

# System dynamics meets the press

Donella H. Meadows

The shared paradigms of society, the public discourse, the deepest assumptions about how the world works, these are the ultimate sources of system structure and the primary obstacles to structural change. The reigning paradigms of the western world are astonishingly unsystematic, and they give rise to badly structured, difficult-to-manage large-scale social systems with persistent problems, such as pollution, poverty, and war. One way to contribute to the restructuring of those systems is to bring more clear, accurate, and inclusive systems concepts into the public discourse—to communicate systems insights regularly and powerfully through the press.

Even the simplest ideas of system dynamics—stocks, flows, positive and negative feedback, the effect of delays, the importance of nonlinearity—can help to clarify public discussion and improve public policy. They must be communicated without jargon, without mathematics, without loop diagrams. That can be done, and the best partners in doing it are those who are already professionals in the art of public communication—the members of the press.

System dynamics has met the press in continuous, sometimes dramatic, often frustrating confrontation since the earliest days of the field. In 1969, when I first became aware of Jay Forrester, he was trying to explain to a nation in the midst of urban crisis that governments should pull down city housing instead of constructing it (Forrester 1969). The press was fascinated by this unusual message, just the inverse of the conventional wisdom of the day. That was when the word *counterintuitive* began to be applied to complex systems.

The first article to be written about Forrester's world model was in *Playboy*, of all places. A year or so later I watched Dennis Meadows discussing *The Limits to Growth* (Meadows et al. 1972) on the *Today* show. He was given three minutes to get across the ideas of exponential growth, overshoot, and collapse, right after a mouthwash commercial and just before a demonstration by the British dart-throwing champion.

The press has paid sporadic attention to the work of the M.I.T. group on national economic modeling, but a 50-year long wave cannot hold the interest of a nation with 4-year election cycles and a media attention span of a few weeks.

The experiences of system dynamicists with the press have sometimes been funny, sometimes frustrating, sometimes fruitful. Those of us who use system dynamics to model large-scale social systems have had many such experiences, and we will continue to have them. We seek out the press because we think our field gives us valuable, sometimes crucial, insights about the world, and we want those insights to be spread widely. The press seeks us out because we usually have something to say that is relevant and off-beat. We rarely come at a topic the same way everybody else does, and the novelty and controversy we generate are magnets for the media.

Strangely enough, given all these skirmishes with the press, our field has paid much more attention to communicating with managers and policymakers than it has to getting ideas across to the general public. Our focus on policy-level communication is understandable, since our models direct our awareness to the decision points in systems. But our field also makes clear the overarching power of paradigms, deep-level, socially shared assumptions about the nature of the world that set up the structures of decision makers, institutions, feedback loops, and system goals in the first place.

If we communicate only to decision makers, we might be able to install better decision rules, we might redirect a physical or information flow or two, but we will not achieve the thoroughgoing restructuring of systems that we know is necessary to solve some of the world's gravest problems: the three big ones—poverty, pollution, and war, and a host of smaller ones—inflation, public indebtedness, land-use planning, city management, and farm failures. For our larger social purposes our proper audience is the general public. Our only way of reaching that audience is through the mass media.

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That's the conclusion I came to, anyway, three years ago, when I set out to be a newspaper columnist. I was finding the state of the world and the feeble responses of policymakers intolerable. I didn't think that more writing for academics or preaching to the converted would help. I wanted to see a regular, system-based, globally oriented, long-term viewpoint on the editorial pages of the newspapers. I kept waiting around for someone else to do it, but no one did.

So I did, and I've learned a lot in the process, about public perceptions and paradigms, about what system dynamics can contribute, about the media themselves and how they work. This article is about what I've learned.

### The present paradigm

Wes Jackson, in his book *Altars of Unhewn Stone*, gives a short, clear definition of what a paradigm is, in the process of describing part of the western industrial paradigm:

Our culture assumes that individuals are free-moving social atoms with their own intrinsic properties. Society is a collection of such individuals. In other words, society as a phenomenon consists of the outcome of the individual activities of individual human beings. This supports the view of Descartes, a view that became a central notion of modern science. This view, this Cartesian view, says that the part has priority over the whole. Cartesianism is not just a tool or a method of investigation. It is a *commitment* to how things really are. [Jackson 1987, 68–69, italics in original]

A paradigm is not only an *assumption* about how things are, it is a *commitment*. There is an emotional investment in a paradigm, because it defines one's world and oneself. A paradigm is a set of deep concepts about the nature of reality that shapes language, thought, and perceptions—and system structures. In social interactions, slogans, and common sayings, the reigning paradigm of the society is repeated and reinforced many times a day. Whenever a speaker of an Indo-European language says something, nouns and verbs reinforce the paradigmatic distinction between *things* and *processes*. Every time you buy or sell something, you affirm the shared paradigm about the value of money. Every time the President rejoices when the GNP goes up, he strengthens the paradigm of economic growth as an unquestioned good.

Your paradigm is so intrinsic to your mental processes that you are hardly aware of its existence, until you try to communicate with someone of a different paradigm. Listen to an ecologist talking with an economist, an antiabortion speaker with a prochoice advocate, a right-winger with a left-winger. In the difficulties and misunderstandings of cross-paradigm discussion, both parties begin to be aware, often painfully, of fundamental assumptions they do not share.

The system dynamics paradigm assumes that things are interconnected in complex patterns, that the world is made up of rates, levels, and feedback loops, that information flows are intrinsically different from physical flows, that nonlinearities and delays are important elements in systems, that behavior arises out of system structure. The paradigm of public discourse contains none of those assumptions. System dy-

namacists were raised in their culture, of course, long before learning system dynamics, so they are not uncomfortable in the normal prattle of everyday life. But their systems training makes them very aware, if they listen, of the many unsystematic assumptions that permeate societal talk, political thinking, and the daily reports of the media.

Here are a few of the common assumptions of the current industrial paradigm that seem to me to be clearly unsystematic and problematic; these are the assumptions that disturbed me enough to want to write a newspaper column to challenge them:

- One cause produces one effect. There must be a single cause of acid rain or cancer or the greenhouse effect, and we just need to discover and remove it.
- All growth is good—and possible. There are no effective limits to growth.
- There is an “away” to throw things to. When you have thrown something “away,” it is gone.
- Technology can solve any problem that comes up (there is no cost to technology, no delay in attaining it, no confusion about what technology is needed). Improvements will come through better technology, but not through better humanity.
- The future is to be predicted, not chosen or created. It happens to us; we do not shape it.
- A problem does not exist or is not serious until it can be measured.
- If something is economic, it needs no further justification. “Call a thing immoral or ugly, soul-destroying or a degradation of man, a peril to the peace of the world or to the well-being of future generations; as long as you have not shown it to be ‘uneconomic,’ you have not really questioned its right to exist, grow, and prosper.” (Schumacher 1975, 39–40) In short, current economic reckoning of costs and benefits is complete and correct.
- Relationships are linear, nondelayed, and continuous; there are no critical thresholds, feedback is accurate and timely; systems are manageable through first-order negative-feedback-loop thinking.
- You can measure results by effort expended. If you have spent more for weapons, you have more security; if you use more electricity, you are better off; if you spend more for schools, your children will be better educated.
- Nations are disconnected from each other; man is disconnected from nature; economic sectors can be maximized independently from each other; some parts of a system can thrive while other parts suffer.
- All choices are either/or, not both/and.
- Possession of things is the source of happiness.
- Individuals cannot make any difference.
- People are basically bad, greedy, and not to be trusted. Good people and good actions are rare exceptions.
- The rational powers of human beings are superior to their intuitive powers or their moral powers.
- Present systems are tolerable and will not get much worse; alternative systems cannot help but would be worse than the ones we’ve got.
- We know what we are doing.

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I submit that all the above statements are partly or wholly false, that they are implicit or explicit in virtually all public discourse, that they give rise to much of the persistent counterproductive behavior of individuals and institutions, and that the harm done by them is incalculable. The only way I know to throw them into doubt is to question them, over and over, with as much documentation, clarity, and persuasiveness as possible, in the most visible public forums.

### **Even the simplest systems concepts help**

System dynamicists sometimes make the mistake of thinking they must have a complete model of a system, with all parameters strictly estimated, all sensitivity tests performed, all equations documented, before they can say a word in public. Such a model is necessary, if one intends to put forth a complete, quantified, thorough analysis, using computer outputs to reinforce one's case. I can't imagine not having a sophisticated model at hand to test alternative energy policies, for example, or to discuss how to counteract the greenhouse effect or how to design a national agricultural policy.

But the level of public discussion is not usually complex enough to justify or tolerate discussion of a complete model, nor is it necessary to be that thorough in order to raise the quality of political debate. The most fundamental tenets of system dynamics, ideas as simple as the difference between a rate and a level, can already clear up significant muddles in general thinking.

I once wrote a whole column on the difference between a debt and a deficit, explaining why slowing the rate of deficit (a hotly debated policy known in the United States as the Gramm-Rudman-Hollings Act) will not reduce the level of debt but will only slow its increase. I'm still not sure most of our politicians understand that point. It is a revelation to most people that you can increase the contents of a level by reducing outflow as well as by increasing inflow (that economic welfare can be enhanced by reducing depreciation as well as by increasing investment, for example). The effect of nonlinear relationships is not generally understood (the public debate on the seriousness of soil erosion has yet to recognize that the relationship between soil depth and crop yield can be sharply nonlinear—that a little erosion may not have much effect, but a little more erosion may reduce output dramatically).

Other systems ideas that have immediate public relevance are the following:

- Simple interconnectedness. (Energy conservation would not only save consumers money directly; it would also cut urban air pollution, acid rain, greenhouse gases, the production of radioactive wastes, the trade deficit, and defense costs in the Persian Gulf—these are only a few of the effects that would radiate through economic and environmental systems.)
- The astounding power of positive feedback and exponential growth. (Nigeria's population grew over the past 35 years from 43 million to 105 million. At the same rate of change over the next 35 years, Nigeria is expected to add another 207 million people, for a total of 312 million. That is 43 million to 312 million over one human lifetime.)

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- The time it takes for levels to change. (After three years of *perestroika* the Soviet Union's economic situation has changed little. People are already calling it a failure, not understanding how long it takes for a nation's capital plant, exhausted soils, and disaffected work force to be revitalized.)
  - The effect of delays on feedback. (Why oil prices went up and then back down and why they will go up again.)
  - The endogenous sources of behavior; the greater importance of structure than of triggering events. (One of the most controversial columns I ever wrote tried to divert attention from the immediate faults of Morton Thiokol's O-rings to the underlying structure that made a space shuttle accident almost inevitable.)
  - The effect of bias in information streams. (Consistent Soviet and American overestimates of each other's weapons capability are a major driving force in the positive feedback loop of the arms race.)
  - The difference between information and physical quantities in systems. (I could write a column every week about the endless confusions between money and the real things money stands for.)
  - Bounded rationality; how rational microbehavior can lead to disastrous macroresults. (The tragedy of the commons, the rise in malpractice insurance, the Kondratieff cycle—there are hundreds of examples of this phenomenon. It is one of the most powerful concepts we have to offer, because it turns public discussion from the problem of blame to the problem of restructuring.)

Just one of these ideas is enough to get across at a time, especially in a newspaper column of 800 words. Sometimes I get tempted to cram in two, as in this column about oil prices. The effect of delay on feedback is in here, as is the negative feedback loop of depletion:

Why, when there is less oil in the ground than there was 10 years ago, is the price of oil going down?

To sort that out, it helps to distinguish between the short-, medium-, and long-term factors that influence oil price.

In the short term, oil price reflects the immediate supply of oil pumped, processed, and ready to deliver, relative to the unfilled orders for that oil. This is the spot market. It can change radically with any event that interrupts the flow of oil, or that makes speculators think the flow will be interrupted or the demand will suddenly change. The short-term price can gyrate if the Strait of Hormuz is threatened, if there's an unusually cold winter, or if the Ayatollah sneezes.

Underlying the short-term blips are the decades-long swings of the medium-term oil price. This price measures the oil-pumping capacity of the world, relative to the oil-burning capacity, the furnaces and cars and boilers.

During the early '70s, oil wells were working at over 90 percent of their capacity. Short-term shocks could not be met by pumping harder, so price rose instead. Gradually, in response to the higher price, more oil wells were drilled. Meanwhile we were all investing in oil-conserving cars and insulating our houses. Pumping capacity rose while burning capacity leveled off.

Since the people who invest in oil wells and the people who invest in cars and furnaces do not communicate with each other about their intentions, capacity adjustments like the ones of the past decade tend to overshoot. We have now reached an overbalance of oil wells to oil burners. Middle East wells are operating at less than 50 percent capacity. Any short-term shock can easily be met by starting up idle oil pumps.

OPEC is weakening, price is going down. Few new wells are being drilled and consumers are buying bigger cars again—we are setting up the next swing, the oil price rises of the 1990s.

In other words, we have a glut of oil wells, not of oil.

The long-term price, which reflects the real cost of finding, producing, and transporting oil, is almost buried under the short- and medium-term noise. But real cost is going up as the biggest, nearest, easiest-to-find oil deposits get used up. Some day—two or three decades from now—it will begin to dominate the market, and we will finally have economic evidence for what the geologists have always known—our ultimate underground oil supply is depleting. They ain't makin' none of it any more, and every time we burn some, it's gone forever.

Over the next 50 years, we will have to replace every oil-burning device with one that uses some more sustainable form of energy. It's a technical challenge equivalent to the one that moved us from horses and coal to oil and gas at the beginning of this century. The less we waste oil now, the longer we will have to make the transition.

The price of oil is a useless guide to energy policy. It swings us around on its pendulum of over- and under-investment in oil wells. "For decades oil prices went down, and we thought they would always go down," says Dr. Ulf Lantzke, Director of the International Energy Agency. "Then in the '70s they went up, and we thought they would always go up. Now they are going down again, and we think they will always go down." [November 16, 1985]

Only once have I tried to combine many of these concepts and in fact to deliver the central dynamic hypothesis of a complete, complex policy model. It was a column on the disappearance of the family farm, and it was based on a system dynamics study by Philip Budzik (1975).

The driving force of the model was a positive feedback loop:

Farmers are caught in a vicious cycle. At any given price, for milk or grain or whatever, the most obvious way a farmer can earn more money is to produce more. So some of them do. But, since most of us are already drinking all the milk and eating all the grain we can, a larger supply means a lower price. Now, since the price is lower, every farmer has to produce more just to keep the same income. So every farmer tries to do that and some succeed, increasing production still more, dropping prices still further, forcing every farmer to produce still more.

The farmers are on a treadmill. Each one feels forced to expand whether or not he wants to, whether or not he can actually do a good job with more land or more cows. "Get bigger or get out" is the message. If the farmer succeeds in getting bigger, he turns the treadmill further, increasing output, reducing prices, forcing himself and others to expand even more in the future. Every time one farmer manages to stay on the treadmill by expanding, he knocks another farmer off.

The next important idea was that of bounded rationality:

Who's doing it to the farmers? The farmers are doing it to each other. They are stuck in a system where everyone's individual rational behavior produces a result that no one wants. If you don't believe that, ask the nearest farmer. They know what's happening.

Then came the ideas of counterintuitive behavior and policy resistance:

When, with the best of intentions, we help the farmers out of their troubles—with subsidies, low-interest loans, easier taxes, higher prices, better technologies—they can expand still more, produce more, and turn the treadmill even faster. Anything that gives

a farmer the ability to expand puts another farmer out of business, sooner or later. When we help a large farm expand, it is usually several middle-size or small farms that bite the dust.

The final message is the unexpected leverage point and the policy recommendation:

There is one astonishingly simple (and at the moment politically unthinkable) way of doing that. Just plain limit the size of farms. Define some upper limit beyond which a farm cannot grow, high enough to capture economies of scale and a decent farm income, low enough to encourage healthy land, communities, and economy.

The limit should vary by crop and land type and change as technologies change. It would be most effective to set it not by acre, but by the amount of each commodity that each farm would be permitted to market. A limit in real commodity units would give the government a way of dealing with the perennial problem of overproduction. It would stabilize farm prices. It would give farmers the freedom to experiment with different management schemes to produce the limit at lower cost. It would encourage them to diversify their crops, making them less vulnerable. And since the total amount of each crop produced is fixed, any decrease in costs would mean an increase in farm income, not in farm size.

If the farm-size limit were set at a reasonable level, it would eliminate the need for farm subsidies, because farms would be profitable without outside help. [May 11, 1985]

The importance of this example for this article is simply to demonstrate that the essence of a quite sophisticated model can be communicated in words, without diagrams, in just a few paragraphs.

Another important point is that the column did not exactly transform the 1985 U.S. Farm Bill. It did provide some ammunition for farmers, many of whom have come to their own realization about how the farm system works and are trying to instill some kind of marketing restriction. The policy that came out of the model is still unthinkable to politicians, who regard it as interference with the free market, which, of course, it is. The free market is widely misunderstood, and it is a central feature of the modern industrial paradigm. I hammer at it regularly in my columns:

We are told, over and over, that the free market is a sort of natural wonder that guides the economy without need for government interference. But, in fact, the market system is chronically, inherently unstable. All market economies oscillate, with 4-to-7-year business cycles, with longer cycles of construction and commodity production, and with 50-or-so-year-long waves that bring, among other things, major financial panics.

The oscillations are inevitable because mutual adjustments of supply and demand are very slow. It takes time for producers to respond to shortages or surpluses by adjusting prices, and time for consumers to respond to price changes by buying more or less. It takes even longer for producers to gear up or down and for those responses to percolate through the system to suppliers and then to suppliers of suppliers. During the adjustment time—which can be years or even decades—shortages or surpluses go on getting worse, until the corrections begin to take hold.

A huge economy cannot bring itself to a prompt supply-demand balance like the neat graphs in Economics 101 textbooks. Production and consumption yaw back and forth, seeking equilibrium, overshooting, correcting, undershooting, in cycles that affect everything from interest rates to opinions about the president to expectations in the stock market.

If we are serious about understanding our economic system, stabilizing it, and bringing it under some kind of control, we'll have to start by admitting its imperfections. Doing

so does not necessarily throw us from the roller-coaster of untrammelled free enterprise straight into the gray, unproductive prison of central planning. There's a lot of space in between—in a region that could be called informed, regulated free enterprise. [November 21, 1987]

That column, written shortly after the 1987 stock market crash, was one of the most unpopular I ever produced. Many papers did not print it. I learned a lesson from that—you can't challenge the prevailing paradigm too directly.

But you can challenge it indirectly, bit by bit, again and again, presenting more and more evidence. Thomas Kuhn, who wrote the seminal book about paradigms that has inspired many system dynamicists (1970), says that what ultimately causes a paradigm to change is the accumulation of anomalies—observations that do not fit into and cannot be explained by the prevailing paradigm. The anomalies have to be presented over and over, because there is a social determination not to see them.

Challenging a paradigm is not part-time work. It is not sufficient to make your point once and then blame the world for not getting it. The world has a vested interest in not getting it; the point has to be made patiently and repeatedly, day after day after day. Fortunately, there are communications systems like newspapers and television that do make points repeatedly, and that have space to be filled day after day after day. If we're going to use these media well, if we're even going to compete successfully for that space, we have to take the time to understand how they work.

### **The filters through which we must speak**

Over the past three years I have come to know at least 50 newspaper editors. They are tremendously well-informed people (they read four or five newspapers a day; editorial-page editors read at least 20 opinion columns a day). They are disciplined, productive, nimble with words (they write to deadline every single day). They follow a set of strong professional ethics about evidence, balance, truthfulness, and the public's right to know. Above all, they care about society and democracy and the information streams that hold a community or a nation together.

Like everyone else, however, they are embedded in a system whose structure, rewards, and punishments inevitably shape their behavior, not always for the good. The enterprises they work for put out a daily product on a rigid schedule that is not conducive to long, careful reflection. They are commercial establishments that have to attract advertisers and appeal to the public taste. There is only so much space available every day, and the competition for that space is intense.

Everything I've said about newspapers is even more true of the broadcast media. The result is a set of behavioral characteristics we are all familiar with—the standard, and generally accurate, set of criticisms about the media:

- They are event-oriented; they report only the surface of things, not the underlying structures.
- Their attention span is short, they create fads and drop them, they don't see slow, long-term phenomena (they ignored the greenhouse effect for decades, until there was drought in the Midwest).

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- They follow a herd instinct; they will send 1,500 reporters to one political convention, but no reporters will be on hand when crucial environmental policy is being made.
  - They are attracted to personalities and authorities; they are uninterested in people they've never heard of.
  - To meet time and space constraints they simplify issues; they have little tolerance for uncertainty, ambiguity, trade-offs, or complexity.
  - They operate from skepticism; they have been lied to and manipulated so much that they don't believe anyone; they carry such a load of cynicism that they often unnerve interviewees who are in fact sincere and telling the truth.
  - They have a tendency to force the world to conform to their story, rather than to see the world as it is (I have several times had the frustrating experience of being interviewed by a reporter who didn't want to hear facts that contradicted "the story").
  - They love controversy and think harmony is boring; they see the world as a set of win/lose, right/wrong situations; they are attracted to conflict and to things that aren't working; they do not pay attention to things that are working.
  - They are strongly conservative, unconsciously reinforcing the status quo and resisting ideas of change.
  - Also unconsciously, they report through filters of helplessness, hopelessness, cynicism, passivity, and acceptance. They report problems, not solutions, obstacles, not opportunities. They systematically unempower themselves and their audience.

Why should we try to communicate messages of complexity, of structure, of long-term thinking, of inclusiveness, of empowerment through a system like this? Because if we want a better world, we have no choice. And because it can be done, in spite of that negative list I just made. I've learned that communicating through the media is harder than I thought, but more possible than I thought, and also more rewarding and more result-producing than I thought.

### **It can be done**

My greatest help has been a handful of editors and TV producers who have recognized what I'm up to, taken me in hand, coached me and criticized me to make my work more effective. Slowly they have taught me to stop resisting the strictures and necessities of the media and to work within them, without, I hope, losing my own purpose or message.

My greatest problem at the beginning was keeping my columns under 800 words. One of my editors thundered at me, "George Will can write less than 800 words. Mary McGrory can write less than 800 words. Why can't you write less than 800 words?" Another reminded me that I didn't have to say everything all at once. With a weekly column, I'd always have another chance.

The moral of that story is—be concise. The public's attention is fleeting. It's important to get the point across, not to say all you know. Once you get used to conciseness, you see it's actually a blessing. You have to come quickly to the essence

of an argument. You have to be clear about the basic message, the important feedback loops in a system structure. Concise writing or speaking takes careful thought; it's as difficult, and as important, as starting a model with a well-specified purpose and an unambiguous dynamic hypothesis.

Be clear, they told me. Use everyday language—there is not a single concept in system dynamics that can't be explained to a 12-year-old in ordinary language. Be specific, not abstract. Offer lots of easily imaginable examples. Be sure your words make pictures in people's heads. Be sure the pictures are the ones you intend.

Use at least three-quarters of your column for the evidence, they said. Tell stories, give statistics, show the impact of the problem, or the solution, on the real world. People can form their own conclusions if you give them the evidence. Don't take much space for grand, abstract conclusions.

Use a hook to the news—that point was hard for an academic like me. If you're writing about energy conservation, tie it to the accidental shooting down of a commercial airliner over the Persian Gulf. If you're writing about the ozone hole, point out that the Senate just ratified an international treaty to combat it. People have to know why what they're about to read is important. They think that the daily news is important, so use that hook, even if you're not going to talk about the daily news.

Write an interesting lead. Another friendly editor once blasted me with, "That was the most terrific column you ever wrote, but it had a boring, killer lead." A killer lead is an opening sentence that makes the reader yawn and turn to the sports page. The one the editor complained about was this: "I have just had the privilege of escorting six Hungarian visitors on a cross-country tour of the United States. All six are agricultural experts. They came to see our farms." It would have been better to start with something right out of the middle of the story, perhaps this: "The Hungarians thought Burger King was great. 'So clean,' they said. When they saw people carrying their own trays, they said, 'So socialist.'"

Never write in an apologetic tone, they told me, or a defensive one. Never, ever, condescend to the reader. Never present a problem without providing at least a hint of what to do about it. Don't get people all riled up and then drop them into helplessness.

A TV producer taught me an especially important lesson—whatever your subject, tell it through *people*. Human beings are much more interested in other human beings than in abstract concepts. Don't shy away from personalities, don't try to hide your own personality (difficult for an academic who has been carefully trained to do so). If you care about something, let your care show as well as your objective evidence. If you're writing about someone else who cares, or who doesn't, a hero or a villain, make that person as real and whole on paper as you possibly can.

Be humble. You don't know everything. Even system dynamicists don't know everything. In fact, no human being knows much of anything, compared with the immense wonders and uncertainties of the universe, so keep a sense of perspective. Say just what you can say and no more, say it with the appropriate degree of certainty and no more. That is the hardest lesson for me to follow. It's a torture every day and a duty, a wonderful discipline and a Zen koan, the bane of my existence and the best challenge of my life.

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Here is another part of a systems-based column, one of the few I've actually identified as such. You can judge for yourself how well I followed the rules I've just listed:

We system analysts like to tell a story about sailboats. It illustrates a problem called "rule beating," which occurs in all kinds of systems—especially, these days, in the U.S. Department of Defense.

Before the invention of organized sailboat racing, boats were intended for transporting people and things across water. Sometimes they raced each other just for fun. But a competition is no fun unless it's fair, and fair competition can only occur between boats of roughly the same size and design and sail area. So some primitive rules were set up, specifying classes and types of sailboats that could race each other fairly. That's when the trouble began.

Sailboat racing began to be a serious business. The rules specifying design limitations on each class of boat became more detailed and rigid. Soon boats were being designed around the rules. The object was to make the fastest possible boat that still fit the guidelines—to "beat the rules."

The result, I am told, was boats that are monsters, so distorted in order to produce maximum speed within a particular set of rules that they are almost worthless for transporting people and things across water.

The moral is to watch out for the rules you set up, because you are likely to get what you specify, and only that. Rules to enforce fair sailboat races give you fair races, but not seaworthy boats. Tomato-breeding to allow long-distance shipping will give you tough tomatoes but not nutritious or tasty ones. Once a family planning program in Pakistan measured its success by the number of IUDs implanted. Doctors implanted them by the thousands, sometimes three or four in the same woman. The rules were met but not the real goal—the birth rate didn't change.

The administration measures our military might, our firm intent, and our national security by the amount of money we spend. What we get from that rule is not might, intent, or security. What we get is spending. [July 6, 1985]

As my columns are appearing in more papers and reaching more people, I am hearing from some of those people, and that is the gratifying part of this exercise. I get letters and phone calls, sometimes angry, sometimes plainly crazy, but mostly thoughtful, appreciative, supportive, interesting, and educational.

People send me additional material about a subject I've written on. They tell me about concrete steps they are taking to correct a problem. They point out my mistakes, usually very patiently. They ask questions and suggest column ideas. They let me know when they think one of my columns is below standard, and they're always right. They tell me they've cut out one of my pieces and sent it to their Senator or their brother-in-law, or they've read it to their ninth-grade class, or they've stuck it up on their bulletin board at work. There's a great audience of engaged, active people out there, yearning to make sense of their world, grateful for the smallest insight you can share with them. They put ideas to work. They are the living receptacles of, perpetuators of, and changers of the paradigms of society.

It's an enormous privilege to be in communication with them, a privilege I take increasingly seriously. Henry Thoreau said in *Walden*: "It is something to be able to paint a particular picture . . . but it is far more glorious to carve and paint the very atmosphere and medium through which we look. . . . To affect the quality of the day, that is the highest of arts."

Sometimes it's glorious, sometimes the responsibility is frightening. John Maynard Keynes (1936), in one of his most often-quoted passages, articulated what must be both the greatest hope and the greatest fear of all idea-communicators:

The ideas of economists and political philosophers, both when they are right and when they are wrong, are more powerful than is commonly understood. Indeed the world is ruled by little else. Practical men, who believe themselves to be quite exempt from any intellectual influence, are usually the slaves of some defunct economist. Madmen in authority, who hear voices in the air, are distilling their frenzy from some academic scribbler of a few years back. I am sure that the power of vested interests is vastly exaggerated compared with the gradual encroachment of ideas.

We shouldn't duck from that power of ideas. Our discipline has given us good ideas, which need to be out there in the public arena, encroaching along with other ideas. Not all of us need to take the time and trouble to learn to communicate through the media as I am doing—most of us, most of the time, should be working at our discipline, doing the research, making the models, having the ideas that will eventually need to be communicated. The point of this article is that system dynamicists should reflect upon, respect, and when appropriate seek out and cooperate with the public media and the skilled professionals whose job it is to communicate through the media. They are our partners in making a better world. We should work with them and bring to them all the clarity, integrity, honesty, and systems insights we can master.

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