stratospheric ozone depletion problem was close to being solved, the environmental movement began to regain some of its confidence. It looked as if it just might be possible to begin solving the problems on the list above. After all, if we can solve the first one, then why can't we use that as a pattern of success and propagate it to the remaining problems?

But this did not happen, much to the consternation of the movement. The difficulty factors explain the reasons why. These reasons are especially easy to see if we compare the top and bottom problems.

The table below compares the ozone depletion and climate change problems. The difficulty factors show precisely where the differences in solution success come from. They are the same for the first two factors, high displacement in space and time. But in all the other factors the climate change problem scores much higher. This is why the climate change problem remains unsolved, while the ozone depletion problem was solved back in the 1990s by the Montreal Protocol. Let's examine factors 3 to 7 to see exactly why this happened.

Difficulty Factor	Wgt	Ozone Depletion		Climate Change	
		Raw	Weighted	Raw	Weighted
1. High displacement in space	1	5	5	5	5
2. High displacement in time	3	5	15	5	15
3. Weak perceived proof of cause and effect	2	1	2	4	8
4. Caused by many types of agent behavior	2	1	2	5	10
5. Caused by a high percentage of agents	2	1	2	5	10
6. High solution cost	4	1	4	5	20
7. High influence of agents who perceive they will be made worse off by the solution	6	1	6	5	30
Total Weighted Rating			36		98
Relative Rating			1,296		9,604
Problem solving success			High		Low

3. Weak perceived proof of cause and effect – Once scientific studies were completed a few years after the problem was first noticed, there was solid proof of cause and effect on what was causing stratospheric ozone depletion and exactly when its effects would occur, causing this problem to receive a raw score of 1. But on climate change solid proof of cause and effect has taken much longer, and there are still wide variations in the predicted consequences of excessive amounts of greenhouse gases. It was not until the third IPCC report in 2001 that scientists were able to predict, with 95% confidence, that global temperatures would rise between 1.4 to 5.8 degrees Celsius over the period 1990 from to 2100. This is 150 years after the buildup of excess greenhouse gases began in the 1850s, due to the beginning of the Industrial Revolution and its dependence on the burning of coal, and later other fossil fuels.

Thus for a long time there was weak proof of cause and effect. In addition, given the variability in predictions of how much temperatures will rise and when, there is still not the high perceived proof of calamitous effects that are needed for society to take a highly ag-

gressive approach to a solution. Thus the climate change problem receives a raw score of 4.

4. Caused by many types of agent behavior – Stratospheric ozone depletion was caused mostly by a single type of human behavior: the release of chlorofluorocarbons (CFCs) into the atmosphere. The pie chart below shows how CFCs were used in five main areas. [32] The sixth area causing harm was other products containing halons, such as waterless fire extinguishing systems.

At first glance it appears that ozone depletion is caused by many types of agent behavior. But "many" is a relative word. Depending on how they are chosen, there are hundreds or thousands of main types of agent behavior. If industries are used then only a very small percent of industries were dependent on CFCs and halons.

The negotiations leading up to the first version of the Montreal Protocol on Substances that Deplete the Ozone Layer thus only had to deal with a relatively small segment of industry. This is so much easier than dealing with hundreds of industries that this factor receives a raw score of 1 for ozone depletion.

But for climate change there is an endless multitude of types of agent behavior causing the problem. Looking at just fossil fuel burning, we have the auto industry, the airlines, the shipping industry on land and sea, the oil industry, the coal mining industry, and the coal, oil, and gas electric power plant industry. Tucked into this are small industries like the use of tractors for farming and pumps for irrigation. And then there is deforestation, which also causes climate change. This is caused by the building of homes and commercial properties, the clearing of forests for agriculture use, logging for the paper and wood industries, and subsistence farming.

The list of agent behaviors linked into the causes of climate change is so long it is impossible to list them all. Thus this factor received a raw score of 5 for climate change.

5. Caused by a high percentage of agents – This follows the pattern of the fourth factor. The percentage of agents involved in the production of CFCs was so low this factor receives a 1 for ozone depletion. But the percentage of agents involved in the production of greenhouse gas emission and the loss of greenhouse gas sinks is so high this factor gets a 5 for climate change.

6. High solution cost – CFC substitutes initially cost 3 to 5 times as much. This would seem to be high, but coolant cost is a small fraction of the total cost of the equipment that uses it, so this factor scores a 1 for ozone depletion.

But the climate change problem has a high solution cost, because affordable substitutes for the uses of fossil fuel have in most cases not yet even been found. For example, biofuels like ethanol are being promoted as a replacement for gasoline. But in temperate climates, such as most of the industrialized world, the energy costs of producing ethanol sources like corn are so high that there is barely a net gain. In addition, the production capacity of countries for ethanol sources is very small compared to their needs.

As another example, photovoltaics (PV) are much more cost competitive. Small PV systems connected to the electrical grid cost only 2 to 5 times as much as buying power from the grid. But they cannot supply any electricity when the sun is not shining. They must be quite large to satisfy peak loads. And unlike CFC substitutes, conversion cost is huge. One 2006 article reports that "In a Sacramento, California home, it would cost around $16-$20,000 to satisfy around 25% of that home's energy needs." [33]

This is so unaffordable that photovoltaics have a very high solution cost. The same is currently true for all large scale fossil fuel substitutes. Thus this factor receives a 5 for climate change.

7. High influence of agents who perceive they will be made worse off by the solution – Finally we come to the factor with the highest weight of them all: a 6. This is the factor that makes the biggest difference.

For the ozone depletion problem, the influence of corporations made worse off by having to phase out CFCs and halons was very small. Their initial resistance was led by the world's largest manufacture CFCs: DuPont, who also invented them. DuPont founded and led the so called Alliance for Responsible CFC Policy, which successfully stonewalled industry conversion for years. But it was a tiny industry, and could not do this forever. As soon as conclusive scientific evidence appeared linking CFCs to ozone layer depletion, DuPont

reversed its position and supported immediate conversion to safe substitutes. Why? Because DuPont was essentially alone against the rest of the world. It was the only corporate giant backing continued use of CFCs. It knew it could not hold out against public opinion alone, and so it gave up the struggle as soon as it was evident the tide would be against it. Thus this factor receives a 1 for the ozone depletion problem.

But the hundreds of oil companies, car companies, and electric power plant companies promoting fossil fuel consumption are not so alone. And they are giants. On page xx is a table of The World's 100 Largest Economies in 2000. 53 of them were corporations. Scanning the first 16 corporations in the left side of the table, we see that 10 of them are car manufacturers or oil companies. ExxonMobil, for example, has larger revenues than the GDP of 170 out of 190 countries in the world. The top 16 corporations each have larger revenues than 156 out of 190 countries. That economic power translates directly into such strong political power that the fossil fuel industry has had little trouble stopping all significant progress in solving the climate change problem for decades. Thus this factor gets a 5 for climate change.

Now we can see why, at the factor level, the climate change problem is so fiendishly difficult to solve, and the ozone depletion problem was so easy. But has the environmental movement been able to see why this is so?

No. A recurrent theme in the environmental literature is attempting to replicate the success of solving this global problem to other problems. For example, a very thorough article on *The Evolution of Policy Responses to Stratospheric Ozone Depletion* in the *Natural Resources Journal*, 1989, stated that: (italics added)

> "The Montreal Protocol is a landmark agreement in that it is the first international treaty for mitigating a global atmospheric problem before serious environmental impacts have been conclusively detected. As such, the Montreal Protocol has stirred much interest, and both scientists and policymakers have suggested that *it can be used as a model for international agreements on other global environmental problems,* especially the problem of C02 and trace-gas induced global warming." [34]

The conclusion that "it can be used as a model for international agreements on other global environmental problems" is faulty. *It can only be used as a model on other problems with similar difficulty factors.* Attempts to use it as a model for solving the global warming problem will not work, because they are as different as day from night. Until environmentalists recognize why, at the factor level, the ozone depletion problem was solved and why others like global warming have resisted solution, their efforts will remain as ineffective.

The Many Difficult Subproblems Factor

Let's step back to look at the sustainability problem as a whole. How difficult is the complete *problematique*? Here we must realize that if any sustainability subproblem remains unsolved, then so does the main problem. A chain is only as strong as its weakest link. Therefore the highest difficult rating is the rating for the whole problem.

But this does not consider an eighth factor: *the presence of many difficult subproblems in the original problem you are trying to solve.* If this is low, then the problem does not require peeling back layer after layer of yet another problem, just to solve the whole problem. But if this factor is high, then the deeper you dig the more problems you find.

The world is belatedly discovering that when it comes to this eighth factor, the sustainability problem is the granddaddy of them all. The problem probably deserves a raw score of 5 and the factor a weight of at least 10. Using the raw score from the most difficult subproblem, this would give the sustainability problem a raw score of 98 + (5 x 10) = 148. Squaring this gives a relative difficulty rating of 21,904. When we compare this to the only problem solved on the list of environmental problem, the ozone depletion, we have a 1,296 versus a 21,904.

Given this, is it any surprise that classic activists have been unable to solve the sustainability problem?

The Dread Factor

Peter Morrisette, in *The Evolution of Policy Responses to Stratospheric Ozone Depletion*, argues that a major reason the ozone depletion problem was solved is it contains a high amount of "dread:"

> **"Catastrophic Nature of the Risks: The 'Dread Factor'**
>
> "The public's perception of the risks from an environmental problem can have a significant effect on how policymakers respond to that problem. Slovic et al. have identified a shared set of characteristics called 'dread' that help explain how the public perceives risks from certain technologies and hazards. The risks from a technology or hazard that are perceived to be high in dread are those that are seen to be globally catastrophic, threatening to future generations, increasing, hard to prevent, not easily reduced, involuntary, and personally threatening. Tech-

nologies and hazards that score high in dread include among others nuclear power, nuclear weapons, DDT and other pesticides, liquid natural gas, and asbestos. A second important factor is familiarity, that is, whether the risks are observable, known to those exposed and to the scientific community, and whether the effects are immediate or delayed. A third factor is the extent of exposure. Risks from technologies such as nuclear power or DDT that are perceived to be high in dread, low in familiarity, and high in exposure are more likely to be seen as unacceptable by the public.

"The CFC/ozone-depletion problem shares many of these characteristics. In particular, the increased risk of skin cancer is a global problem which is threatening to future generations, increasing, hard to prevent, and not easily reduced. Furthermore, exposure is involuntary and personally threatening. In addition, the recently discovered ozone hole over Antarctica has likely contributed greatly to the perception of global catastrophe and dread, adding a new sense of urgency. Also, familiarity with the ozone depletion problem is low: the risks are not easily observable, and they are delayed and not well understood by scientists. In other words, the risks associated with ozone depletion are high in dread, low in familiarity, and high in exposure. The problem is global, with a potential for catastrophic impacts on human health and the environment, and it is not well understood by the public or scientists.

"The dread and unacceptable nature of the risks associated with stratospheric ozone depletion have undoubtedly contributed to maintaining political interest in the problem and the search for a solution. The well-documented risk of increased skin cancer has long been a driving force behind efforts to protect the ozone layer: it was central to the SST/ozone depletion debate, and it was the principal reason for the U. S. aerosol ban in 1978." [35]

This is indeed a major factor. But I believe the seven factors used in the difficult problems table are even more influential. For example, the horrors of lung cancer are well known. But that did not make how to alert the public to the risks of tobacco smoking an easy problem to solve. It took decades. What finally made the problem solvable was the appearance of irrefutable proof of cause and effect. Another example is most of the environmental problems will cause massive famines and deadly conflict, including full scale warfare, if they come to pass. This does not appear to have made them any easier to solve. Finally, even though the ozone depletion problem was high in dread, it remained unsolved until irrefutable proof of cause and effect appeared. Once that happened, DuPont reversed its position and came out in strong support of banning the use of CFCs.

But we could be wrong. Maybe dread should be included in the difficulty table factors. A more thorough study of these factors would be able to determine this.

The Non-environmental Problems

The power of an abstraction increases exponentially with its universality. To more fully flesh this one in, let's apply it to a few well known non-environmental problems. This will demonstrate how the seven factors can explain the difficulty of a variety of complex social system problems, not just environmental ones.

The urban decay problem – Chapter one described this problem in graphic terms:

> "In the 1950s and 1960s, urban decay and the symptoms it caused was America's biggest problem. It would eventually reach the crisis stage with the Los Angeles race riot of 1965, which left 34 people dead. Other riots occurred in Newark and Detroit. The problem continued to deteriorate, and in 1968 Martin Luther King Jr. was assassinated, which sparked further riots, including some in the nation's capitol. The riots, high levels of crime, growing discrimination and race hatred, and a host of factors increased white flight from inner cities. Businesses also moved out. This made the urban decay problem even worse, causing a vicious cycle. Despite a plethora of attempted solutions, the problem failed to get better. By the late 1960s the problem looked hopeless."

Chapter one then proceeded to show how Jay Forrester, using the new tool of system dynamics, was able to model the problem and pinpoint where the low and high leverage points were. Problem solvers had been pushing on the low leverage points, which the system successfully resisted. His model showed how if they pushed on the high leverage points instead, using much less investment than they had been using before on the low leverage points, the problem could be solved. And it was solved in about ten to twenty years, largely by using Forrester's insights. Today urban decay is still a problem, but it is no longer the crisis it once was. Society has had medium success in solving the problem, as listed in the table on the next page.

Difficulty Factor	Wt	Urban Decay		Civil Rights		Women's Suffrage	
		Raw	Wtd	Raw	Wtd	Raw	Wtd
1. High displacement in space	1	1	1	1	1	1	1
2. High displacement in time	3	3	9	1	3	1	3
3. Weak perceived proof of cause and effect	2	5	10	1	2	1	2
4. Caused by many types of agent behavior	2	2	4	2	4	2	4
5. Caused by a high percentage of agents	2	5	10	3	6	4	8
6. High solution cost	4	4	16	1	4	1	4
7. High influence of agents who perceive they will be made worse off by the solution	6	5	30	3	18	3	18
Total Weighted Rating			80		38		40
Relative Rating			6,400		1,444		1,600
Problem solving success			Med		High		High

Again, please remember the factors, raw scores and weights are all estimated. This is not a definitive study. Its purpose is to illustrate that complex social system problems have a pattern of superficial, easily measured factors that can be used to determine problem solving difficulty. If the process used on a problem does not take its high difficulty factors into account, then the group of problem solvers using that process will be unable to solve the problem, unless they get very lucky.

Let's examine the difficulty factors for the urban decay problem, to see how they can explain the problem's difficulty. Looking at the table on the right, we see that *(1) High displacement in space* scores a 1. It is very low. The physical distance from source to cause in urban decay is very short. Scarcity of jobs or low paying jobs in an area cause that area to become populated with low income households. The same holds for level of parental education, level of crime, and level of illegal drug use. Note that these sources are not the so called root cause source, but are intermediate sources of the cause of the problem.

(2) High displacement in time is medium, so it gets a 3. Forrester's model showed that it took decades for the structural causes of urban decay to show up as decay symptoms. But these causes were so subtle, and so counterintuitive, that no one before him had noticed them. Thus there was a very *(3) Weak perceived proof of cause and effect*, so that factor scores a 5.

Once Forrester completed his model of the problem, it became obvious that urban decay was caused by a fairly limited number of types of agent behavior. But it was not caused by only one type of behavior, so it scores a 2 for *(4) Caused by many types of agent behavior*. The fundamental causes were seen as coming from two policy areas:

> "The natural tendency toward imbalance in which *housing dominates industry* might be corrected by urban policies that encourage industry as well as by policies that discourage construction of excess worker housing." [36]

Thus the two fundamental causes of urban decay were lack of pushing on these high leverage points. A third cause must be added to this: pushing on intuitively attractive low leverage points. *The conventional wisdom was that urban management programs like jobs for the underemployed, training for the under skilled, financial aid, and low cost housing were the solution.* Most of the agents in the system passionately believed this solution would work. The poor supported it, because it promised them lower expenses and higher incomes. Employers supported it, because it decreased employee costs and increased their skill level. Urban managers, academics, and the middle and upper class supported it because it made good sense and fit the pattern of transfers of wealth to the poor as a helping hand for getting them on the path to economic equality.

It didn't work. But because all the major agents strongly believed it would, the *(5) Caused by a high percentage of agents* factor scores a 5.

The urban decay problem also had a high perceived solution cost. The favored solution was expensive. As a result it was difficult to keep it adequately funded over the long term. But it was not prohibitively expensive, so *(6) High solution cost* scores a 4 instead of a 5.

Finally, there was a very *(7) High influence of agents who perceive they will be made worse off by the solution*, so this factor scores a 5. More than anything else, the solution required large expenditures over an indefinite period of time. The money for this came from the middle class and especially the rich. This group, as it usually does, had high political clout. As a result it refused to fully fund the solution long enough for the solution to work.

But Forrester's model showed that this solution never would work, because it was pushing on low leverage points. Ironically Forrester's solution, the one that did work, turned out to be so much cheaper than ones that did not work that today urban management programs are in general sufficiently funded.

Weighting these scores and summing them up, we arrive at a total relative rating of 6,400. Problem solving success has been medium, which is what you would expect from a rating in this range.

The Phenomenon of Disappearing Difficulty - The urban decay problem exhibited a common phenomenon. Once the right high leverage points were found and problem solvers knew about them, problem difficulty disappeared because the most important difficulty factors now had a low rating. Let's examine these to see how this happened, starting with the factor with the highest weight of them all.

This is *(7) High influence of agents who perceive they will be made worse off by the solution*. When problem solvers were pushing on low leverage points by using conventional wisdom solutions, this factor was very high. It was a 5, because high influence agents perceived that they would have to pay a lot of money for a long time for an expensive solution, one that was not even working. But Forrester's solution, which pushed on high leverage points instead, was so supremely efficient that it was a low cost solution. In addition the new solution profited industry directly. The policy of encouraging businesses in inner city areas required tax breaks and subsidies. These two aspects caused solution support resistance from the highest influence agents, corporations, to vanish, which changed this factor from a 5 to a 1.

The *(6) High solution cost* factor fell to about a 2. The *(5) Caused by a high percentage of agents* fell to a 1, because now most agents supported the right solution instead of the wrong one. *(4) Caused by many types of agent behavior* also fell to a 1, because once the right solution was known by the agents in the system, only a very low percentage of agents still supported the wrong solution and continued to push on low leverage points. Finally, *(3) Weak perceived proof of cause and effect* also fell to a 1, because once you understood Forrester's model, the fundamental causes of urban decay were strikingly clear.

Factors 1 and 2 remained unchanged. But the new raw scores, when weighted and added up, change the total weighted rating from 74 to 32, and the relative rating from 6,400 to 1,024. [37] This is why the sudden discovery of the right high leverage points caused problem difficulty to disappear. Such is the power of the right analytical approach.

It appears the same phenomenon can be repeated on the sustainability problem as a whole, by educating key agents about the presence of high leverage points that have never been pushed on, and how they might be pushed on effectively.

The Civil Rights Problem – According to Wikipedia, "Civil rights are the protections and privileges of personal liberty given to all citizens by law." The civil rights problem was mostly solved by the civil rights movement of about 1960 to 1980, when new laws granting all citizens full equality and opportunity to reach equality were passed in much of Africa, Europe, and the United States.

Once it became a major issue, this was an easy problem to solve. The cause was systemic discrimination and the absence of laws and programs to actively eliminate discrimination. Let's identify this cause with the single word "discrimination." The symptoms of the problem were grossly lower economic and social outcomes of those who were members of ethnic groups who were discriminated against.

The distance in space and time between discrimination and the symptoms was very low, so the first two factors score a 1. It was so obvious that discrimination was the cause of the symptoms that the third factor, *Weak perceived proof of cause and effect*, also scores a 1. But the fourth factor, *Caused by many types of agent behavior*, was not very low. It was only low, so it scores a 2. There were dozens of subtle ways to discriminate and still stay within the law. But these behaviors were a small percentage of the total behaviors of society.

The fifth factor, *Caused by a high percentage of agents*, is medium, so it gets a 3. Somewhere around 30% to 70% of the citizens in power in those countries with a discrimination problem did actually discriminate.

Some complex social system problems have a very inexpensive solution. The civil rights problem was one of them. Enacting new laws, educating the people about them and enforcing them is all that was required. This was such a cheap solution that the sixth factor, *High solution cost*, scores a 1.

There was, however, change resistance. The seventh factor, *High influence of agents who perceive they will be made worse off by the solution*, was medium, so this scores a 3. There was plenty of organized, prolonged resistance. But there was also plenty of organized, prolonged support, which is what gradually caused those resisting change to see things in a new light, and change their minds.

These scores add up to a 1,444 for the relative ranking of problem difficulty. This is low, which is why the civil rights problem was so easy to solve. In many countries it was a hard fought battle at the time, but in retrospect it was an easy battle, because it was a relatively easy problem. In fact it was so easy that it could be solved with Classic Activism. But just because the process of Classic Activism can solve one activist problem does not mean it can solve them all.

The Women's Suffrage Problem – This problem has scores that are identical to those for the civil rights problem, except for one factor: *(5) Caused by a high percentage of agents*. Since mostly men were in power and

for a long time most of them felt they were superior to women, this scores a 4.

But after the women's suffrage movement began, this factor fell to a 3. This is part of the phenomenon of disappearing difficulty. Other factors fell too, but to keep this chapter short they will not be described here.

The "This Has Worked Before" Trap

These three non-environmental problems were all solved. The first one, urban decay, was solved using system dynamics. The other two, civil rights and women's suffrage, were solved using the very popular process of Classic Activism. Notice how they were so easy that they had little change resistance. This is why Classic Activism was able to solve them.

But herein lies the trap that millions of environmentalists have fallen into. Classic Activism, the standard process used by the environmental movement, works beautifully on easy social system problems. It sometimes works on medium difficulty problems. But it almost never works on high difficulty problems. However, if you are unaware that some problems are inherently easy and some are difficult, then you will assume that the process you are using is not at fault when solution failure occurs, *because it has worked before*. Instead you will assume that somehow the process has been applied improperly, and so you must try again. But this will not work. No amount of clever or muscular application of the wrong tool will solve a problem the tool does not fit. Can a mathematician solve a molecular chemistry problem with calculus? Can a Phillips screwdriver turn a slotted screw? Can a cow jump over the moon using a pogo stick?

The purpose of the next chapter is to make the "This Has Worked Before" trap so visible that environmentalists will never fall into it again, because they will be inclined to switch to a process that works on difficult problems.