4. It takes old paradigm supporters awhile to change paradigms. This delay must be taken into account. An initially slow transformation does not necessarily mean failure lies ahead—it may merely mean that change cannot be rushed.
5. It is possible to tailor a new process to fit a subclass of problems well, but not the entire set of problems. If the subclass of problems is solved first, this would cause the new process to have high beginning efficiency and low ending efficiency, which would cause early success and later failure. Avoid this trap. It has already occurred once.
6. *The highest leverage point is process efficiency.*
7. *The second highest leverage point is perceived process appeal.*
8. *The third highest leverage point is ability to see that the new process is better than the old one.*

The greatest insight is probably not where the high leverage points are. It is the fact that the transformation of Classic to Analytical Activism is just another case of the Kuhn Cycle, and so has all the characteristic behavior of that cycle. Only by deeply and correctly understanding the Kuhn Cycle will problems solvers will be able to engineer the successful cycle that all of humanity is now dependent upon.

The Memetic Evolution of Solutions to Difficult Problems

The process revolution model treated process efficiency as a black box. Input equaled output, because process efficiency equaled process appeal. But if process itself is what we want to better manage, then we need to know how processes work.

The class of processes we are most interested in is those that produce solutions to difficult, complex problems that push the envelope of solvability. Solving such problems is not a neat and tidy matter, but is historically messy, unpredictable, and wasteful, since most solution candidates do not pan out.

The best abstraction I know of for modeling such processes is memetic evolution, because that is exactly what is happening. Memes evolve just as genes do. A **meme** is a mental belief that was learned from someone else. They follow the same three steps of the evolutionary algorithm as genes do: mutation, selection, and replication. A **memeplex** is a complex of memes that work together to achieve more than its component memes could accomplish working alone. Most memes are actually memeplexes, but are called memes for short. From this viewpoint, a **solution** is a memeplex whose component memes work together to solve a problem. The main portion of a model of how memes evolve into solutions is shown on the next page.

The Solution Evolution Model

The backbone of the model is the seven stocks of solution component memes. As its life cycle progresses, a solution meme moves from the top of the model to the bottom, ending up as either sound or unsound. A sound meme is one that works. An unsound one doesn't. Once enough solution components are accumulated a problem is considered solved, with a probability of solution that depends on problem difficulty and the soundness of the solution.

A solution consists of Sound Solution Components plus Unsound Solution Components. No one ever knows how many unsound memes are in a solution until a port mortem analysis, and even then it's hard to tell. All we can be certain of is whether the solution works or not. A poor solution is one with too many unsound memes, not enough sound memes, or both. A solution to a difficult problem will have anywhere from hundreds to millions of memes, or in some cases, such as putting a man on the moon, billions. The more difficult the problem, the more solution memes required to solve it. Due to the challenge of understanding and managing solution meme relationships, the cost and difficulty of solving a problem varies exponentially with the number of memes required to solve it, because as the number of memes in a solution rises, the number of relationships among them rises exponentially.

The model has three sections: mutation, selection, and replication. These are the three steps of the cycle of evolution, which applies equally well to genes or memes.

A solution meme begins its long journey through life when it is born in hypotheses generation. The proper goal of a hypothesis is to create a new meme that has a high probability of becoming part of the solution, or contributing indirectly to the solution, such as basic research. A newly generated hypothesis is a mutation, because it differs from past hypotheses.

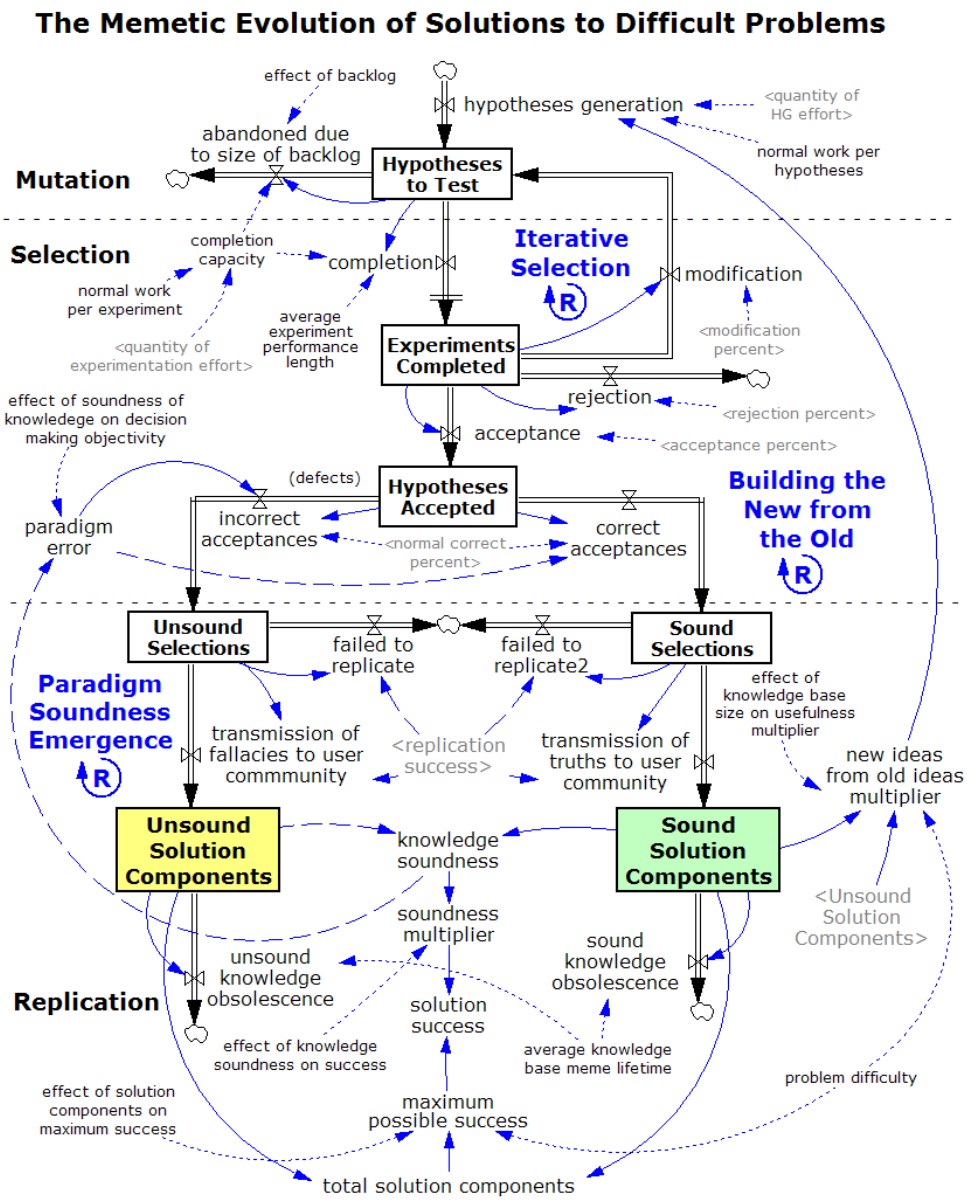
A new hypothesis enters the stock of Hypotheses to Test. If the stock grows too large, hypotheses may be abandoned due to size of backlog. But in a healthy process most hypotheses, after a delay of average experiment performance length, enter the stock of Experiments Completed.

Now our friendly little meme faces its greatest crossroad in life: selection, also known as survival of the fittest. It can now go in any of three directions. This brings us to the five steps of the Scientific Method, which are:

1. Observe a phenomenon that has no good explanation.
2. Formulate a hypothesis.
3. Design an experiment(s) to test the hypothesis.
4. Perform the experiment(s).
5. Accept, reject, or modify the hypothesis.

The meme just completed the fourth step. If the hypothesis was not accepted or rejected, but instead looks promising enough to rework and try further experimentation, it flows upward through the modification pipe and back to Hypotheses to Test. If acceptance occurred, it flows downward to Hypotheses Accepted. If rejection occurred, the meme dies.

Once a meme makes it to the stock of Hypotheses Accepted, the model takes into account that this



is not a perfect world. People make mistakes. In fact, my motto is that if I'm not making at least ten mistakes a day, I'm working on something that's too easy. So if an error occurred when reviewing the experimental results, the meme flows through the incorrect acceptances pipe to Unsound Selections. Or if the experimenters were highly trained, the meme probably flows through correct acceptances to Sound Selections.

Our plucky little meme has survived all the way to sound or unsound selections. It has one more step to go, however, because so far only those doing experimental review know about these memes. It is not until others know about them that they can become useful to all. Thus these memes need to be *replicated*

by transmission to user minds. This can be done by conversation, books, articles, conferences, videos, television, and so on. But until it is done, the user community cannot use the selections.

Hence for Sound Selections, it takes transmission of truths to user community to move a meme down to Sound Solution Components. Here is where it spends most of its productive life, as it works closely with other memes as a complex solution to a difficult problem. The same thing occurs to the hopefully much smaller number of memes in Unsound Selections when transmission of fallacies to user community moves unsound memes to Unsound Solution Components.

That Unsound Solution Components happen is why solutions contain so many problems of their own. Because it is impossible tell which solution components are sound and unsound once they are selected, problem solvers need to proceed cautiously and think in terms of solution probabilities and potentially defective solution components.

Some transmissions will not be high enough quality to be understood, remembered, or easily looked up. The model considers these as never sufficiently transmitted. Thus some or even most selections will have failed to replicate, and so will die instead of being replicated.

But the rest make it to Sound Solution Components or Unsound Solution Components, where they work hard, often for a long time, to solve the problem. After a meme's productive life is over it dies. This can happen when it becomes lost, forgotten, misunderstood, garbled, etc. But the biggest reason its life ends is it becomes obsolete as the problem it was solving changes over time. A solution meme sooner or later dies because it cannot change itself, and so fails to adapt to a changing environment. Thus Sound Solution Components is continually drained by sound knowledge obsolescence, and Unsound Solution Components is drained by unsound knowledge obsolescence. Because of this continual loss a problem solver's work is never done.

There are two main reinforcing loops in the model. The **Building the New from the Old** loop takes the knowledge in the bottom two stocks, Sound Solution Components and Unsound Solution Components, and uses that to increase the creation rate of new hypotheses. *It is only by building the new upon the old that knowledge is advanced significantly*. In other words, the new must *evolve* from the old, instead of starting from scratch. Otherwise our knowledge would consist only of original, unimproved ideas. These would be so small in number and so simple that such a society could not possibly be anything more than primitive.

The loop produces a solution with higher and higher fitness as it takes proven, reliable new knowledge and uses it to generate the next round of hypotheses. Properly done, this can produce a very high fitness solution.

The other loop is **Paradigm Soundness Emergence**. It's about three times as strong as the other loop, because in general, the process of solution evolution does not suffer nearly as much from a shortage of new ideas as it does from errors in accepting or rejecting those new ideas, which determines the quality of the final product.

Tunnel vision is the inability to see outside your own paradigm. Tunnel vision is rampant in large, challenging problem solving endeavors, because solving such problems requires a strong, driving body of knowledge to form and carry the project along to completion. But such a tidal force can also carry minds along the wrong currents, because if you believe in one thing strongly you tend to overlook, downplay, or deny alternative possibilities. Your own defects, in the form of Unsound Solution Components, are invisible. This causes more unsound components to be accepted, because a mixture of fallacious and true beliefs cannot be used to determine the truth reliably. All this occurs because the mind is attempting to maintain consistency and work efficiently, using the paradigm it has built from accepted hypotheses as its only frame of reference.

Paradigm tunnel vision is especially strong in groups. The larger a group is, the more pressure there is to follow the social norm. This is also known as peer pressure and following the herd. If you want to truly look at a tough problem objectively and be able to see what most others cannot, drop out of the herd for awhile, like I did.

Acting against the debilitating effect of tunnel vision is **soundness emergence**. As the soundness of a body of knowledge increases, its effect on reducing paradigm error increases faster than the rate of soundness increase. This causes a small amount of

soundness to be amplified by the loop into even more soundness. This effect is due to the way components working together have *emergent properties* that are greater than the components working alone. *Most fortunately, the effect of soundness emergence is stronger than the effect of tunnel vision*. The result is the **Paradigm Soundness Emergence** loop causes solution evolution to produce a solution that is much more sound than without the loop. For example, if the effect of soundness of knowledge on decision making objectivity curve is changed to a straight line, which is a one to one relationship, run 11 tops out at 65% solution success instead of 99.9%, and no attempt to better optimize the investment policies will improve it.

This is the fundamental structure explaining how solutions to difficult problems evolve. It is the structure that invention of the Scientific Method "discovered." But it was really there all along. All inventing the Scientific Method did was point out that the structure was there in a stable, replicatable manner. Thus the Scientific Method itself is a meta solution meme. After the basic rules of logic that we learn in our youth, it is the largest and most important solution meme known.

Looking At the Model as a Process

So far we have looked at the model as if it was a natural evolutionary sequence, mixed with the Scientific Method. But the way it is normally looked at is far less abstract. Usually it is viewed as a process.

A **process** is a repeatable series of steps to achieve a goal. In the model the process consists of three main steps: hypotheses generation (mutation), experimentation (selection), and transmission (replication). How much is invested in each step determines how efficient the process will be.

In this model *process efficiency* is output divided by input. The output is the solution success, which is the probability the solution components will solve the problem. The input is total problem solving effort. Because problem solvers tend to have a fixed amount of resources, total problem solving effort is held constant in the simulation runs.

The *appeal* of the process is solution success, because that is the ultimate measure of how good it is. If two processes had the same success percentage, and one had a higher efficiency, and thus a lower cost to solve the problem, it would have more appeal. But for simplicity we are ignoring that.

For simulation runs the model allows the process to be "managed" by deciding how much to invest in the six areas of effort required to build the solution. These are:

Percent Effort (these must add up to 100%)
- Step 1. Hypotheses generation
- Step 2. Experimentation
- Step 3. Transmission to user community

Percent Training (these are independent)
- Step 1. Hypotheses generation
- Step 2. Experimentation
- Step 3. Transmission to user community

Effort is actual work. Training is the quality of that effort. The effect of training on quality curve (not shown because it's on a subsystem) is designed so that as training rises from 0% to 50%, quality rises from .5 (which is half of normal) to 10. The maximum of 10 is entirely realistic, when you consider how difficult the process steps are, and the difference between the person on the street and a PhD with nine years of full time training in school, and more on the job.

The output of each process step is a function of training and work effort, which is the same as quality of effort and quantity of effort. This approximates the real world, where the amount of skill a person has makes much more of a difference than the actual work hours they put in. Investment in training is also the same as paying much more for people who are already trained. All this is why the model assumes that creating solutions to difficult problems is such a arduous task that training can increase work output by up to a factor of up to 10.

Solution Evolution Model Variables		Simulation Runs Table 2										
		1	2	3	4	5	6	7	8	9	10	11
Changeable Variables	**Percent Effort**	Full CA Different Difficulties			In Transition from CA to AA			Mostly AA				Full AA
	Step 1. Hypotheses generation	3%	3%	3%	3%	3%	3%	3%	3%	6%	6%	6%
	Step 2. Experimentation	37%	37%	37%	62%	37%	62%	62%	88%	84%	84%	84%
	Step 3. Transmission to user community	60%	60%	60%	35%	60%	35%	35%	10%	10%	10%	10%
	Percent Training											
	Step 1. Hypotheses generation	25%	25%	25%	25%	25%	25%	25%	25%	25	40%	40%
	Step 2. Experimentation	10%	10%	10%	10%	15%	15%	37%	37%	37%	37%	37%
	Step 3. Transmission to user community	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	37%
Result Variables	Problem difficulty (process capacity)	100	560	268	268 !	350	350 !	691	941	942	976	1000
	Solution success (confidence level)	98.9%	18% !	95%	95%	95%	95%	99.9%	99.9%	99.9%	99.9%	99.9%
	Knowledge soundness	95%	21% !	82%	82%	82%	82%	99.8%	99.6%	99.6%	99.5%	99.5%
	Payoff (using risk adverse values)	94	-2,184	188	188	246	246	689	936	937	971	994

The Simulation Runs

By looking at The Memetic Evolution of Solutions to Difficult Problems as a manageable, improvable process whose success depends on investment decisions, we can approximate how the processes of Classic and Analytical Activism work. Let's review a series of simulation runs to see how the model behaves. This will show us how the environmental sector of society behaves when it comes to solving difficult environmental problems. The purpose of the model and these runs is to help us to better design and manage the process aspects of the solution to the transformation of environmentalism to Analytical Activism problem.

Above is the table of the simulation runs. The first three are where the environmental movement is today. Runs 4, 5, and 6 are where it will be while in transition from Classic to Analytical Activism. Runs 7, 8, 9, and 10 are where the movement will be when it is almost there. Finally, run 11 is full Analytical Activism, as you can see by its ability to reach the full problem difficulty goal of 1,000 with a solution success of 99.9%. Wouldn't it be nice if we could do that?

The goal of 1,000 is an arbitrary number selected to represent any large, difficult problem. It was set by adjusting total problem solving effort (not shown) until the 1,000 could just barely be achieved with a 99.9% confidence.

Runs 1, 2, and 3 all use the same six investment policies to represent full Classic Activism. The percent effort investments use a very low budget of 3% for hypotheses generation, a modest 37% for experimentation, and a gargantuan 60% for transmission. If you compare these to run 11, which is full Analytical Activism, you will notice that Analytical Activism has double the hypotheses generation budget, over double the experimentation budget, and one sixth the transmission budget.

This illustrates the stark differences between Classic and Analytical Activism. In the process of Classic Activism, introduced on page 30, there are only three main steps: find the proper practices, tell the world the truth about the problem and the proper practices, and if that fails, exhort and inspire people to support the proper practices. Thus Classic Activism has little use for the analytical work of formal hypotheses and experimentation, though some is done informally, or to be more precise, intuitively. Thus classic activists put the bulk of their work into transmission of what they "know" to be the solution: spreading the word about the proper practices all must follow for our world to be sustainable. This is also called "more of the truth."

In glaring contrast, full analytical activists put 90% of their effort into analytical work, and only 10% into transmission. This is because they know that a correct analysis will find solution elements that do not need much effort at all to promote, *because built into the solution elements are incentives for agents to adopt the new proper practices.*

The result variables tell how well an investment policy worked. Problem difficulty is how difficult a problem a particular investment policy can solve. It is the number of solution components required to solve a problem. Given a particular set of investment policies and a solution success goal, problem difficulty is the *capacity* of that process.

Solution success is the percent probability that the solution will work. This is also known as a *confidence level*, such as "I'm 95% confident this solution will work, based on how its components have worked in the past, in pilot programs and other large scale experiments."

During a run, except for runs 1 and 2, a desired solution success level is the goal, and the problem difficulty is adjusted to be the maximum that will support that goal. For example, in run 3 the success goal is 95%. The difficulty was adjusted until success was 95%, and then the difficulty it took to do that, 268, was recorded. 268 is thus the maximum problem difficulty the process can solve for the investment policies in run 3, if a 95% probability of solution success is required.

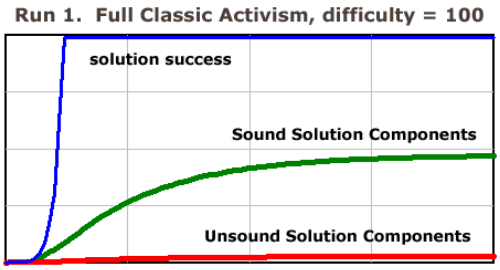
Knowledge soundness is Sound Solution Components divided by Sound Solution Components plus Unsound Solution Components. Notice how run 2, in which classic activists attempt to solve a medium size problem of 560, has a soundness of 21%. This means somewhere around 79% of the assumptions classic activists make when attempting to solve medium size problems are false. This of course is why run 2 has such a low solution success of 18%. But in the last five runs soundness is over 99%. High knowledge soundness is why those five runs can achieve what the environmental movement also needs to achieve: solving big, tough, hairy problems no one has ever solved before with a very high degree of confidence.

The payoff is a simple calculation of the net benefits of following a run's investment strategy. The formula is payoff equals 1 utility unit for every percentage point of success times problem size, minus 5 utility units for every percentage point of failure times problem size. Failure equals 1 – success. The 5 represents a risk adverse policy, which is what applies to the sustainability problem. If *Homo sapiens* wins and is sustainable, that's good news because we can continue doing about what we've always done. But if *Homo sapiens* losses, that is catastrophic news. Thus the bad news is far worse that good news is good, which explains the value of 5.

By the way, for the real problem this shouldn't be 5. It should be more like 5,000,000. Just ask anyone who was on Easter Island after deforestation caused its population to crash in the 15th century by 75% and, due to the horrors of mass starvation, the island's first warfare and cannibalism begin.

Now let's take a look at the individual simulation runs. In all cases all the stocks start at zero.

Run 1 – We start with a small problem difficulty of 100. This corresponds to the easy problems the environmental movement worked on at first, using full Classic Activism. If we have modeled how memetic solutions evolve correctly, then a very low dofficulty should have a high success. The result is shown below.

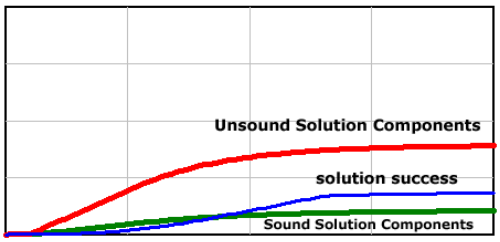


As expected, solution success is very high, at 98.9%. And it doesn't take it long to get there, just as it didn't take long for the movement to jump on easy problems like local pollution in the 1960s and 70s. All it took to solve these easy problems was a very small number of Sound Solution Components. And because they were easy problems, Unsound Solution Components was low. This is because even a terribly poor process can solve easy problems, because the defect rate while working on them is so low. In this run the defect rate was a mere 6%, which is why soundness was so high, at 95%. But as we shall see in run 2, a poor process has a high defect rate when applied to difficult problems.

Because this is such an easy problem, the payoff is very low, at 94.

Run 2 –In this run we raise problem difficulty from 100 to 560, which is a medium size problem. Examples of medium size problems are national pollution and regional natural resource depletion. Historically, medium size problems tend to be solved poorly or not until after several tries. These problems are well past the ability of Classic Activism to solve reliably, so the model should reflect that.

Run 2. Full Classic Activism, difficulty = 560



Wow! The classic activists didn't do just do a little worse—they fell flat on their faces with a dismal solution success of only 18%. Why did this happen?

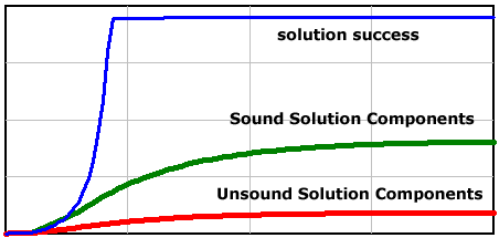
The reason is even a medium size problem of 560 is well over the process capacity of Classic Activism, because as we will see in later runs, it is not investing enough in experimentation effort and training. Only that investment will produce the large number of tested solution components required to solve medium and large problems. Without the needed investment in quantity and quality of experimentation, solution components and success levels off at levels to low to solve the problem.

Because of the low investment in experimentation training the defect rate is high. People are making educated guesses at what will work, instead of the long hard series of experiments it takes to produce sound knowledge. The result is a high defect rate, which translates into a low knowledge soundness of 21%. That means that 79% of everything classic activists believe to be true is actually false, when it comes to how to solve medium size problems. It's not exactly 79%, because this is just a rough, uncalibrated model. But it is probably safe to say that it is high, too high to solve anything but easy problems like in run 1.

The medium problem difficulty of 560 and the low solution success of 18% combine to give an astounding low payoff of -2,180. That is a calamity! If you have any doubt, just ask those Easter Islanders—it really is that bad when it happens.

Run 3 – Still using the full Classic Activism investment policies, let's set problem difficulty to the maximum it can be to achieve a success of 95%. We have chosen 95% because it is a common scientific standard of acceptance that a hypothesis is probably true. 95% (or sometimes the range of 90% to 99%) means "very likely." Whatever the resulting maximum problem difficulty is will approximate the problem solving capacity of Classic Activism as it is practiced today.

Run 3. Full Classic Activism, difficulty = 268



The maximum problem difficulty turns out to be 268. This is 27% of the 1,000 that is possible if the most efficient process management decisions possible are made, which is what run 11 does.

Note how about one fourth of the way through the run solution success reaches its peak of 95% and holds there for the rest of the run. This occurs because enough sound and unsound solution component have been accumulated to solve the problem. Even though the solution components curves keep growing, that makes no difference in the success rate.

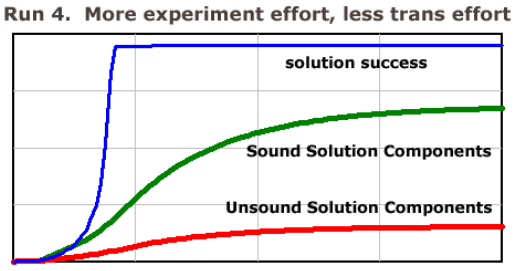
If you compare runs 2 and 3, you will notice that the sound and unsound solution components curves have switched places. That's what causes the dramatic outcome differences in the two runs. A relatively high unsound curve means terrible results, while a relatively high sound curve means great results.

But they are not great enough for the real problem, which has a difficulty of 1,000 and a required success of 99.9%. So we must do much better. We are now about to change the investment policies a little at a time, as we gradually change the model's dynamic behavior from Classic Activism into the goal of this book: Analytical Activism.

Run 4 – What is the quickest, most efficient way for classic activist organizations to change to Analytical Activism? Because the model is based on the only known method for producing reliable knowledge and the only known algorithm for efficient evolution, the model will tell us what the best route is when it comes to general top level strategy. But for lower level tactics, each organization will need to solve its own transformation problems.

The purpose of modeling is to gain insights into how to solve a problem. This is a process model, so by pushing here and there on it, we can see where the high and low leverage points in the process are. Let's push on a few of these points and find out where we can get the biggest amount of improvement for the least amount of input. Whatever the answers turn out to be, that is where the environmental movement needs to go first.

Nothing characterizes Classic Activism more than its emphasis on transmission of ideas to users, which in our analysis of Classic Activism is called "more of the truth." So it would seem to make sense to start by reducing that. This is easily done by reducing transmission to user community effort. Since the three percent efforts must always add up to 100%, let's offset this by raising experimentation effort. After all, nothing characterizes Analytical Activism (as well as science) more than lots of careful experimentation. So let's drop transmission effort from 60% to 35% and raise experimentation effort from 37% to 62%. These are large changes. This should take us quite a ways down the road from Classic to Analytical Activism. Here is the result:



Wow! What happened? The sound and unsound solution components went up, but the success curve didn't budge. Furthermore, all four result variables in the table of runs are also the same. So raising experimentation effort and lowering transmission effort had no effect whatsoever on what matters most: solution success and problem difficulty. What could possibly explain this?

In the real world it would be hard to tell. But in the model it's easy to find out, because a model displays its assumptions clearly for all to inspect. Digging into the model, we see that work effort has no effect on work quality, which makes sense. Only training affects quality. Thus even though run 4 is getting more experiments done that run 3, since quality has not changed the defect rate is the same, which causes the ratio of sound to unsound components to remain the same as before. Since there are already enough total solution components, this causes solution success to remain the same. If it is the same, then problem difficulty cannot be increased without reducing success, which would ruin our goal of 95% success.

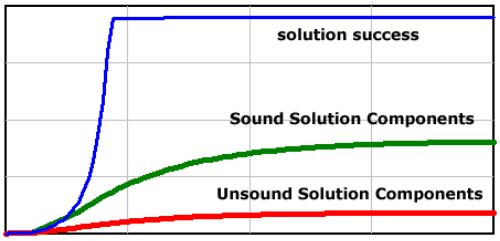
It would seem that more work with same quality should increase capacity. It does increase production capacity of components. But it does not increase ability to solve more difficult problems at a specified level of reliability, which is the type of capacity we are concerned with in this model.

This run illustrates what happens when intuition is used to decide what to do. We intuitively decided to increase experimentation and reduce transmission, and expected that to improve success and/or problem difficulty capacity. But we were wrong. Now let's use the power of the model to decide what to do. Since the model is the result of analysis of the system, this takes us into analytical decision making.

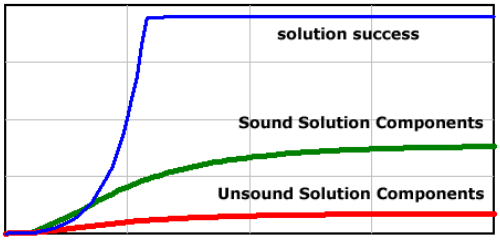
Run 5 – First let's roll the model setting back to run 3. Then we consider this question: Where is the best place to start if we want to change to Analytical Activism? That is, what is the best way to start increasing problem difficulty and/or probable solution success?

Study of the model shows the highest leverage point is the amount of experimentation training. This is because as quality of experimentation effort increases, so does the normal correct percent, which has a larger effect in increasing capacity or success than any other point in the model. So let's increase experimentation training just a tad, from 10% to 15%, and see if our understanding of the model is correct. Below are runs 3 and 5 so you can compare them.

Run 3. Full Classic Activism, size = 268



Run 5. Increase experiment training from 10% to 15%



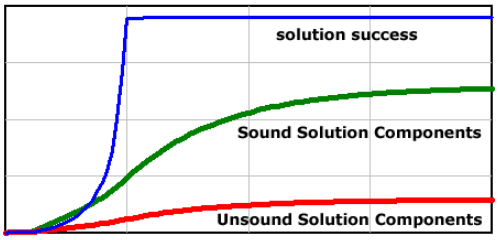
The result is as expected. Holding our success goal at 95%, the slight increase in experimentation training causes the problem size capacity to rise from 268 to 350. This is a 31% increase in capacity, though to make it all the way to a capacity of 1,000 we need a 273% increase. That will be easy in the model, but not in the real world.

Notice how the sound and unsound solution components curves are nearly identical in runs 3 and 5. This is also to be expected, because increasing experimentation training does not increase production *quantity*—it only increases production *quality*. Thus the model tells us one thing loud and clear: *Because quality of production is the main problem with the environmental movement's current process, that is the place to start.*

Thus the only difference in the graphs is that in run 5 it takes longer to reach the solution success goal of 95%. This makes plenty of sense, because it takes longer to do a good job. Quality takes time.

Run 6 – Next, let's start reducing Classic Activism's reliance on "more of the truth" by lowering transmission effort from 60% to 35% and raising experimentation effort from 37% to 62%. Because more effort increases production of solution components, this should raise the problem solving capacity.

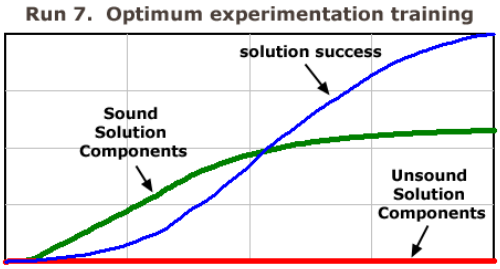
Run 6. Increase experiment training from 10% to 15%, then more experiment effort and less trans effort



Wrong. Although this change did increase solution components considerably, it did not raise capacity one iota. It is stuck once again. Why?

This time we have a very simple answer. We forgot what we learned from run 4. *Process effort does not affect process quality.* In addition, at any given level of quality, there is a tradeoff between problem difficulty and solution success. *As difficulty goes up success goes down, and vice versa.* Thus all more experimental effort will do is increase production. It will not increase quality, which is what's needed. So in the next run let's increase that.

Run 7 – In run 5 we increased experimentation training from 10% to 15% and got a 30% increase in problem difficulty capacity, at a 95% confidence level. Let's get really serious with this factor and raise experimentation training all the way up to what we know to be its optimum level. Because this will raise quality of production to its optimum, the results should be dramatically better. Here they are:



Boom! What a difference! The graph is so completely difference from any before that we must be in some sort of entirely new mode. Well, it turns out we are. The new mode is Analytical Activism.

For the first time Unsound Solution Components is dead flat at near zero. And solution success does not hit its usual plateau. Instead, it keeps right on growing up to a fantastically high level of 99.9%, which is what is needed to solve what is currently civilization's most difficult problem by far: the global environmental sustainability problem. This allows, are you ready for this, a jump in problem difficulty capacity from 350 to 691, a stunning 97% increase. And the beauty of it is we did not spend any more money on solving the problem—we only spent it more wisely—on quality instead of quantity.

This graph has several interesting aspects. One is the way Sound Solution Components is actually a little lower than the previous run, despite the fact this run had dramatically better results. *This shows how solving difficult problems reliably is not a matter of quantity—it's a matter of quality*. If you grasp the importance of that statement, please do me a favor: Whisper it into the ear of every environmentalist you meet.

Another aspect of the graph is it takes a long time to reach super high levels of quality. Runs 3, 4, 5, and 6 took from 20% to 30% of run length to reach their quality goal of 95%. But runs 7, 8, 9, 10, and 11 all take 100% of the run to reach their goal of 99.9%.

Presently activists are accustomed to near instant growth of solution success when using Classic Activism on easy problems. What might happen when they switch to Analytical Activism and encounter its much slower initial growth in solution success? We would probably see impatience. We might even see the false assumption that Analytical Activism is not working, which could lead to disgust and abandonment of the new process and a hasty return to the old one. *The way to avoid this trap is to thoroughly understand the dynamic behavior of the fundamental process involved*.

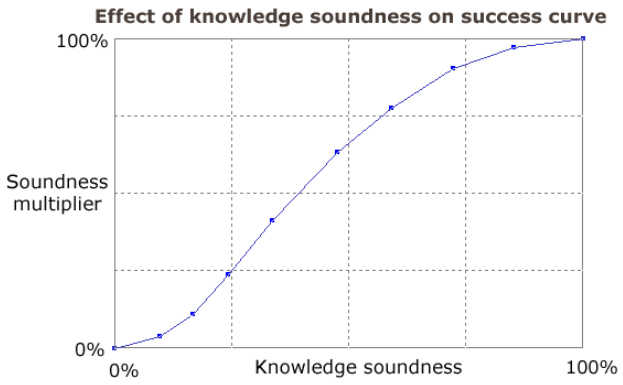
In the first half of the graph, why is the growth of success so slow while the growth of sound components is so fast? And why does solution success follow the classic S curve shape of population growth?

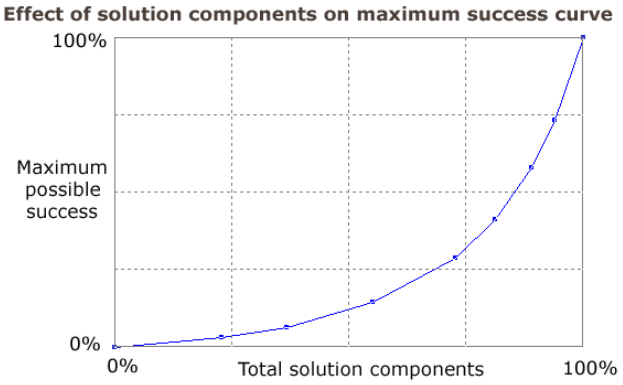
The success curve depends on the solution components curves, so let's discuss them first. Unsound Solution Components stays at near zero because defects are so low, since we now have optimum experimentation training. Sound Solution Components follows mostly a goal seeking curve shape, because of diminishing returns on labor and the limit that total problem solving effort imposes.

Solution success follows an S curve because there is a non linear relationship between knowledge soundness and success, which is defined in the effect of knowledge soundness on success curve, as shown in the first curve on the next page.

There is also an exponential relationship between total solution components and maximum possible success, which is defined in the effect of solution components on maximum success, as shown in the second curve. This exponential growth curve shape and the S shape of the upper curve combine to produce the solution success S curve.

These two relationship curves approximate the behavior found in solving real problems. The first reflects the fact that as knowledge soundness rises, at first it has little effect on success. But then, as it starts to be 20% sound and become useful, it starts to have a big effect. But eventually diminishing returns set in, causing the last 30% of the curve to bend over to meet the maximum effect of 100%. This gives the soundness multiplier an S shape.





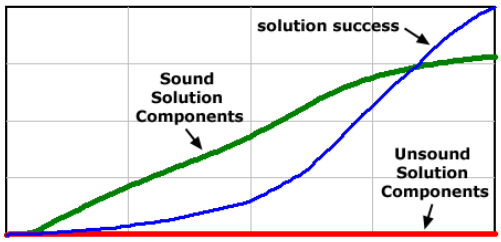
In the second curve, it is the exponential growth in the number of relationships between total solution components that defines the curve, because as these relationships grow, so do the emergent properties that affect maximum possible solution success. This is similar to the way the number of lines of communication grows exponentially as an organization's size grows, which is a well known factor in determining how hard it is to manage a growing organization.

Looking at the diagram of the model back on page 12, you can see that the soundness multiplier times maximum possible success equals solution success. While these calculations may seem arcane, by explicitly stating them in the model we are stating our assumptions about how real problem solving processes behave, on the average. If these arcane assumptions produce behavior that approximates the real world, and the structure of the model makes sense, then the model is approximately correct, and can be used to roughly predict how the real world will respond when certain changes are made.

There's a reason we have labored so long to explain why the solution success curve behaves the way it does. It's because solution success is what has been so elusive for the past 30 years, when it comes to solving the *complete* global environmental sustainability problem.

Run 8 – Raising experimentation training to its optimum in run 7 made a dramatic difference. Let's raise the other half of experimentation, effort, to near its optimum and see if we get similar results. This can be done by dropping transmission effort to its optimum of 10%, which will raise experimentation effort to 88%.

Run 8. Optimum experiment training and trans effort

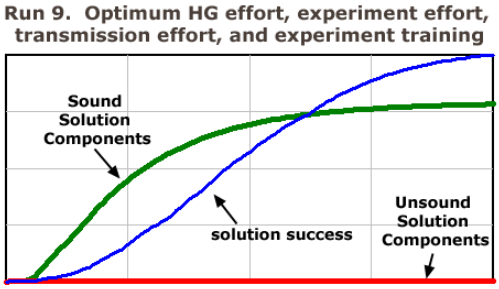


We're on a roll. Dropping transmission effort to its optimum has improved results once again. Problem difficulty capacity jumps from 691 to 941. Our solution success goal of 99.9% is holding steady. Things are looking very good—if we can do the same thing in the real world.

Run 9 – In all previous runs hypotheses generation effort has been 3%. This was the optimum for Classic Activism. Now let's change it to the optimum for Analytical Activism, which is 6%. The reason is about what you would expect: an analytical approach to problem solving requires more cogitation up front, in the new idea creation step.

New hypotheses are not the same as sitting around brainstorming, or waiting for lightening to strike in the shower. Most highly successful new hypotheses are the result of inordinate amounts of sifting through past experiments and hypotheses, as well as reams of related literature and talk with your peers. Thus doing a good job requires real work and lots of it. This is why Analytical Activism requires double the amount of hypotheses effort that Classic Activism uses.

Here are the results of changing hypotheses generation effort from 3% to 6%:



The behavior is about the same. The only significant difference is faster initial growth of Sound Solution Components, since now there is plenty of hypotheses generation work.

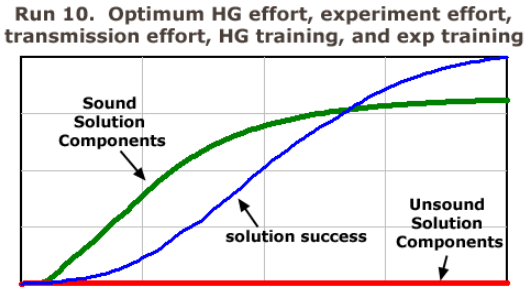
But problem difficulty capacity has increased only slightly, from 941 to 942. It seems something is constraining the process from its greater potential. Could it be that we not only need to increase hypotheses generation quantity, but quality as well?

Yes. The next run shows what happens when that is done.

Run 10 – When it comes to applying a process to a difficult problem, quality of work is almost always more important than quantity of work. This is because a difficult problem by definition does not yield to normal quality of cogitation. If it did, it would be an easy problem instead.

Run 9 changed quantity of hypotheses generation to its optimum. Now let's do the same for the quality side of that process step.

In all previous runs hypotheses generation training has been 25%. This was the optimum for Classic Activism. But the optimum for Analytical Activism needs to be more, since it is so dependent on the quality of input to the process. Let's raise hypotheses generation training to its optimum for Analytical Activism, which is 40%, and see how much of a difference that makes. It should be very significant, judging by the way the model uses this variable to calculate the hypotheses acceptance. The higher the quality of hypotheses generation, the higher the acceptance percent, which increases overall process throughput. Here are the results:



The curves look almost the same as before. We can see that Sound Solution Components finished slightly higher. This translates into a higher ability to solve difficult problems. Looking at the table of simulation runs, we see that improving quality had a much bigger effect than improving quantity of hypotheses generation. Problem difficulty capacity increased from 941 to only 942 in run 9, but in run 10 it increase from 942 to 976. This is an increase of 4%. It's not much, but it helps.

However as problem solvers get close to reaching a difficult goal, how to best measure progress changes. It is no longer a question of how far you've come. It is now a question of how much of a gap is left to close. The gap after run 9 was 1,000 – 942 = 58. After run 10 the gap is 1,000 – 976 = 24. Looking at the results of this run this way, increasing hypotheses generation training to its optimum made a very large difference. It closed the problem difficulty capacity gap of from 58 to 24, which is a 59% reduction. That is terrific in anyone's book, because such gaps can be very hard to close.

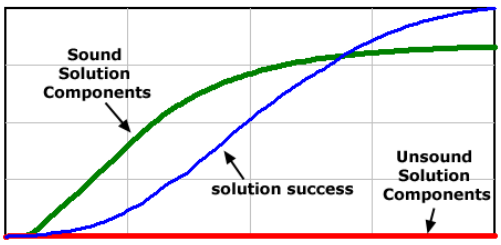
Run 11 – We're almost there. Of the six process management variables, one was at its optimum in run 7. Run 8 had two at their optimum, run 9 had four, and run 10 had five. Now, in run 11 we change the last one, so that all six process policies are at their optimum for Analytical Activism.

The final policy to change is transmission to user community training. This was at 30% for all previous runs. You might think that 50% is necessary for Classic Activism, because that process places almost all its eggs in the basket of "more of the truth." But every little bit of additional transmission training reduces transmission effort, causing the optimum for Classic Activism to be 30% instead.

Analytical Activism is experimentation centric. This could lead to suspicion that the optimum transmission training for Analytical Activism is less than for Classic Activism. But because Analytical Activism has such a low transmission effort budget, 10%, it has a definite need for quality of that transmission, so that transmission effort is not wasted. This leads to an optimum of 37% for transmission training for Analytical Activism.

Thus our final change to complete the transformation from one process to another is to increase transmission training from 30% to 37%. Once again, here are the results:

Run 11. Full Analytical Activism, all policies at optimum



We have reached our destination. Problem difficulty capacity is now 1,000, with a confidence level of 99.9%. This process, with these very approximate six investment decisions, is what it will take to solve the global environmental sustainability problem. While there may be another process just as capable, I and the scientific community are unaware of it, because the Scientific Method is the only known process for producing reliable new knowledge, and the evolution algorithm is the only known way to produce the many new memes necessary to solve extremely difficult problems.

Model Summary and Conclusions

The solution evolution model argues that difficult problems are solved by the memetic evolution of many coordinated solution components. Once there are enough total solution components and their soundness is high enough, the problem is solved. The more difficult the problem, the more solution components needed to solve it. A solution component is a simplifying abstraction representing an average small part of a solution.

All non-trivial solutions contain a mixture of sound and unsound components. The ratio of sound to total components determines the soundness of the solution. If a process is incapable of producing a solution with high soundness, it will be unable to reliably solve difficult problems, even if a large number of solution components are produced. This is because the problem difficulty capacity of a problem solving process is a function of total solution components and component soundness. Both must be high to solve highly difficult problems.

Solution evolution occurs in three distinct steps: mutation, selection, and replication. In the first step, memetic mutations appear as new hypotheses are generated. These pass to the second step, selection, where experiments are used to subject the hypotheses to a survival of the fittest test. A hypothesis may be accepted, rejected, or sent back for modification and further experimentation. Those that are rejected die. Those that are accepted are sound if no mistake has been made, and unsound if an error has occurred. Thus unsound solution components are the same as the popular concept of defects.

Once accepted, a hypothesis is no longer a hypotheses—it is now a solution component, and passes into the third and final step of solution evolution, replication. Here an attempt is made to transmit the sound and unsound solution components to the user community. If a transmission succeeds the component is considered to have been replicated, because it has been copied from the mind of the experimenter who accepted it to those who will use it to actually solve the problem. If a transmission fails the solution component meme dies.

Each of the three steps of memetic evolution maps to a step in the Scientific Method. Mutation is hypothesis generation. Selection is experimentation and peer review, though for simplicity the model

treats peer review as the final step of experimentation, rather than a separate step. Replication is publishing and education.

Each of these three steps can be done poorly or well, depending on how much is invested in the quantity and quality of the step. This is called effort and training in the model.

By modeling the foundational process that all solutions to difficult problems use, we can more clearly see the fundamental differences between processes.

The process of Classic Activism is characterized by a very high commitment to the third step of replication, where transmission of the solution to the user community occurs. This is because Classic Activism has only three main steps: find the truth by finding the proper practices to follow, spread the truth by telling the world about the problem and the proper practices, and if that fails, exhort and inspire people to support the proper practices. This is essentially "more of the truth." When even exhortation and inspiration fails, classic activists assume the problem is they have done a poor job of that, and so they try to exhort and inspire even more, using an endless variety of new packaging of the same old content. All this causes classic activists to put most of their effort into transmission, which shortchanges the rest of the process.

Analytical Activism, however, does not fall into that trap. It looks at the total process and tries to optimize the quantity and quality of each step. This results in a low emphasis on transmission, a high emphasis on experimentation, and interestingly, a low emphasis on hypotheses generation. It also results in more training for all three steps, due to recognition that quality of work, not quantity, is what makes the difference. *As a result, Analytical Activism has a problem difficulty capacity that is an order of magnitude higher than the one for Classic Activism, at a solution success confidence level that is several orders of magnitude higher than Classic Activism's.*

This completes the presentation of the simulation runs. By now you may be very familiar with how evolution, process, the Scientific Method, and The Memetic Evolution of Solutions to Difficult Problems work. But what exactly lies inside the two key stocks of the model: Sound Solution Components and Unsound Solution Components?

The High Level Solution Components

This section goes beyond the scope of this chapter, but I feel it is important for readers to know what's in these key stocks. Let's look at what they contain when the process is classic and when it's analytical, at the very high strategic level:

Classic Activism:

Unsound Components

1. All it takes to solve an activist problem is to find the proper practices to avoid the problem, tell the world the truth about the problem and the practices, and if that fails, exhort and inspire them to adopt the practices.
2. This is primarily a technical problem. Thus all we have to do is find the proper technical practices to live sustainably, and get people to adopt them. Therefore the process I have always used will work in this case.
3. The high leverage point is to tell the public more of the truth about the problem and the proper practices required to live sustainably.

Sound Components

1. Many proper practices, such as alternatives to fossil fuels, organic low tech agriculture, and endless variations of reduce, reuse, and recycle.
2. The public needs general education on the importance of solving the global environmental sustainability problem.

Analytical Activism:

Unsound Components

1. Due to tunnel vision I cannot see my own defects, but there must be some. For example, Dr. Maurie Cohen, editor of an environmental sustainability journal at http://ejournal.nbii.org, argues that: "You offer, at least to my mind, an overly rationalistic interpretation of the 'truth.' The suggestion here is that political debate is largely over 'facts' (and the misuse of otherwise factual information). However, much of what takes place in the political

arena is about values and ideology that, as such, are not readily reducible to the kinds of objectivistic measures that I understand you to be proposing."

Sound Components

1. This is a very difficult complex social system problem. Therefore a custom process tailored to this type of problem is required to reliably solve it in time.
2. This is primarily a social problem, not a technical problem. Thus the crux of the problem is change resistance to adopting the proper practices needed to live sustainably.
3. The fundamental cause for solution adoption resistance is The Dueling Loops of the Political Powerplace structure, the presence of the New Dominant Life Form, and its successful exploitation of the race to the bottom.
4. Given this structure, the reason Classic Activism fails is it is pushing on the low leverage point of "more of the truth."
5. There is a high leverage point in this structure that has never been seriously and comprehensively tried. It is general ability to detect political deception.
6. Currently general ability to detect deception is low. If problem solvers could unite and raise it to a high level the race to the bottom will collapse, leaving the race to the top dominant. Politicians will then respond correctly to the truth about the global environmental sustainability problem because it will now be in their best interests.

These are only rough lists, but they should show the two very different paradigms classic and analytical activists live in. They are two completely different worlds.

A **paradigm** is a collection of facts and rules, one so integrated and inclusive that it creates the complete worldview a person uses to grapple with a particular world. Examples of paradigms are a code of morality, a political ideology, a field of science, or what's needed to solve a specific problem. A paradigm defines the mental world its users inhabit while using it.

I invite you to consider which of these two worlds you would prefer to live in.

It is possible to perform an analytical comparison of these two processes. A simple process comparison model using the effect curves in the solution evolution model was built, as shown below.

Counting each of the preceding components as a hundred, we get 300 unsound and 200 sound Classic Activism solution components, and 100 unsound and 600 sound Analytical Activism solution components. Running the process comparison model with these values and a problem difficulty of 1,000 gives a Classic Activism solution success of 6% and an Analytical Activism success of 26%. A problem difficulty of 800 gives 10% and 53%. A problem difficulty of 700 gives 14% and 97%. Using a range of low problem difficulties shows the maximum possible solution success for Classic Activism is 51%, while for Analytical Activism it is 97%.

That tells the story.

There is a further story, however. *The two sound solution components of Classic Activism can be reused in Analytical Activism.* Thus Analytical Activism actually has 800 sound components, not 600. This makes a big difference, because it changes its solution success for a problem difficulty of 1000 from 26% to 60%, for 800 from 53% to 98%, and for 700 from 97% to 98%. The maximum possible solution success for Analytical Activism rises from 97.2% to 97.8%. It can't rise much more, because of the defect of one unsound solution component.

We've got to eliminate that defect....

Process Comparison