Sam Savage

Sam Savage is a Consulting Professor at Stanford University for the Management Science & Engineering Department.
He has also been a Visiting Professor at Northwestern University's Kellogg School and the Naval Postgraduate School in Monterrey.
Dr. Savage is founder and president of AnalyCorp Inc.

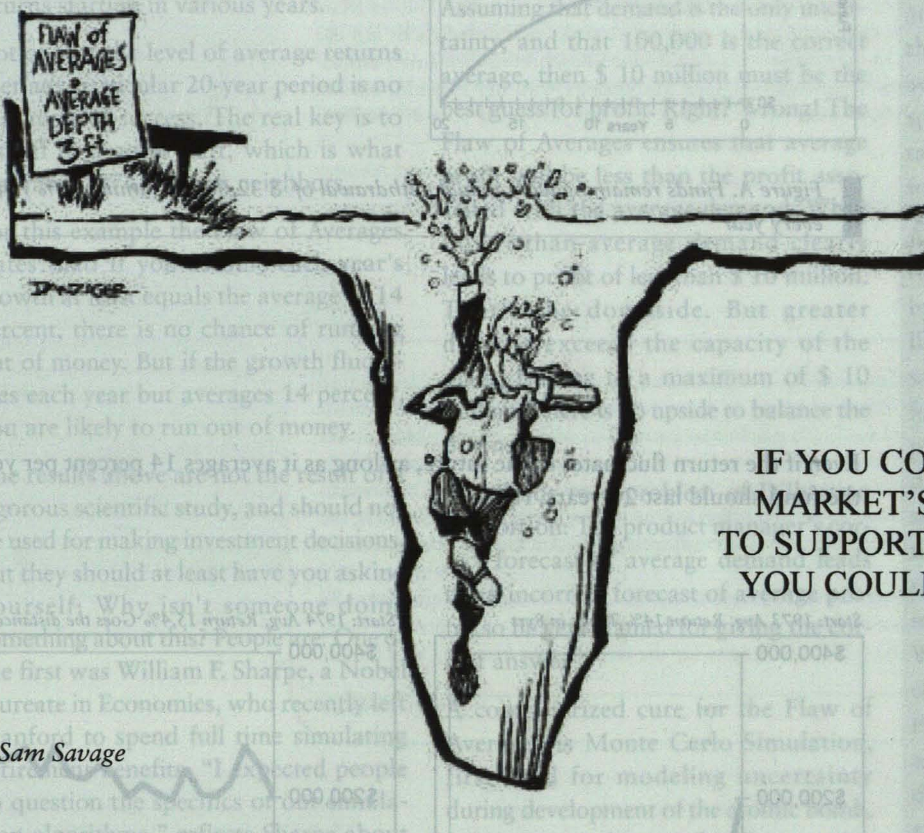
Management Science oder die Renaissance der quantitativen Planungsmethoden

Mit dem Siegeszug der Personal Computer hielt auch die computerunterstützte Tabellenkalkulation Einzug in der Geschäftswelt. Listen, Kostenaufstellungen, Bilanzen und Geschäftspläne werden damit abgebildet – in großen wie in kleinen Unternehmen. Moderne Tabellenkalkulationsprogramme sind zudem mit mächtigen Analyse- und Berechnungsfunktionen ausgestattet, sind programmierbar und haben Schnittstellen zu anderen Programmen und Datenbanken. Durch die Möglichkeit, darin auch verschiedene Szenarien abzubilden, sie Daten-getrieben zu variieren oder gar zu optimieren, eröffnen sich neue Anwendungsgebiete für die Planungsaufgaben: Quantitative Verfahren als strategische Waffe für operative als auch für strategische Planungsaufgaben. Damit sind quantitative Planungsmethoden nicht mehr nur auf die Sachbearbeiterebene beschränkt, sondern werden heute auch immer mehr von Managern eingesetzt. Aus deren steigendem Interesse an einschlägigen Seminaren und Workshops möchte man auf eine starke Renaissance und steigende Bedeutung dieser Management-Science-Methoden in Verbindung mit Tabellenkalkulationsprogrammen schließen.
In diesem Zusammenhang ist es uns eine besondere Freude, im Anschluss einen Artikel von Prof. Sam Savage, dem Pionier der analytischen Modellierung in Tabellenkalkulationsprogrammen (Spreadsheets), mit dessen freundlicher Genehmigung abdrucken zu dürfen (erschienen in den San Jose Mercury News).

Viel Vergnügen beim Lesen,

Siegfried Vössner
Vorstand des Instituts für Maschinenbau- und Betriebsinformatik an der TU Graz

The Flaw of Averages



IF YOU COUNT ON THE STOCK MARKET'S AVERAGE RETURN TO SUPPORT YOU IN RETIREMENT, YOU COULD WIND UP PENNILES

by Sam Savage

The only certain is that nothing is certain." So said the Roman scholar Pliny the Elder. And some 2000 years later, it's a safe bet he would still be right. The Information Age, despite its promise, also delivers a dizzying array of technological, economic and political uncertainties. This often results in an error I call the Flaw of Averages, a fallacy as fundamental as the belief that the earth is flat.

The Flaw of Averages states that: Plans based on the assumption that average conditions will occur are usually wrong.

A humorous example involves the statistician who drowned while fording a river that was, on average, only three feet deep.

But in real life, the flaw continually gums up investment management, production planning and other seemingly well-laid plans. The Flaw of Averages is one of the cornerstones of Murphy's Law (What can go wrong does go wrong).

Fortunately, superfast computers can overcome this problem by bombarding our plans with a whole range of inputs instead of single average values. Today, this technique, known as simulation, is at the center of such diverse activities as Wall Street investing and military defense planning.

But back to the flaw, and an area that's important to all of us: investing for the future.

Suppose you want your $ 200,000 retirement fund invested in the Standard & Poor's 500 index to last 20 years. How much can you withdraw per year? The return of the S&P has varied over the years but has averaged about 14 percent per year since its inception in 1952. You use an annuity workbook in your spreadsheet that requires an initial amount ($ 200,000) and a growth rate for the fund. "I need a number", you say to yourself, so you plug in 14 percent. Now you can play with the annual withdrawal amount until your money lasts exactly 20 years. If you do this you will be pleased to find that you can withdraw $ 32,000 per year (see Figure A).

Impressum

Medieninhaber (Verleger):
Österreichischer Verband der Wirtschaftsingenieure

WING-Sekretariat:
Kopernikusgasse 24/3, 8010 Graz,
Tel. (0316) 873-7795
WING-Homepage: www.wing-online.at

Redaktion:
Mag. (FH) Ursula Zmölnig
Mobil: 0676/7294653
e-mail: ursula.zmoelnig@chello.at

Schriftleiter:
Univ.-Prof. Dipl.-Ing. Dr. techn. Ulrich Bauer
e-mail: ulrich.bauer@tugraz.at

Redaktionsteam:
Chefin vom Dienst & Marketingleiterin:
Mag. (FH) Ursula Zmölnig
Redakteure:
Dipl.-Ing. Andreas Drumel,
drumel@iwb.tu-graz.ac.at
Dipl.-Ing. Dr. Stefan Grünwald,
stefan.gruenwald@tugraz.at
Dipl.-Ing. Dr. Börge Kummert,
boerge.kummert@tugraz.at
Dipl.-Ing. Georg Rummer,
rummer@tugraz.at
Dipl.-Ing Gerald Lichtenegger,
gerald.lichtenegger@tugraz.at
Dipl.-Ing. Roland Winkler,
roland.winkler@tugraz.at
Thomas Eichner,
eichner@sbox.tugraz.at

Anzeigenkontakt:
Mag. (FH) Ursula Zmölnig
e-mail: ursula.zmoelnig@chello.at
Mobil: 0676/72 94 653

Anzeigenleitung:
P2 Marketing
Mag. (FH) Ursula Zmölnig
St. Peter Hauptstraße 119/1, 8042 Graz
Tel.: +43/676/72 94 653, Fax: 0316/46 61 80
e-mail: ursula.zmoelnig@chello.at
www.p2marketing.at

Satz, Layout, Druck:
Styria Printshop Druck GmbH
Am Hartboden 33, 8101 Gratkorn
Tel. (03124) 290 90, ISDN: DW 44
Fax (03124) 290 90-30
e-mail: printshop@styria.com

Auflage: 3.000 Stk.

Erscheinungsweise:
4x jährlich, jeweils April, Juli, Oktober sowie Dezember.

Nachdruck oder Textauszug nach Rücksprache mit der Schriftleitung des „WING business".

Erscheint in wissenschaftlicher Zusammenarbeit mit den einschlägigen Instituten an den Universitäten und Fachhochschulen Österreichs. Wirtschaftsingenieure sind wirtschaftswissenschaftlich gebildete Diplomingenieure mit Studienabschluss an einer Technischen Universität, an einer technischen Fakultät einer Universität oder einer technischen Fachhochschule.
ISSN 0256-7830

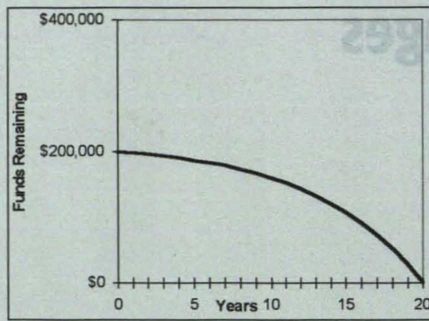


Figure A. Funds remaining with annual withdrawal of $ 32,000, assuming 14% return every year

Even if the return fluctuates in the future, as long as it averages 14 percent per year, the fund should last 20 years, right?

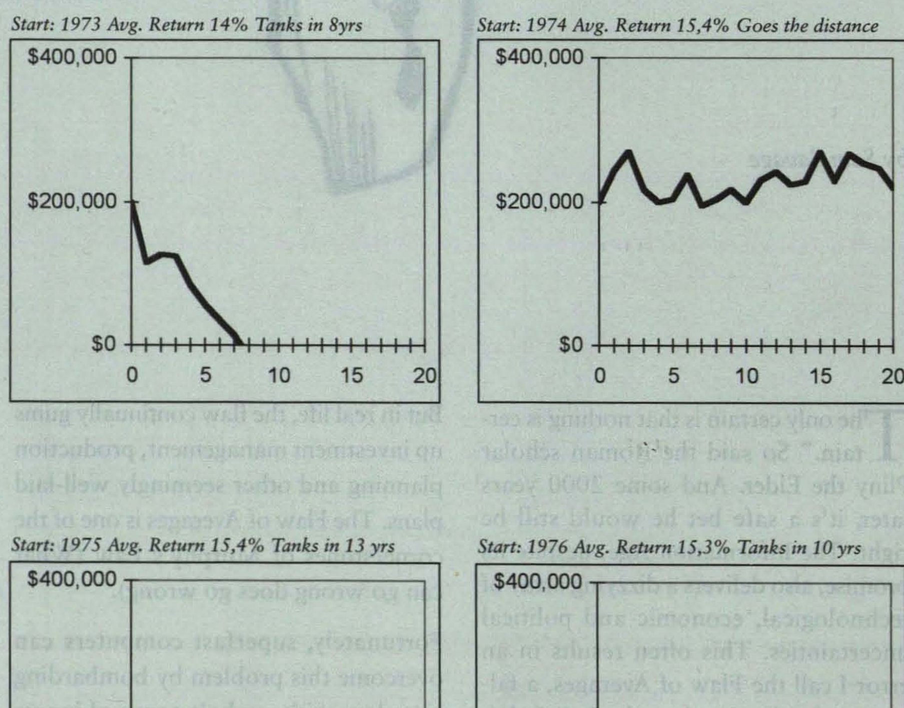


Figure B. Simulated Fund performance if started in various years.

Wrong! Given typical levels of stock market volatility there are only slim odds that the fund will survive the full time. The following charts simulate this retirement strategy with actual S&P 500 returns starting in various years.

Notice that the level of average returns over any particular 20-year period is no guarantee of success. The real key is to get off to a good start, which is what separates 1974 from its neighbors.

For this example the Flaw of Averages states that: If you assume each year's growth at least equals the average of 14 percent, there is no chance of running out of money. But if the growth fluctuates each year but averages 14 percent, you are likely to run out of money.

The results above are not the result of a rigorous scientific study, and should not be used for making investment decisions, but they should at least have you asking yourself: Why isn't someone doing something about this? People are. One of the first was William F. Sharpe, a Nobel laureate in Economics, who recently left Stanford to spend full time simulating retirement benefits. "I expected people to question the specifics of our simulation algorithms," reflects Sharpe about the launch of Palo Alto-based Financial Engines Inc., "but to my surprise, everyone else out there was just plugging in averages." (As in Figure A)

The Flaw of Averages distorts everyday decisions in many other areas. Consider the hypothetical case of a Silicon Valley product manager who has just been asked by his boss to forecast demand for a new-generation microchip.

"That's difficult for a new product," responds the product manager, "but I'm confident annual demand will be between 50,000 and 150,000 units."

"Give me a number to take to my production people," barks the boss. "I can't tell them to build a facility with a capacity of between 50,000 and 150,000 units!"

So the product manager dutifully replies: "If you need a single number, the average is 100,000."

The boss plugs the average demand and the cost of a 100k capacity fab into a spreadsheet. The bottom line is a healthy $ 10 million, which he reports to his board as the average profit to expect. Assuming that demand is the only uncertainty, and that 100,000 is the correct average, then $ 10 million must be the best guess for profit. Right? Wrong! The Flaw of Averages ensures that average profit will be less than the profit associated with the average demand. Why? Lower-than-average demand clearly leads to profit of less than $ 10 million. That's the downside. But greater demand exceeds the capacity of the plant, leading to a maximum of $ 10 million. There is no upside to balance the downside.

This leads to a problem of Dilbertian proportion: The product manager's correct forecast of average demand leads to an incorrect forecast of average profit, so he gets blamed for giving the correct answer.

A computerized cure for the Flaw of Averages is Monte Carlo Simulation, first used for modeling uncertainty during development of the atomic bomb. It generates thousands of scenarios covering all conceivable real world contingencies in proportion to their likelihood.

In the 1950s, Harry Markowitz, a brash young graduate student at the University of Chicago, dealt another blow to the flaw. "I was reading the contemporary investment theory, which was strictly based on averages," recalls Markowitz. "I said to myself: 'this can't be right.' " His resulting portfolio theory, which was based on both risk and average outcomes, revolutionized Wall Street and won him a Nobel Prize. Markowitz also devoted much of his career to designing simulation systems.

Simulation-based acquisition is now used routinely in the military. Its instigator was William J. Perry, who in spite of a bachelor's degree, master's degree and doctorate in math, has had a remarkably well-rounded career as a Silicon Valley entrepreneur, U.S. Secretary of Defense and Stanford professor.

In 1996, while at the Pentagon, Perry issued a directive stating that models and simulations must be used to reduce the time, resources and risks of the acquisition process. Perry says in retrospect: "With tens of thousands of uncertainties, it was just a perfect application for simulation."

A dramatic example of the savings that resulted from Perry's directive is related by John D. Illgen of Santa Barbara-based Illgen Simulation Technologies Inc., who says: "In response to improvements in foreign weapon systems, the Navy was preparing to spend tens of millions of dollars to upgrade its shipboard defensive systems. With a $250,000 simulation we were able to show that the present defensive system was adequate to meet the increased threat."

While many of today's managers still cling tenaciously to "flat earth" ideals, the innovators are abandoning averages and facing up to uncertainty. Those who dare discover a New World of managerial tools including simulation, decision trees, portfolio theory and real options.

And what happens when one of these innovators is confronted by someone cloaking themselves behind a single number? The story of the emperor's new clothes says it all.