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Update—Futurism 101

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Summary: An update on Futurism Section activities will take place and will be followed by an introduction to the common techniques of futurism, plus examples of how actuaries can use these techniques in their day-to-day work. The new Futurism study note provides the basis for this session.

Mr. E. Tom Hughes: This session is the first in a series of efforts by the Futurism Section Council to provide basic education on the principles of futurism. The council has defined this as a major function that it should perform.

This need for basic education, even among actuaries, or especially among actuaries, has been validated by the membership survey that was sent out recently. More than half of the responses indicated a need for greater understanding of what futurism is in its most basic and elementary forms. So basic education is a principal thrust of the council in the upcoming year. We hope to repeat this program or something like it at the 1997 two spring meetings in Palm Springs and Montreal. There are ways, of course, of providing basic education other than seminars such as this, and we're looking into those different approaches as a council.

In addition to providing basic education to our membership, we think the council has other purposes; the one I'd like to talk about very briefly is a significant initiative on our part to venture with other futurist organizations in order to improve and

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expand the kinds of activities that actuaries are involved in, especially relating to the area of futurism.

Unfortunately, I don't yet have hard projects to report to you, but we have a number of significant initiatives underway.

By the way, we're always open for ideas. So if you or other Futurism Section members have suggestions for projects, research, joint development work within the profession, or with a particular pet organization that you might be aware of, please send them to us.

The business portion of this section meeting is going to be very brief. I will report the demographics quickly. There are 1,050 Futurism section members.

We have a war chest of some $18,000, which is about average for a section in terms of a treasury per membership. In any event, we think we're reasonably well financed. We'll have an election of officers in the section immediately after the annual meeting. The group meets via telephone. We don't spend much of the section funds traveling around the country.

This will be my third year on the council, and my first year as chairman. It has been an exciting, fulfilling assignment. We have a great deal of work to do. This section doesn't run itself. Futurism is a conceptual subject that needs some dedicated people to make things happen. We've got a couple of them with us. Peter Bishop is head of the future studies program at the University of Houston.

Mr. Peter C. Bishop: It's terrific to be here at the Society of Actuaries (SOA) annual meeting because it's unique. Among the many speaking engagements that I do each year, this one is special because you're the people I talk about. I talk about you because you have credibility. Those of us in future studies do not yet have that kind of credibility. But I also talk about you because you approach the future differently than we do. Your techniques are known for their precision and sophistication. My purpose is not to criticize or in any way suggest that those techniques should be changed. How could I? They've been successful!

My purpose is rather to describe a different set of techniques that complement what you do. They are directed at a different class of problems. The assumptions involved in one class of problems may not carry over to the other class. So we're talking about two different sets of techniques. This would not replace what you do in the cases where it works, but we would add additional capabilities.

Those additional capabilities are important for your profession and for mine. In the future, you may be asked to deal with problems for which the assumptions required in traditional actuarial techniques do not apply. Using futurist techniques, you can do useful work on those problems. Your capabilities are important for my profession because if any profession has the ability to apply these techniques in the right way, with the right amount of sophistication, with the right amount of credibility, it is yours. You are already looked to, in order to provide answers and to give guidance on understanding the future.

So with an additional set of techniques, you will not only do a great service for your clients, but also a great service for your profession. Your profession will be able to address, not only those problems for which your quantitative models are appropriate, but also those for which analysis in a larger domain of interest is important.

Therefore, this session is not only important for us professionally; it might even be historic because the Futurism Section might be the beginning of an integration of two ways of dealing with the future.

THE EMERGENCE OF FUTURE STUDIES

My mind goes back one hundred years. One hundred years ago we had little understanding of probability or inferential statistics. One hundred years ago people didn't know the normal curve. They didn't know what a significance test was, and they were faced with phenomena that they did not understand. Many of these phenomena, like variations in weather, were routine. They confronted them every day, but they scratched their heads over them. They said, "Well that's just random, or that's just disorder. We'll never understand that."

Then the probability distribution was designed, and patterns began to emerge. They found good news and bad news. The good news was that they could describe the distribution of many cases over time. The bad news was that they would never be able to tell the outcome of a single case. Were they glad to have achieved something or disappointed that the prediction of the singular case eluded them? We have inferential statistics, a very useful branch of mathematics for the world today, although the prediction of the singular case still eludes us.

I believe that we are on the verge of a similar discovery—a class of problems that are currently a mystery, but ones we must understand to be successful in a complex, rapidly changing world. The result of that understanding will give us the same good news/bad news feeling. Tractable problems are those for which current mathematical techniques are useful. The other class are those that may be understood, but not with the same precision. For these, we use the term "forecasting." We make a distinction between predictions, which are relatively precise, usually single-valued statements about the future, and forecasts, which are qualitative statements about multiple possibilities in the future. The bad news is that we cannot make explicit, precise predictions about the long-term future in most domains; the good news is that we can say something about the possible futures in those domains. Knowing something is better than knowing nothing, even if it is less than we had hoped.

The characteristics of these two classes of problems are listed below:

Prediction	Forecasting
• Physical evidence	• Intangible evidence
• Strong Assumptions	• Weak assumptions
• Unitary phenomenon	• Multiple possibilities
• Higher quality inferences	• Lower quality inferences

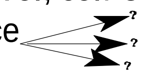
Notice that most human systems are more like the right-hand set of characteristics than the left. Clearly demography and actuarial analysis are suitable for prediction. But even there, one must make multiple assumptions about the social environment: values, family structure, and legal and political change. One can readily admit that those are a different class of phenomenon.

The basic difference between the left-hand and right-hand phenomena is the degree of uncertainty. Our knowledge of all systems is uncertain, but in the scientific laboratory, where most of us practiced a relatively standard Newtonian form of science, we were able to assume that the uncertainty was not there. We acted as if the system, whether a balance beam or a calorimeter or whatever, was a closed system. We assumed that the rest of the universe did not affect that system.

That's an excellent assumption in simple physical systems. The calculations came out, and the experiments worked. In human systems, on the other hand, that's not a very good assumption. We handle uncertainty the same way. We assume that the economy, for instance, is isolated from the rest of the world, like technological innovation, value shift, or political upheaval. That assumption is patently incorrect, and it would be risky to continue to hold it in the face of so much contrary evidence.

Resolving uncertainty by making assumptions is great. It's a wonderful approach, except when it's wrong. What do we do when we cannot resolve it that way? What do we do when we cannot say, for all intents and purposes, this is a closed and well-understood system? That's the class of problems that we're dealing with. In cases of high uncertainty, we have to turn to a different set of techniques. We must account for the uncertainty, not simply assume it away. Uncertainty in forecasting arises in many ways, as you well know.

<u>Sources of Uncertainty</u>

- Insufficient or incorrect information
- Insufficient or incorrect understanding
- Inherently unpredictable systems (chaos)
- Inherently novel, self-organizing systems (catastrophe, complexity)
- Human choice 

The traditional sources of uncertainty have to do with the adequacy of the model and the boundary conditions. While we never have complete certainty concerning how good our models or data are, we do have the opportunity of reducing that uncertainty by applying resources and skill to data collection and model verification. The less traditional sources of uncertainty, however, are not so easily handled. We know that some systems are chaotic some or all of the time. Chaotic systems are deterministic systems for which minuscule changes in the boundary conditions result in large changes in behavior in a relatively short time, making prediction impossible.

A newer class of systems, catastrophic or complex, can undergo radical change in very short times. The conditions for the onset of these discontinuities are not at all understood; hence, they can arise unpredictably at almost any moment. The final, and perhaps most traditional source of uncertainty, is human choice itself. If we are in fact free to make up our minds and direct our actions to be free from overwhelming constraint, then humans are their own greatest source of uncertainty. Though somewhat predictable in the mass, humans are a perverse lot that surprise forecasters with their blatant novelty and creativity!

Taken together, these sources of uncertainty are formidable for all systems, particularly the human systems we are most concerned about—the financial system, the government, the family, the work force, etc. No one can claim that these systems resemble the physics laboratory at all. Thus, we should not make the same assumptions about uncertainty in the world that we do in the laboratory.

The futurist's approach to handling uncertainty is to change the statements about the future. Rather than provide definitive descriptions of the future, we provide a range of possible futures. Each of those futures emerges when an uncertainty breaks one way or another. It is like sensitivity analysis in some ways. Vary one or more parameters and predict the results. But it is unlike sensitivity analysis in other ways because the uncertainties in human systems have enormous consequences. The value of parameters like the inflation or discount rate or birth and death rates are uncertain, but mathematically tractable and linear in their consequences. The future boundaries of the U.S., the replacement of the retail markets by the Internet, and the appearance of virulent and resistant bacterial strains are the kinds of uncertainties that resist mathematical formulation.

Some aspects of these uncertainties can be quantified and handled mathematically, but many of them cannot. They constitute mathematical singularities, points at which the model and the equations, (not just the parameters) change. No technique can extrapolate the future of the Russian economy given data on the Soviet economy. These watersheds include degrees of novelty that cannot be captured in standard techniques. While they may be rare, we cannot ignore their plausibility in any full description of future possibilities.

So the answer we give is only partially satisfying, like the statisticians of old. No, we cannot tell what future will emerge from highly uncertain conditions, but we can describe the range of plausible alternative futures that may emerge. The language here is important. "Will" is a declarative statement of the future tense. It is clear, definitive, but also probably wrong. William Renfrew, a Washington DC consultant, puts it this way, "The most probable future isn't." *May* is a subjunctive statement of possibility. It is tentative, uncertain, but also probably right. The trade-off is the classic case of giving up precision to achieve validity. Must we always use a rifle, even when we are hunting quail? Under conditions of high uncertainty, we must give up the precision of mathematical techniques in favor of more robust qualitative techniques that yield a useful, though not precise, understanding of the future.

We would like to know, and in some cases we need to know what's going to happen. But if we can't tell, let's not assume that we can. Let's leave the uncertainty at the appropriate level and deal with it on the table rather than sweep it under the rug and hope that it goes away.

The two types of forecasting we are discussing are listed below.*

Predictive Forecasting	Heuristic Forecasting
• Short-term horizon	• Long-term horizon
• Single domain	• Many domains
Few factors	Many factors
• Few assumptions	• Many assumptions
• Focus on continuity	• Focus on discontinuity
Hide uncertainty	Reveal uncertainty
• Single point forecast	• Range of *plausible* forecasts
• Often wrong	• Often correct

I have coined the term heuristic forecasting because heuristics are rules for discovery or learning. They are incremental rather than definitive. They help us learn along the way rather than jumping to the answer or solution. Heuristics are valuable when definitive methodologies are lacking or not helpful. We are trying to learn about the future in an incremental way because it is impossible to know what it is exactly.

Predictive forecasting drives to the final result—what will the future be? Heuristic forecasting uses the forecast as a means for understanding the range of possible futures. In an odd way, heuristic forecasting is not about the future at all or only indirectly so. The range of possible futures arises because multiple uncertainties each shape which future actually becomes a present. What those uncertainties are and how they will play out is the subject of conjecture in the realm of assumptions. If we assume, contrary to the physics lab, that the system is not closed to outside influences or is subject to other sources of uncertainty, then we must assume what those uncertainties are and how they will affect the future. I agree that this is all fuzzy stuff, but the assumptions we have about the future are the single greatest constraint on the range of plausible futures we are willing to consider. "That can't happen" is often followed by "It did!"

*A third type of forecasting is Stochastic or Monte Carlo approaches. Stochastic forecasting handles uncertainty the same way that sensitivity analysis does, positing a range of values for key parameters. Stochastic forecasting is different from sensitivity analysis only in the number of parameters it can handle. Sensitivity analysis is confined to one or two variables at a time while stochastic models can handle an indefinite number of uncertain variables. The output is a full probability distribution rather than the discrete alternative forecasts that sensitivity analysis provides.

The purpose of heuristic forecasting, therefore, is the examination of our assumptions. The bulk of my talk is to look at tools for heuristic forecasting. I have selected a set of tools appropriate to the criteria and they are listed below:

- Criteria
  — easy to learn, easy to use
  — transparent structure
  —clear links from assumptions to forecasts
  —quick results, iterative operations
- Examples
  —systems dynamic
  —Godet tools
  —Expersim, EZ-Impact

These tools are mathematically quite simple. Nevertheless, they do allow us to reflect on our assumptions in a more objective way and to talk about them more productively. Therefore, they need to be easy to use; they need to be robust and iterative without requiring days and weeks of programming.

These tools are to understanding assumptions what the word processor is to writing or the spreadsheet to calculation. Its interactive nature lets us try something out, see and discuss it, go back and do some more, see and discuss some more, etc. The action is rapid enough to constitute a dialogue between us and the tool—seeing and changing the results of our actions as we go. Most highly mathematical models, like econometrics or logistics, are too hard to use in rapid fire discussion.

The tools in this short list are “systems dynamics” developed at the Massachusetts Institute of Technology (MIT) in the 1960s, a tool set called Prospective out of Europe by the futurist Michel Godet, and a system developed by a colleague of mine at Texas A&M University called EZ-Impact. These are just examples. My purpose is to demonstrate how these tools would be used in the analysis of a real issue. I have chosen one that is at the center of our national future and one that you all know very well: the future of the Social Security System.

SYSTEMS DYNAMICS

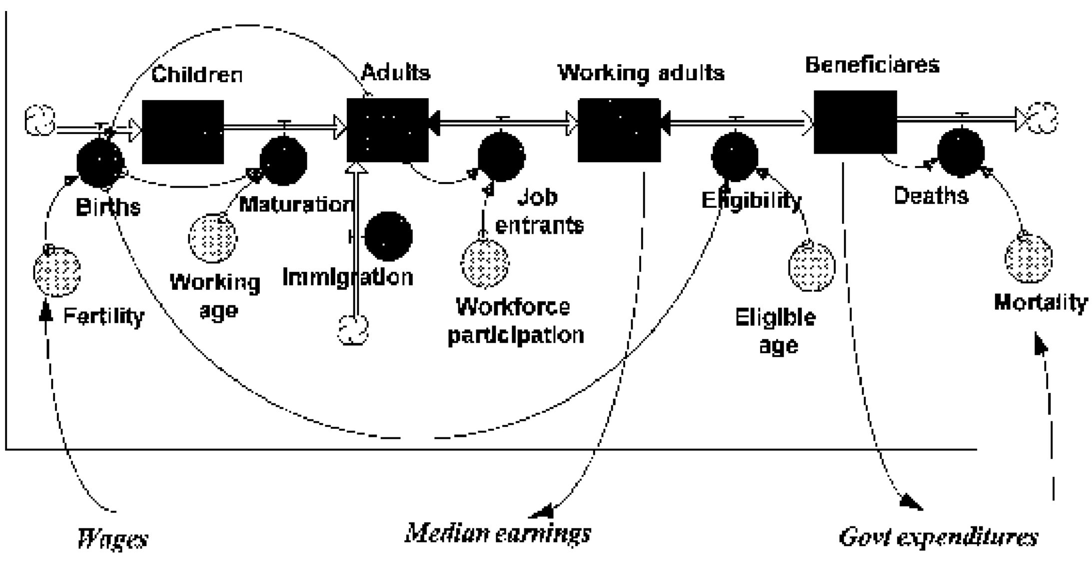
Systems dynamics has been around for 35 years now. Developed originally at MIT by an engineer turned urban analyst, Jay Forester, it received its most famous application as the basis of a study in 1970 called The Limits To Growth. The Club of Rome, a group of industrialists who wanted to do good for the earth, was the sponsor. They peppered the world with studies. Frankly, this study was not intended to be the blockbuster that it turned out to be. In fact, it was published before the members of the club even saw it. It's timing was impeccable, appearing right before the first Arab oil embargo. Although the study had a 125-year time horizon, it looked like it was coming true right away!

Systems dynamics is a technique that can be implemented easily on a personal computer. It is a robust, short-term, relatively easy way of constructing simulation models. I use this technique in my own classes, and it is used throughout the world for that purpose.

A systems dynamic model of the Social Security system includes four sectors: a population sector, a wages sector, a finances sector, and a government sector. Productivity links wages, savings, and investments.

Chart 1 contains an image of the details of the population sector. The systems dynamic uses what is called a stocks-and-flows metaphor for analyzing systems. The boxes in the model are stocks, accumulations of some quantity that persist over time. The image is a water tank with a certain level of water at any time. The pipes in the model are flows, the faucets of the water tank. They increase or decrease the level at a certain rate. Notice how this model distinguishes between quantities and rates in a simple, understandable manner.

CHART 1
POPULATION SECTOR



The circles are translators. They contain the parameters or boundary conditions of the system, the exogenous variables that give the system definition.

So the population sector of the Social Security model includes stocks, which are the number of people at various ages. The flows are birth, maturation, immigration and death—the only ways to add and subtract population from the different age groups.

Some of the exogenous variables are fertility rate, working age, and work force participation, among others.

One can use a computer package to identify the relationships within and between the sectors using difference equations. Then we can generate graphs of results over time. One can then easily change a parameter and see the results on the graph. Building and modifying the system is even more interesting than running it. The computer model is the simple articulation of your more complex mental model. You would have questions about the results of my model. You would do it differently. That's the beginning of a discussion about assumptions. That's the beginning of the payoff using the tools of heuristic forecasting.

Although the tool runs on an individual personal computer, it is better as a group tool. I have a different assumption. Let's talk about it. Maybe I'm wrong. Maybe you're wrong. Maybe we're both wrong. Or maybe we're both right. In which case, we can't decide one or the other. Let's run the model both ways and see what the results are.

Systems dynamics is a clear and precise way of articulating our assumptions for the purpose of examination and discussion. It is not always for the purpose of choosing. It is not always for the purpose of saying who is clearly right and wrong. In some cases, we can decide; in other cases, we just don't know enough. Let's not pretend that we do when in fact we don't. Let's leave the uncertainty at the right level and embody it in our different scenarios.

Another advantage of systems dynamics as a tool for heuristic forecasting is that it allows us to bound the system. Notice that the population sector takes other variables as input, wages for instance, and changes other variables as output, such as median earnings. Those are variables in other sectors. They are exogenous to this sector but endogenous to the whole model. That sparks a discussion of boundaries. Anything outside the boundary cannot affect the system in any significant way. In order not to end up modeling the whole universe, we must draw the boundary somewhere, which leads to an assumption about what affects the system and what does not. The price of a particular commodity will probably not have a substantial impact on the system. Therefore we might choose to leave it out. But some political legislation or a medical breakthrough might affect this system a great deal so we decide to leave it in. That's an excellent discussion for clarifying what's part of the system and what's not.

Let’s look at what the equations of this system look like:

Systems Dynamics Equations:
Fertility = 2.0*Wages/20000
Children (t) = Children (t−dt) + (Births−Maturation)*dt
INIT Children = 0.15*250000000
Births = Fertility/30*Adults/2
Maturation = DELAY (Births, Working_age)

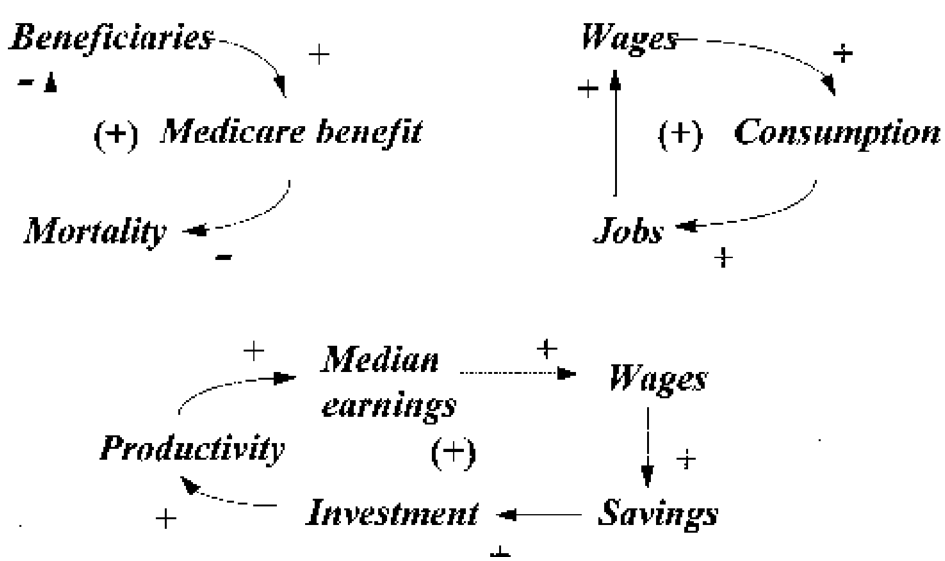
The number of children is a stock that increases with births (inflow) and decreases with maturity (outflow). Children have an initial value in the model. The inflow of births is a function of fertility and the number of adults. The maturation is a delay from the time of births to the working age.

My purpose is not to teach how to do this, but to show that this tool is simple and easy to use to create models.

One of the analytical elements of systems models is the appearance of loops. Loops map the influence of feedback. Feedback is the influence that a change in a variable has back on itself. Feedback is the perverse characteristic of systems that often prevents prediction in a closed mathematical solution.

Chart 2 contains three loops present in the model I created. Each of these is a reinforcing loop, meaning that the feedback reinforces the direction of the initial movement. The change tends to accelerate.

CHART 2
LOOPS



The first loop explains the acceleration of beneficiaries. The more beneficiaries there are, the more Medicare benefits there are. And the more Medicare benefits there are, the lower the mortality. The lower the mortality, the higher the number of beneficiaries. So Medicare benefits actually serve to perpetuate the life expectancy and therefore prevent beneficiaries from dying off. They're in a positive reinforcing loop. One of the more perverse aspects of the system is that, if it's successful, it will actually generate more clients, and therefore more cost. The plus sign in the center of the loop means that this is a reinforcing system.

One final benefit of these models is the ability to study policy initiatives. What happens when you raise the eligibility age. The model contains an eligibility variable, and one can adjust the eligibility of people moving from the working adult to the adult population. One can adjust the benefit level. All are variables in the model. What would happen if we did this?

I am sure that systems dynamics is quite similar to the kind of modeling that you've done. But it is easier to use and therefore allows you to focus on your assumptions in a real-time iterative environment.

LA PROSPECTIVE

Our second technique originates in Europe. Michel Godet is one of the futurists there. He believes that futurists in the U.S. are good at telling stories, but we are not very good at the details. So he has proposed a set of mathematical techniques, some of which I find very useful, and they are the ones that I've included. Some of his other techniques are a little strange, or perhaps I don't understand them fully.

Basically he has two techniques. One called MICMAC, and one called MACTOR. They sound much more thrilling when you say them with a French accent, which I'm not able to do. They are acronyms of long French words that I didn't understand when I heard them and certainly don't remember. Anyway he refers to them as MICMAC and MACTOR.

MICMAC reveals the structure of the system, or how the variables relate to each other. Chart 3 contains a simple system where tax rate and wages are the primary determinants of the taxes created. Taxes reduce savings and debt. But savings increase investment, and debt reduces investment which reduces productivity and wages.

MICMAC places these relationships in a square matrix (Table 1). Reading down the columns, a column variable affects a row variable if there is a one in the cell. So for instance tax rate influences taxes but nothing else. Taxes themselves influence savings and debt but nothing else. This matrix is sometimes called a cross-impact matrix.

MICMAC then sums the rows and the columns to reveal two characteristics of the variables. The sum of the columns represents the extent to which a variable influences other variables (dominant). The sum of the rows indicates the extent to which a variable is influenced by other variables (dependent). So the only exogenous variable, the tax rate, has a row sum of zero and is therefore not dependent on anything.

Squaring the matrix reveals a more intricate structure. Where the first matrix contained the first-order influences, the squared matrix contains the second-order of influences, influences with one intervening variable. Squaring the matrix again reveals the third-order influences through two intervening variables (Table 2).

For instance tax rate influences investment through two different paths of two steps each. Tax rate, you remember, influences taxes. But from there it goes either to savings or to debt and then finally to investment. These matrices also show which variables are dominant and which are dependent.

CHART 3
MORE LOOPS

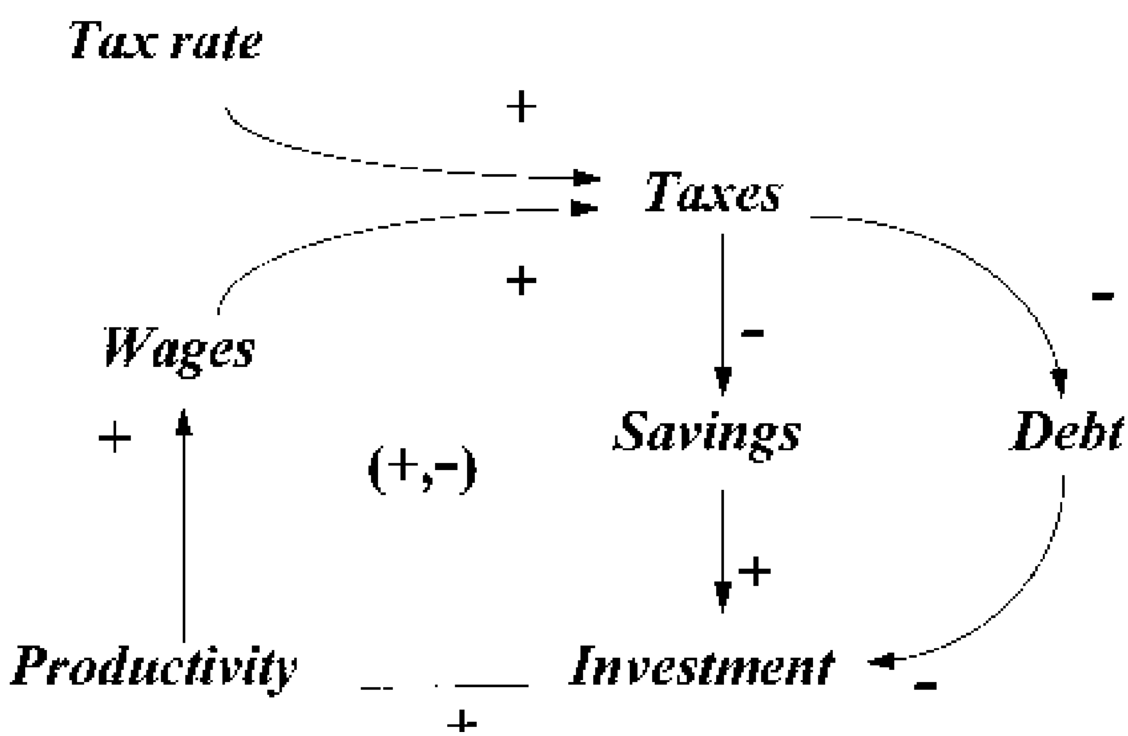


TABLE 1
MICMAC
FIRST-ORDER INFLUENCE MATRIX

Column affects row directly	A	B	C	D	E	F	G	**Dep**
A *Tax rate*	0	0	0	0	0	0	0	0
B *Taxes*	1	0	0	0	0	0	1	2
C *Savings*	0	1	0	0	0	0	0	1
D *Debt*	0	1	0	0	0	0	0	1
E *Investment*	0	0	1	1	0	0	0	2
F *Productivity*	0	0	0	0	1	0	0	1
G *Wages*	0	0	0	0	0	1	0	1
Dominant	1	2	1	1	1	1	1	

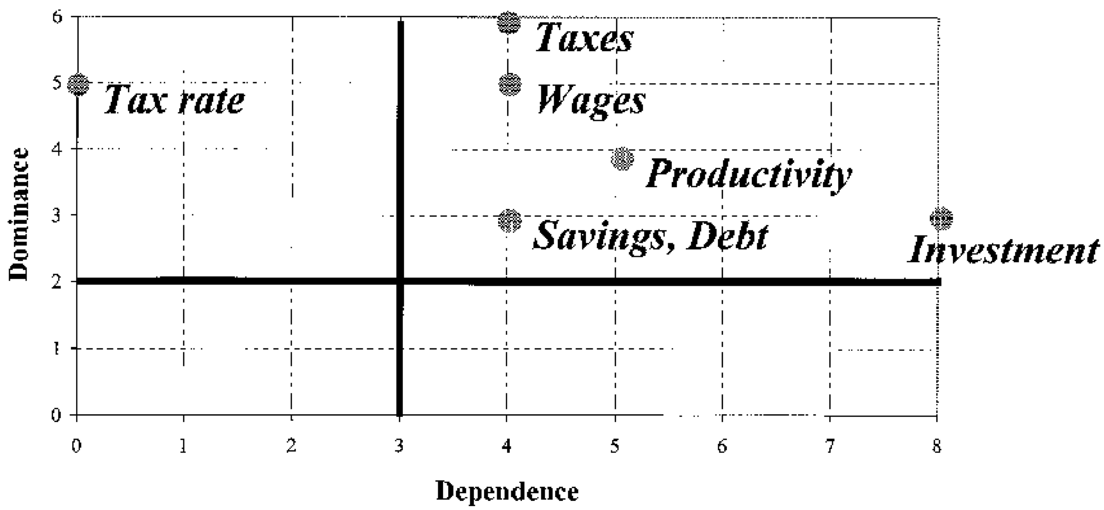
TABLE 2
THIRD-ORDER INFLUENCE MATRIX

Column affects row with one intervening variable

$M^2 \times M = M^3$	A	B	C	D	E	F	G	Dep
A *Tax rate*	0	0	0	0	0	0	0	0
B *Taxes*	0	0	0	0	1	0	0	1
C *Savings*	0	0	0	0	0	1	0	1
D *Debt*	0	0	0	0	0	1	0	1
E *Investment*	2	0	0	0	0	0	2	4
F *Productivity*	0	2	0	0	0	0	0	2
G *Wages*	0	0	1	1	0	0	0	2
Dominant	2	2	1	1	1	2	2	

Summing the dominance and dependence scores from all three matrices places the variables on a dominance-dependence graph (Chart 4). The four regions display the different degrees of dominance and dependence. Thus, the tax rate is exogenous in the low-influence, high-dominance cell. Conversely, investment is moderately dominant, but highly dependent on other variables.

CHART 4
WHERE THEY STACK UP...
DOMINANCE–DEPENDENCE



This simple tax-investment model contains only seven variables so that the structure is immediately obvious. MICMAC begins to pay off with systems of 20 variables or more.

MACTOR employs the same sort of analysis, not on the variables of the system, but on the stakeholders—those parties that stand to gain or lose given the behavior of the system.

Beneficiaries, taxpayers, employers, the government itself, financial institutions and health providers are stakeholders for the Social Security System. I have also listed what I believe would be the positions of each stakeholder on some proposals to reform the system (Table 3).

TABLE 3
MACTOR
STAKE HOLDER POSITIONS

	Bene-ficiaries	Taxpayers	Employers	Government	Financial Institutions	Health Providers	Sum
A *Raise age*	0	−1	0	0	0	−1	−2
B *Means test*	−2	0	0	−1	0	−1	−4
C *Reduce ben*	−1	1	1	0	0	0	1
D *Cap medical*	−2	0	−1	−1	0	−2	−6
E *Increase tax*	−1	−2	−1	1	−1	0	−4
F *Reduce exp*	0	−1	1	−1	1	−1	−1
G *More work*	1	1	1	0	0	0	3
H *Req pension*	0	−1	1	−1	2	0	1
I *Tax consump*	−2	1	−1	−1	2	0	−1
J *Invest surplus*	0	1	0	−1	2	0	2
Sum	−7	−1	1	-5	6	−5	

The positions are represented from plus two (very favorable) to minus two (very unfavorable). The sums of rows and columns in this matrix have a different meaning from MICMAC. The row sums indicate how all stakeholders respond to each proposal. So means testing and capping medical benefits receive strong negative ratings. On the other hand, investing the surplus in the trust fund rates a mild positive approval. Currently this is the reform receiving the most attention.

The column sums in Table 3 indicate how each stakeholder feels about the proposals taken as a group. The beneficiaries, the government, and health providers are the least inclined to consider change, and the financial institutions are the most inclined. Who is benefiting most from the present system? Who is most harmed by the present system?

Table 4 reveals the internal structure of the stakeholders by squaring the matrix (or multiplying by the transpose, since it is not a square matrix). So the coalition of beneficiaries, the government, employers, and health providers generally agree on their opposition to change. The other stakeholders are not strongly aligned with each other, meaning that the forces opposing change are probably stronger than the forces promoting change. One strong exception is the contest between the government and financial institutions over who will control the trust fund surplus. The diagonal indicates the strength of each stakeholder's position. So beneficiaries and financial institutions believe they have the most to gain or lose in these proposals.

TABLE 4
STAKEHOLDER STRUCTURE

Allies share positive numbers; opponents negative						
$M \times M^T = M^2$	A	B	C	D	E	F
A Beneficiaries	15	2	5	5	−3	6
B Taxpayers	2	10	1	−2	3	2
C Employers	5	1	7	−1	2	1
D Government	5	−2	−2	7	−8	4
E Investors	−3	3	2	−8	14	−1
F Health prov	6	2	1	4	−1	7

So MACTOR reveals structure among stakeholder groups. Structure is not hard to see with six stakeholders, but more complex systems require a better way to see where coalitions might emerge and where they might not.

The result then would be groups for more moderate reform proposals versus those interested in more substantial reform.

An interesting outcome of this analysis is the middling position of taxpayers. Taxpayers certainly need to fund this system, so you might think they would be in favor of significant reform, particularly to reduce cost. But they are also a secondary beneficiary because the system is taking care of their parents and grandparents. So one of the impediments to reform is a strong advocacy group for the status quo (beneficiaries and their supporters) against an advocacy group with less of a stomach for reform. Taxpayers are not sure whether they want to push for reform because they don't want to pick up the medical costs and the living expenses of their older relatives. As the costs increase, however, the tax pressure will move them toward reform. That's the kind of discussion that this analysis generates.

Table 5 contains another interesting structure. The square of the transpose creates a 10×10 matrix revealing the extent to which issues are related. That matrix reveals that the stakeholders' position on means testing is generally the same as their position on capping medical benefits, because they are both cost reduction techniques. Conversely, their position on increasing taxes would be opposite from their position on investing the surplus; they are much different proposals.

TABLE 5
ISSUE STRUCTURE

$M^T \times M = (M^T)^2$	A	B	C	D	E	F	G	H	I	J
A Raise age		1	−1	2	2	2	−1	1	−1	−1
B Means test	1		−2	7	1	2	−2	1	5	1
C Reduce ben	−1	−2		−3	−4	0	3	0	−2	1
D Cap medical	2	7	−3		2	2	−3	0	6	1
E Increase tax	2	1	−4	2		−1	−4	−2	−2	−5
F Reduce exp	2	2	0	2	−1		0	5	1	2
G More work	−1	−2	3	−3	−4	0		0	−2	1
H Req pension	1	1	0	0	−2	5	0		3	4
I Tax consump	−1	5	−2	6	−2	1	−2	3		6
J Invest surplus	−1	1	1	1	−5	2	1	4	6	

The results reveal three categories of issues. The first group are the drastic measures. The second set, the government solutions, increase the ability of the government to support the system as it is, by reducing other expenditures and increasing taxes. The third set, the economic solutions, looks to the economy to provide the revenue by increasing savings rates and investing the surplus in investment bearing investments.

Whether you agree or disagree with my interpretation, at least it provides us some basis to discuss our mutual assumptions about stakeholder positions and the resulting stakeholder coalitions and issue clusters. That's the discussion of assumptions that MICMAC and MACTOR support. They fit the criteria of heuristic forecasting tools. They are easy to use; one could even run them in an assumptions workshop format. After rapid fire iteration and discussion about the details, a set of assumptions may emerge. Even when the group cannot agree on their assumptions, then the uncertainty is the basis for legitimate scenarios that need to be investigated, anticipated and monitored. Either way, the discussion of assumptions is a vital piece in understanding the possibilities of the future.

EZ-IMPACT

Unfortunately, I don't have time to go through the EZ-Impact process in detail. It was developed by a good friend of mine, Professor Tom Bonnicksen, a forester by trade and a computer modeler by hobby.

EZ-Impact is based on a simple fact that Tom learned in his early days of modeling forests. Tom developed the models, and policymakers used the models to make decisions. Tom observed, however, that the policymakers did not understand the models. They were too complicated. Most of all, they did not understand the numerous assumptions the model required or the trade-offs that the modeler had to make. There and then, he realized that the only good models were those that were understood by the client.

About that time, Tom discovered an algorithm that normalized the scale of the variables in a cross-impact matrix that allowed the calculation of future values. He created a simple computer program that allows an individual or a workshop of stakeholders to build a computer model of the system under investigation.

Stakeholders are identified and their preferences are entered into the model as future values of the model variables. They have to be specific. They can't just say they want to be happy or safe or secure. They have to tell which variables they want to go up or down, and by what percentage and which variables they want to stay the same. The model can then calculate not only the values of the future variables, but the satisfaction of each stakeholder against their announced preferences. Some will be happy; some will not. But the model can be changed by forcing some variables in specific directions using policy or resources or both. The stakeholders end up in a cooperative game of trying to increase the general satisfaction with very specific discussion of feasible strategies.

Bonnicksen has used EZ-Impact mostly in environmental disputes, some of the most contentious in our society. The amount of cooperation and agreement emerging in such groups is amazing. Stakeholders share their mental models, align them with one another, announce their interests in an objective way, run the model to see how much of those interests are served, and adjust the boundary conditions to maximize their interest. Sounds like magic, and it almost is.

I don't know of another system that allows for the precise articulation of a mental model and stakeholder interests. The workshop is actually captured in a very precise language of the future. Because the personalization of the issues is greatly reduced, most of the politics goes away too. It becomes a game after a while. Can we really get this thing to operate in everyone's best interest?

This cross-impact is not necessarily a "valid" model of the system or the future. It is a heuristic tool in every sense of the word. It is an articulation of the group's mental model, but nothing more. Tom is very firm on throwing the model away when he's done.

One of the most successful applications of EZ-Impact was a workshop he did for the Texas Bureau of Land Management. The bureau had been directed to develop a management plan for the Texas Gulf Coast. The workshop focused on three issues: beach erosion, beach access, and declining wetlands. All the stakeholders were there: developers, government officials, environmental groups, and residents. They developed these models, and came up with the strategies. When the legislature convened hearings, every group spoke in favor of the plan. The committee chairman said he had never seen such unanimity in 20 years in the legislature.

I have been talking about EZ-Impact for ten years, but I have yet to find a client willing to try it. It sounds too complicated and perhaps too scary. Frankly, people use it as a last resort when they have to get a solution and when they have exhausted all the other methods. People don't like it because it dispels the fog of political competition. Political people like the fog . They believe that if anything would dispel the fog, they would be found out. The rationalism that EZ-Impact offers is simultaneously its greatest strength and its most serious weakness.

Tom's used this on the spotted owl controversy in northern California, as well as on a number of environmental issues throughout the country. It’s really a phenomenal technique.

CONCLUSION

Heuristic forecasting is a complement to actuarial techniques. When the assumptions of the actuarial models apply, by all means, they are the preferred tools. When those assumptions do not apply, when the uncertainty about the future is real and unresolved, when different people have different models and assumptions about how things are or could be, turn to tools like these to work on the problem. They will not provide precise answers to your quantitative questions, but in uncertain times, they give something more valuable—an understanding of how we are thinking about the present and the future, what assumptions we carry within us, and what possibilities we may not have thought of. The only way to discover these insights is through the skillful discussion of a group dedicated to seeing beyond the obvious nature of the problem. The perspective of futures studies and these tools are ways to bring about that discussion.