A GENERAL THEORY OF VALUE
Appendix One: **A Note to the Math Anxious**

Dear reader, if you are not mathematically inclined, you may have scanned the equations and diagrams in this book with dread. Or—if you *are* mathematically inclined and know how far short simple equations fall of describing anything as complex as human behavior—you may regard them with skepticism. In Chapter One, for example, I use probability theory to talk about the "information content" of decisions, about the nature of "complexity," and so on, knowing full well that the subject matter is far more complex than the equations I offer can describe, and that ordinary people do not calculate probability in any textbook sense anyway. And in Chapter Six, I try to explain addiction with the help of graphs of "satisfaction waves" treated, in their own mathematical terms, quite strictly. What could these tidy little graphs possibly have to do with the complexities of real life and real addictions?

Given these admissions, then, on what grounds do I recommend that we apply ourselves nonetheless to wrestling with graphs and mathematical expressions?

Consider this fact: that no one who can ride a bicycle (or catch a ball, or stand without falling over) can write down the dynamical equations of motion that allow them to do so, let alone give an account of the neurological pathways employed, or of how the requisite information is processed by our perceptual and motor systems. And yet we ride bicycles and catch balls and stand steady with ease. Clearly, our bodies *embody* the mathematical knowledge they need. Our nerves and muscles carry out the needed computations almost flawlessly. If we can grant that our bodies simply "do the math" whenever we exercise our perceptual and motor skills, can we not not argue, by extension, that the same is likely true of our cognitive skills? I.e. that when we think and plan and remember and feel...that our brains are also "doing the math?"

All this is math-doing is unconscious, one might reply, and ought not to count as evidence that a knowledge of mathematics, the discipline, is necessary to understanding the world at a conscious level. Perhaps.

But consider this: *we use math all the time*, and quite consciously. The words "left," "right;" "inside," "outside;" "fast," "slow," "high," "low," "more," "less," "big," "small," "medium," and "average;" "push," "pull;" "rigid," "flexible;" "later," "never," "accelerating," "slowing," "separate,""combined", "in order," "sometimes," "frequently", and "always;" "except," "if," "only if," "when," "neither," and "but"...are all quantifiers, modifiers, and logical and topological connectives that are fully mathematical in nature and to which we have quite clear and conscious access as we go about our lives

The same can be said of the "probabilities" we discuss in Chapter One. While it is true that few of us stop to assign numerical-fractions-which-sum-perfectly-to-1 to our feelings-of-confidence-that-this-or-that-event-will-happen, it is also true that we have a pretty good idea about how probabilities—likelihoods—should "go." We know almost instinctively, for example, that the (greater) likelihood of one event happening logically diminishes the likelihood of another event happening if the two events are truly alternatives to each other. (If we are quite sure that Joan will marry John *or* Jeff, then the *more* likely it is that she will marry John, the *less* likely it is that she will marry Jeff.) We also know that the likelihood of *both* of two causally unrelated events happening simultaneously is smaller, by far, than the likelihood of *either* happening by itself. (I am far less likely to fall off my bicycle today *and* get a check in the mail than fall off my bicycle today *or* get a check in the mail.) And so on. Indeed, the mathematical theory of probability—and of information, complexity, and the rest—*is very much derived from our already-mathematical intuitions about how these things ought to go.* Using mathematical symbolism just allows us to be more precise. It allows us to extend the range of our thinking beyond the basics. It allows us to follow through on the consequences of our simple beliefs in order to see what happens as they concatenate and interact beyond our native ability to follow them Often we are surprised at the results—and therein lies the pleasure and profit of it all.

Now, there are many situations in which we cannot assign probabilities. We may have no history of similar events from which to extrapolate, for example. To make matters worse, much beyond gambling and games, we can often not *know* how many, or which, future events really constitute a "mutually exclusive" set of alternative possibilities. To use numerical values in such situations may seem quixotic if not foolish. The philosopher J. J. C. Smart (although here he is defending utilitarianism rather than information theory) is worth quoting at length on this problem. "(I)t is usually not possible to assign a numerical probability to a particular event," he writes. And goes on:

> No doubt we could use actuarial tables to ascertain the probability that a friend of ours, who is of a certain age, a certain medical history, and a certain occupation will die within the next year. But can we give a numerical value to the probability that a new war will break out, that a proof of Fermat's last theorem will be found, that our knowledge of genetical linkage in human chromosomes will be much improved in the next five years? Surely it is meaningless to talk of a numerical value for these probabilities, and it is probabilities of this sort which we have to deal with in our moral life.
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> When, however, we look at the way in which in fact we take some of our ordinary practical decisions we see that there is a sense in which most people think that we can weigh up probabilities and advantages. A man deciding whether to migrate to a tropical country may well say to himself, for example, that he can

> expect a pleasanter life for himself and his family in that country, unless there is a change in the system of government there, which is not very likely, or unless one of his children catches an epidemic disease, which is perhaps rather more likely, and so on, and thinking over all these advantages and disadvantages and probabilities and improbabilities he may come out with the statement that on the whole it seems preferable for him to go there or with the statement that on the whole it seems preferable for him to stay at home.[1]

In other words, if we are rational at all—which is here to say, if (1) we have reasons for our actions, if (2) we compare values and weigh our alternatives, and if (3) we choose to do the "best" thing in the light of these considerations—then we are all mathematicians at heart. And this is why any critical discussion of rationality is apt to bring out either the tools of mathematics, which *is* rationality examined to the *n*th degree, or of philosophico-legal reasoning, which is ordinary language driven to the limits of its capacity for precise expression and logical argumentation.

More problematic to some readers will be the attempt to extend Shannon and Weaver's simple formalism to biological phenomena and, later, to economic and psychological ones, phenomena whose true complexity beggars attempts at formalization a hundred times more sophisticated mathematically and computationally than the ones proposed here. Indeed, throughout this book, elementary mathematical models of "satisfaction," "value," "exchange," "price," and so on are proposed knowing full well, on the one hand, that the precision implied cannot be matched by acts of objective measurement, and, on the other, that they are all radical generalizations, mere formalizations of intuitions...in a word, all *models* of extremely complex and connected phenomena, and moreover models that, for all their simplicity, may *still* not be the ones used by ordinary people, consciously or otherwise.

My use of mathematics, therefore, should be seen as an attempt to complement and enlarge what can be argued—what *I* can argue—in words, and not as the donning of a lab-coat in the pretense of an accomplished science. Mathematics is the language of quantity and relation. In Mathematics one can compare quantities with "ratios" and "differences;" one can describe quantities which are definite or uncertain, sensitive or insensitive to each other and/or the passage of time. In Mathematics there are twenty ways of "summing things up" and combining them, twenty ways of changing parameters which verbal exposition might overlook in its need, always, to make narrative sense. But perhaps most important, the language of Mathematics offers a way to keep track of the (claimed) connections between things which are themselves the result or embodiment of dynamic relationships between yet further "things" which can be quantified, this in relatively long chains and trees and nested structures. Employing only ordinary language one would soon lose track of these links or fall into vague metaphor. (As has just happened.)[2]

From a mathematicians point of view, the mathematics in this book is elementary. Any reader with who has completed perhaps one course of college level algebra and hasn't practiced much since, with a little patience ought to have no difficulty following the equations in this book. I use no calculus, just graphs and sums and logarithms. I try move into and out of narrative mode, sketching out what I see as the implications buried, as it were, in simple equations. Mathematical form is *inspirational* in this way: to cast an idea into even simple mathematical form is to become duty-bound to test it out, to "take it for a walk" by tracking the behavior and effect of every variable one has claimed ought to be there. It is also to become acutely aware of what is omitted: complexities which, drifting like shadows in the back of one's mind—like *knowing better*—only metaphor can fetch and bring to the table.

Notes:

[1] J. J. C. Smart "An Outline of a System of Utilitarian Ethics" in J. J. C. Smart and Bernard Williams, *Utilitarianism: For and Against* (U.K., Cambridge University Press, (1963) 1993), pp. 39, 40.

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[2] It is no wonder that economists frequently use mathematics to express and keep track or their assertions, this quite apart from any hope they might have of fitting empirical data to their equations or vice versa. Of all the social sciences, economics has gone furthest with this particular mania and have suffered the consequences: derision from both sides, i.e., from the physical sciences for the lack of experimental control and functional specificity, and from the humanities for the threadbare picture that economics promotes of human Being—of *homo economicus*, rational economic man—as well as for its reluctance to allow "value" to have any ethical weight beyond money price. For a critique along these lines that is at once both kind and devastating to economics, see Donald N. McCloskey, *The Rhetoric of Economics* (The University of Wisconsin Press, 1985).
