On science, politics and simulations

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We live in politically stoked times. From questionable elections to political violence to social problems such as unemployment, there is little chance for anybody not to be concerned about some political topic. However, often, the "solutions" to these problems seem to make matters worse.

What if these issues were approached taking a fresh look from a scientist or an engineer's point of view? In doing so, we may run the risk of being laughed at by some experts and ignored by others. Their patience and forgiveness is greatly appreciated. The intention here is to provoke thought. Therefore, this article is neither political nor scientific. It does not favor any particular political agenda, and most of it does not present results of scientific research.

The scientific way

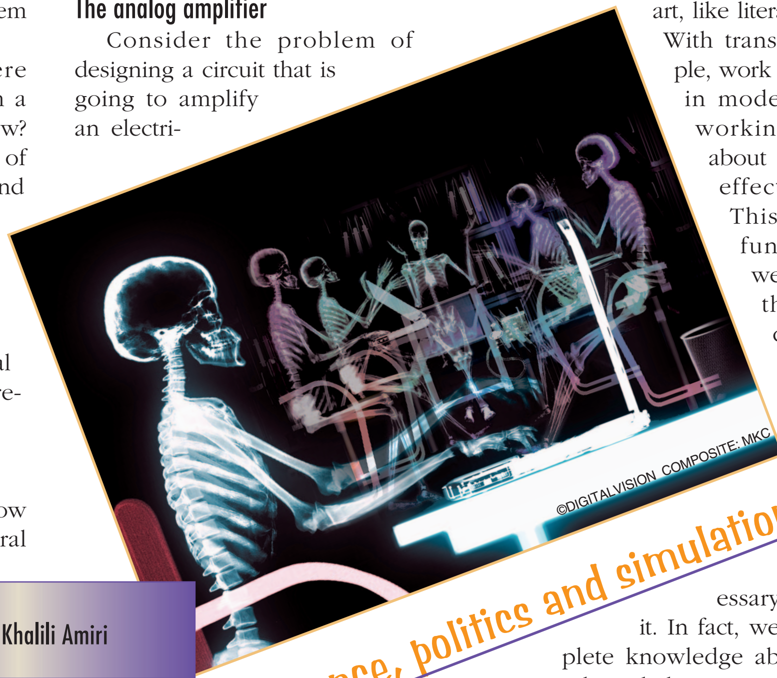
From a scientist's point of view, how to handle a political issue (in general and maybe somewhat simplistically) involves the question of how to govern a country or community. Thus, if we figure out how it works, we can probably figure out an optimal approach to solve that issue. The general scientific approach to solving a problem is to look at the phenomenon, put up a theory (guess), compare the theory to the experiment, check to see whether the experiment works, which in most instances it probably will not on the first try. Then the guess is refined, modified or thrown away so as to start anew. This procedure is repeated until a theory is reached whose results are pretty much within the margin of error needed to sufficiently solve that particular problem. Or as Plutarch said, "Research is the act of going up alleys to see if they are blind."

The theory is applied to find out what the outcomes will be based on the solution used. (This assumes we know what outcome is desired.) However, eventually, with some effort, a good solution typically emerges for the problem.

This approach is put to regular use essentially daily in engineering. There is a slight difference though. Unless doing basic research, an engineer is typically not directly involved in finding out the theory. Nevertheless, the general shape of this process is evident when looking at a specific example, in this instance the design of an analog amplifier. Without getting too technical, this specific example will also show us some details we didn't notice in the rather simplified picture just stated.

The analog amplifier

Consider the problem of designing a circuit that is going to amplify an electrical signal. From the context of the problem, we know the specifications, i.e. the expected voltage/power gain, bandwidth, output/input swing and so forth. We then have a specific goal and we want to figure out how to reach that goal. The most general way to view the problem is to observe what phenomena we have in nature (or could put up in a lab) which would be able to amplify a signal. There may be a lot of such phenomena, but vacuum tubes and transistors tend to be the most popular. Now choosing the one to use really depends on the situation. But let's assume that we have chosen the transistor because it is faster and more reliable.



The transistor, of course, is not a naturally occurring phenomenon. Thus, we have our first deviation from the simple process presented earlier; i.e., that we just have to figure out how something works.

In fact, most phenomena discovered or instruments invented, came to be because that person(s) thought down the road it might be useful or just because it was fun to do. In fact, most of the time it is the latter! Andy Grove, former chairman of Intel, who has definitely done a lot of work on transistors, put it this way: "When you figure something out and make it work, there is pleasure and excitement. Not just because the technology is going to do something, but because you created something with its own inherent beauty, like art, like literature, like music." With transistors, for example, work is still being done in modeling their inner workings, finding out about all the secondary effects and so forth. This might seem funny considering we have been using the transistor for decades. Knowledge comes with time, and complete knowledge about something is not necessary in order to use it. In fact, we don't have complete knowledge about many things used regularly.

In the earlier days of semiconductor technology, the modeling work was on more gross attributes of the transistor, although it was a human invention. A lot of work had to be done to really understand how the transistor worked, and how to manufacture it in a controlled way to get the expected device. This involved putting up all kinds of theories involving solid-state physics, electromagnetism and quantum mechanics. Then comparing them to experiments on real transistors to find and deal with the shortcomings of the theory. Noticeably, this work is not finished and may never be. But at some point it was decided that the theories were solid enough to design useful circuits. The theory only has to be as good as needed for the specific problem. A complete theory isn't necessary to commence work.

Also, even with a good model of the phenomenon and the necessary product specifications, it still may not be easy to design. A theory usually means a circuit's performance can be determined knowing the circuit's topology and specifications of the devices which have been used. But it doesn't state how to create the circuit to get the performance sought (i.e. what topology and devices to choose). This fact is par-

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ticularly true in analog design, but also in the design of the semiconductor devices themselves. This is why design usually involves a lot of trial and error. Also, some intuition, or gut feeling, for the problem is needed to get the design that does the trick. The creativity required to find a "good design" does not always lend itself easily to implementation on a computer.

Let's sum up the main points then discuss dealing with political issues in a scientific way. What we can observe so far is:

1. The first step in finding out something is putting up theories, and comparing them to the experiment. You don't need to have a complete theory. In fact, often the theories we use are incomplete. They should, however, be accurate and useful for the specific problem being worked on.

2. In engineering problems, we usually know what we are looking for. So if there is a way (theory) of knowing the end results to a given design, we can with some effort find a design that fits its specifications.

3. It is not always easy to find a good design, even when we have a good theory and know what the specifications of the final product should be. Solving the inverse problem may turn out to be very difficult.

Is it relevant to politics and society?

The general premise is that people want to know how to govern their societies in order to attain the best results that make everyone as happy as possible. Clearly, even if we had a perfect theory telling us what happens if we do this and that, we are going to have a problem identifying what it is that we want to happen. In fact, unlike engineering problems, the specifications of a good, successful society do not seem to be clear. This is most evident when considering the complexity of social and political issues.

A political decision may create jobs, which is a good thing, while at the same time it increases the budget deficit, which may be a bad thing in the long term. This is not just true for difficult economical issues: some may want to promote tolerance in a society while others' religious feelings will be hurt as a result.

In accepting how complicated society can be, we can likewise define our goals in a complex manner. Anyway, it probably will not be immediately clear what the goals should be. In other words, different political powers (e.g. parties) most likely would on many issues not only disagree on how to reach their goals, but also in what the goals should be.

These points raise serious doubts on whether a scientific approach alone can provide a solution, although it is certainly worth trying. Also, there is a reason why we had such well-defined specifications in mind for that amplifier: it is because we knew where it would be used, as part of a system. Thus, the interrelationship of that amplifier with the rest of the system is what dictates the features it should have.

Looking at political problems that way, it is evident that essentially the same process occurs in politics (provided that we think politicians know what they're doing). Decisions on problems such as those presented before are usually made based on some higher considerations, often reflecting the ideology or general beliefs of those in power. While it cannot be ruled out that scientifically developed theory may one day replace those general ideological considerations, many have serious doubts on that ever happening.

Getting back to our three-point summary, we have discussed what the second point would look like in politics, and things do not look as nice as they do in engineering. Since politicians will eventually have to decide and set goals (no decision is in effect a decision), there is no essential difference on the third issue, i.e. finding the best (or at least a good) solution to reach the goals.

One may also think that many political problems are of a different nature than what has been described. This means that on many issues (maybe most of them), we do know what it is that we want done, we just have no good, reliable way of realizing it. The list of campaign promises that seem to remain unaccomplished at the end of each administration's term in many countries is a sure sign. (Let's not cynically think that those politicians never had any intention of realizing their goals. Rather, let's believe that they tried for at least most of the goals, but just didn't succeed.)

Looking at the first summary point, we immediately notice that it is essentially impossible to assume that we have a good theory on the workings of society and politics. There is at least one good reason for that: To take into account all (or at least, reasonably many) effects of political decisions on societies, we would have to wait for very long periods of time.

Even with approaching the problem from a scientific viewpoint, making theories and testing them through experiment, there is the problem that the experiment would: 1) take too long, sometimes as long as a hundred or a few hundred years to give results, and 2) it would not be a really controlled experiment.

Generations of scientists would be needed to observe the experiment with none really having any control over its conditions. In other words, you couldn't really select a society and try theories for a period of say, one century, to see what happened and to what extent they worked. Besides sounding kind of perverse, it is practically impossible. So we have a real problem because we have to put up theories and test them although we do not really have a very good laboratory.

Instead, the scientist has to rely on the mercy of the people, politicians and luck, to gather the information he or she needs. This approach, although scientific, would take a very long time to give results. In the meantime, we would have to remind ourselves that we don't know the answer; that everything we do is based on our limited understanding and only partly tested theories.

Richard Feynman says, "We are only in the beginning. We have plenty of time to solve the problems. The only way that we will make a mistake is that in the impetuous youth of humanity we will decide we know the answer. This is it. No one else can think of anything else. And we will jam. We will confine man to the limited imagination of today's human beings."

In fact, this "taking into account our limited understanding" is the best justification for free speech and democracy. In Feynman's words "It is a way to govern when you don't know how to govern."

A question that may arise at this point is what relevance the discussion of inventions (i.e. transistors) previously has in the present case. Looking at our societies, however, we immediately notice a lot of such inventions on the political and social scene: political parties, all kinds of different models of government, social institutions and the like can be considered our "inventions."

Complexity and simulations

In his lectures on quantum computation, John Preskill presents an interesting question: Why is it that nature behaves nonlinear on a macroscopic scale whereas on the atomic level, it is linear (i.e. described by the Schrödinger equation)? The best theory we have for describing nature's phenomena nowadays is quantum mechanics, which is, as stated by Preskill, essentially linear. Nature, however, does not preserve that linearity in large systems. Thus, it gets harder to describe by mathematical theories the (exact) behavior of larger systems.

In practice, we still have very good approximations and simplified models for many large-scale systems, as any engineer would point out. Eventually, however, for a system as large (compared to an atom or a transistor) as a society, the complexity of a mathematical description accounting for all its different attributes and details would most probably render it useless. Based on this, despite the tremendous progress using mathematical methods has provided us with in the natural sciences, there have not been—to the best of the author's knowledge—any major successful attempts at doing so in the humanities, i.e. social science, political science and the like. Of course, this statement involves some simplification. Very often, the concerns of humanities are different from that of the natural sciences. For example, mathematics is not essential to understanding poetry, even if we could mathematically deconstruct a poem. Also, most poets and their readers probably would not be interested in its revelations.

However, for those subjects in the humanities that deal with the practical questions of how to govern a society, which are essentially design problems, the aforementioned statement is reasonably true. It is the complexity that prevents us from finding a fully analytical, neat, mathematical answer to these questions.

Many regard the solution to be simulation. Basically, it is the same approach that we have in engineering: If a system is too complicated to be described analytically by a mathematical formula, we simulate it with a computer. Nowadays, it is impossible to simulate problems as complex as predicting the future of a society as a function of certain political decisions, e.g. a certain set of laws and policies.

However, it may be a possibility in the future, especially with the tremendous computational power that quantum computers or molecular manufacturing (yet to be actually implemented) would provide us. This possibility seems even more interesting when viewed in relation with the "imperfect laboratory" problem discussed previously. A simulator may help us test theories in a much shorter time, and in a much more controlled fashion, thus enhancing our understanding of our own society. This prospect has even motivated serious philosophers to raise the question whether or not we are already living in such a realistic simulation unaware of it (look at "Read more about it" for suggested reading on these subjects). Crazy? Maybe, maybe not.

To sum up

In summary, the world is too complex and we are too limited a species (especially in time) to think that we may already know how to solve all our societal problems. We certainly cannot claim that we know how to create a "perfect" government or society, if that goal is even attainable. A scientific approach to the problem would mean patiently trying to understand the workings of society, always keeping an open mind for new ideas and theories. This way we constantly improve our models of how our societies work and, consequently, of how they should be governed to aid in the decision-making process.

This approach would require fundamental re-thinking by ordinary citizens, politicians and political scientists alike. Politicians need not be scientists themselves, but they should at least work with scientists on the many issues. The consequences could be a more scientific view both among the politicians and the people. Politicians could admit they don't know the solution to every problem, and people could learn to accept it.

The worst way to deal with a complex problem is to rush to a solution just to solve the problem and then sticking to that solution. Unfortunately, governance sometimes requires urgent measures which is why snap (poor) judgments are made as politicians rush to a solution. Other times, it is the population itself that demands a quick solution to a given issue and politicians scramble to find an immediate "best-fit" response. Taking the time to analyze (and maybe, in the future, simulate) it will provide a much better long-term result. Planning (simulating) ahead of the curve those possible scenarios would help improve those quick decisions. That seems obvious to a scientist, but it is not how many behave in politics. Lastly, when a quick decision does turn out to be a less than good call, the politicians and constituents need to take a scientific approach. They must be willing to admit and accept that errors are often made in reaching the best solution.

Read more about it

• Much of the discussion is based on or motivated by:

Richard Feynman, "Meaning of It All: Thoughts of a Citizen Scientist," Perseus, 1999.

• John Preskill's lecture notes on quantum computing can be found at:

http://www.theory.caltech.edu/people/preskill/ph229/#lecture

• Whether we're living in a simulation:

Nick Bostrom, "Are You Living In a Computer Simulation?," Philosophical Quarterly, 2003, Vol. 53, No. 211, pp. 243-255.

• The above paper can be found, along with other interesting material at:

http://www.simulation-argument.com/

• The issue of inverse problems came up within the discussion of engineering

design. A journal on inverse problems can be found at:

http://www.iop.org/EJ/journal/IP

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