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The Purpose of Mathematical Models Is Insight, Not Numbers

by Andrew Vazsonyi, Feature Editor

Apparently, the columns on the use of math in decision sciences pushed the right button; I received a great many responses. The latest was from a friend of mine, Dick.

Dick has a 14-year-old daughter. "I would like her to go into management," he says. "Jean is not a people-people person, so what do you think she should do?"

"How does she like numbers?" I ask. "Pretty good."

"She should go into the quantitative end," I say. "And she should be exposed to the required math."

"I want to be sure she understands why math is used, what math is required, and how to prepare herself," he says.

"I'll see what's available," I say.

First I check in the bookstore on the SAT math exam. I do not find the experience very helpful. I check all the math books in the bookstore—dozens of them—but they do not look relevant. I check the public library, and still cannot find anything suitable. However, looking through math college texts I find an interesting looking text: *For All Practical Purposes, Introduction to Contemporary Mathematics*. This text is used in over 500 colleges, and Part I covers management sciences in 169 pages. It opens with a three-page case study: the launching of Apollo II, and sets the stage for an engineering and production view of management science. There are four chapters on management science:

- **Chapter 1:** Street networks
- **Chapter 2:** Visiting vertices
- **Chapter 3:** Planning and scheduling
- **Chapter 4:** Linear programming

We learn that "projects are not the only area where organization and efficiency are valuable. . . . [P]roduction problems offer great opportunities for cost savings using management science." "The underlying

theme of management science, also called operations research, is finding the best method for solving some problems—what mathematicians call the optimal solution." It also appears that "management science cannot deal with chance and uncertainty."

This is hardly the way to make students interested in taking management science. But how do we prepare material to advocate management science? There is a method I learned from von Neumann.

von Neumann's Bridge

In 1938 my girlfriend and I were having yogurt outdoors with von Neumann at the Hangli coffee house in Budapest, on the banks of the Danube. I had a problem with an equation in the theory of games. I thought I might as well go to the fountainhead and asked Professor von Neumann for an explanation.

He said, "Tell me what you know; I will build a bridge to what you need to know."

Emulating von Neumann, I suggest that we build bridges to the students who learned math in high school, and have only a vague—often negative—outlook on management. We must start with case studies that mean something to the student like: how to manage your health, your retirement plan, the criminal justice system, which HMO to join.

I suggest we introduce math models with the example of the Pythagoras theorem of the right angle triangle: $a^2 + b^2 = c^2$. Many of my students think that if they draw a right angle triangle, and measure the length of the sides, the results will agree with the theorem. They fail to know that the equation relates to an idealized triangle, and not to the carbon particles deposited on the paper. They also fail to know that the theorem is descriptive of the idealized triangle. To make it useful we must solve the equation and get prescrip-

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tive statements on how to do the calculations. When students write a spreadsheet program, they write a sequence of prescrip-

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tive statements, a sequence of mathematical formulas, a mathematical procedure.

Usually we teach how to solve the equation for the hypotenuse. It is less publicized how the ancient Egyptians used the theorem. The yearly flooding of the Nile posed a problem: how to survey the land again and again. To work the problem they used a long, circular rope with twelve knots equally placed. They tightened the rope by holding the first, fourth and eighth knot.

They got a right angle at the fourth knot, a basic need for surveying.

The crux of the matter, as von Neumann points out, is the peculiar relationship of math to the real world. Mathematical models hold in a world of make believe, and not in the real world. Notwithstanding, mathematics is useful when dealing with the real world. Mathematics aids in calculating and gives insight to real situations, but it does not replace thought. It is a means to the end of better cognition.

In the exact sciences the distinction between descriptive and prescriptive math has always been clear. Exact sciences use such fields of knowledge as applied mathematics and numerical analysis. The title of my column is a modification of the saying by R. W. Hamming, author of the classical text, *Numerical Methods for Scientists and Engineers*: "The purpose of computing is insight not number." The fact is that the role of numerical analysis in exact sciences

is similar to the role of mathematical models in management sciences.

Our pundits have been preaching for years that the purpose of math models is to gain understanding, generate further discussions and provide a creative language to solve managerial situations. Unfortunately, these terms are vague. We need to sharpen our statement.

Cognitive scientists stress that we make our decisions on the basis of the mental models we have. First we collect information, then we build our mental model. We manage this model and come to decisions. Math helps to build our mental models, and the computer removes the onus of making tedious calculations by hand.

Call to Arms

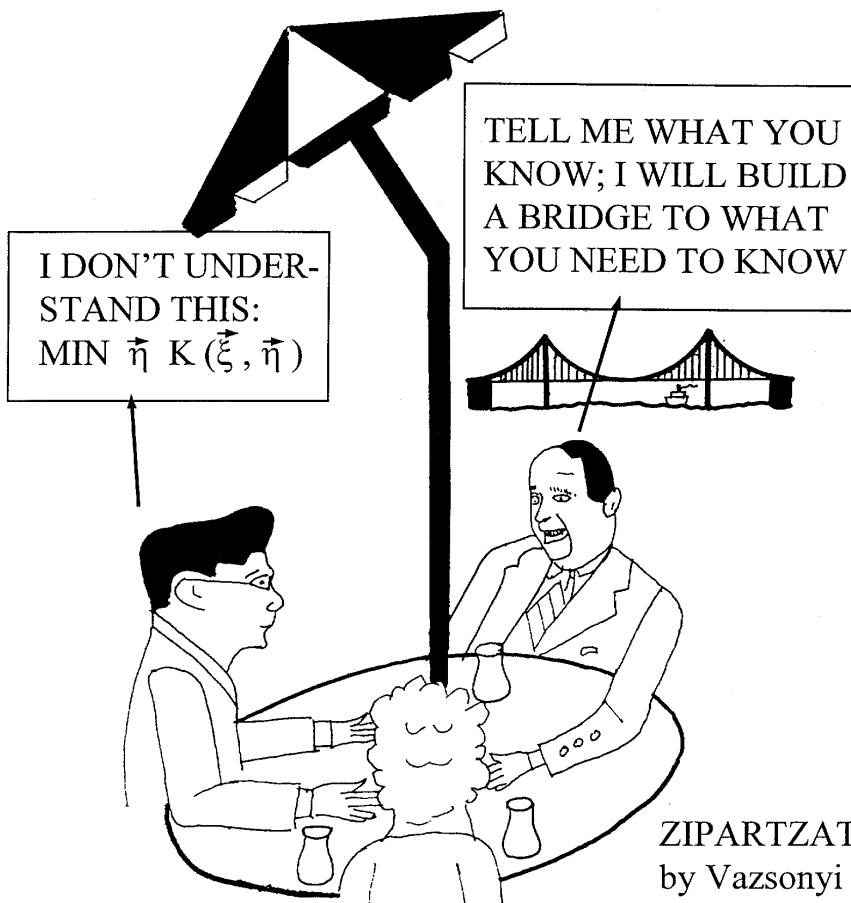
We cannot wait until our students come with the right "background" for math; we must take a proactive attitude and include in our approach the math upgrade of our students. We must create material on Meta Management Science.

The key to success will be to build von Neumann bridges from what the student knows, or is familiar with, to what the student needs to know. Using high school math skills, the knowledge obtained in the functional areas of business (such as mathematical formulas), a bridge can be built to mathematical models, and discussion of how the models are used for benefit. Spreadsheets banish number crunching, and in fact promote the design and interpretation of math models.

We need to write and promote Meta Management Science publications for present and future managers. We need to convince publishers that the publication of such works is necessary and profitable. We need to place articles in journals and magazines read not by only management scientists, but by people who can benefit from management sciences. But first, and most of all, we must convince ourselves and our bosses that creating and publishing such articles and books is a proper endeavor for us. ■

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The von Neumann Bridge



ZIPARTZAT
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