

# **Multiple Criteria Decision Making: Early Developments**

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Middle East Technical University

"Our ability to analyze and resolve complex decision problems is one of the most important developments of the last half of the 20th century. But, like all such endeavors, advances were often based on earlier ideas from a multitude of fields, ideas that encouraged and gave impetus to new generations of researchers. All readers of *Multiple Criteria Decision Making: From Early History to the 21st Century* will find that the authors have woven the early and modern histories of MCDM into a scientific adventure story, one that helps us to understand better how advances in a field of research are the result of many, many seemingly unrelated activities."

Saul I. Gass  
Professor Emeritus

Department of Decision, Operations and Information Technologies  
Robert H. Smith School of Business, University of Maryland, College Park

"Rarely do we get to understand the evolution of a scientific field told with such care and understanding. And a handy guide to the MCDM literature as well. I'll have all of my students read it!"

Mark H. Karwan

Praxair Professor in Operations Research, SUNY Distinguished Teaching Professor  
Industrial and Systems Engineering at the University at Buffalo (SUNY)

"I really enjoyed reading this book. It was written by three experts who have lived with MCDM and its history for a long time (two of them for over 40 years). Now our community has a useful and valuable book that can be used by students and researchers to learn about MCDM and its history. I particularly like the photos which bring the history and its people to life."

Pekka Korhonen

Professor of Statistics  
Aalto University, School of Economics

"This book brings to life — contributors, contributions, activities — the evolution, growth, and future directions of MCDM, a multidiscipline that embraces all facets of decision making. Kudos to three highly distinguished MCDM scholars who have written a classic, which should be essential reading and serve as a resource for scholars in all academic and professional disciplines."

Herb Moskowitz

Purdue University Retired Professor

Multiple Criteria Decision Making (MCDM) is all about making choices in the presence of multiple conflicting criteria. MCDM has become one of the most important and fastest growing subfields of Operations Research/Management Science. As modern MCDM started to emerge about 50 years ago, it is now a good time to take stock of developments. This book aims to present an informal, nontechnical history of MCDM, supplemented with many pictures. It covers the major developments in MCDM, from early history until now. It also covers fascinating discoveries by Nobel Laureates and other prominent scholars.

The book begins with the early history of MCDM, which covers the roots of MCDM through the 1960s. It proceeds to give a decade-by-decade account of major developments in the field starting from the 1970s until now. Written in a simple and accessible manner, this book will be of interest to students, academics, and professionals in the field of decision sciences.



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Multiple Criteria Decision Making

Köksalan | Wallenius | Zions

# Multiple Criteria Decision Making

From Early History to the 21st Century

Murat Köksalan  
Jyrki Wallenius  
Stanley Zions



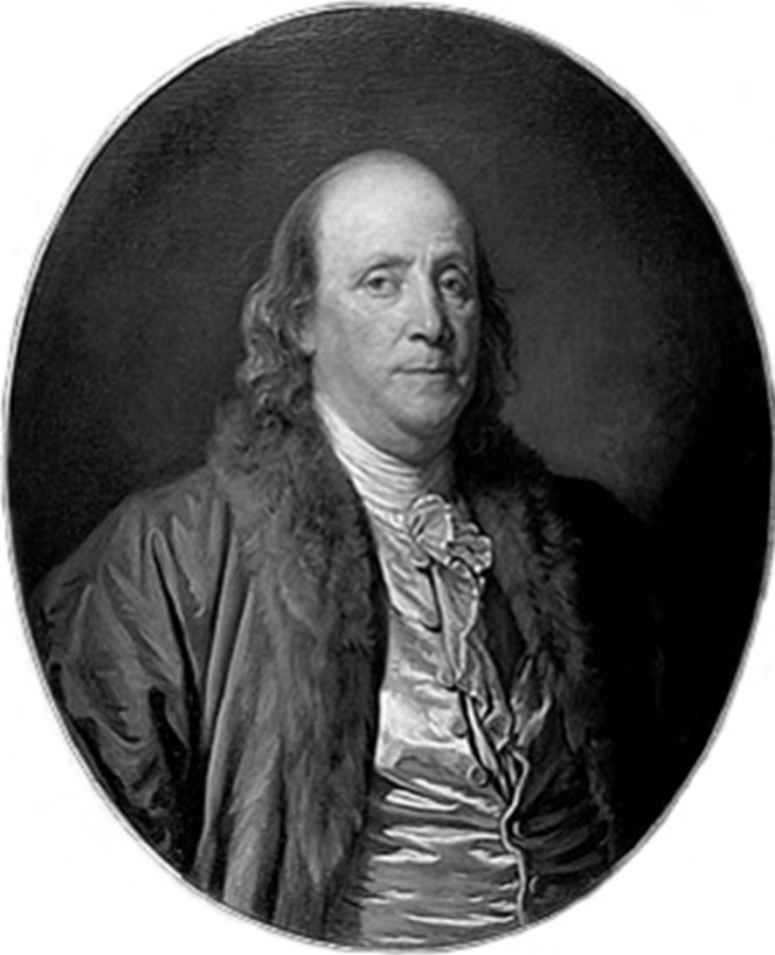
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# Preamble

- Decision Making is Ancient.
- Origins are Somewhat Obscure.
- Can Separately Trace Some Origins to:
  - Decision Analysis/Utility Theory
  - Multiple Objective Mathematical Programming.
- One of the first known recorded work on MCDM was done by Benjamin Franklin.



# Benjamin Franklin 1706-1790



- US Founding father, statesman, scientist, inventor, printer, ...
- In a letter (in 1776), gave advice to a friend (actually described an algorithm)

# Benjamin Franklin (1772)



PROS

X1

X2

X4

X3

X5

CONS

X5

X4

X3

X1

X2

X4



# Marquis de Condorcet 1743-1794



- Condorcet Paradox:  
Even if each individual  
is transitive, majority  
vote could be  
intransitive

# Vilfredo Pareto (1848-1923)



- French-Italian Economist
- 80-20 (Pareto) principle- 80% of the results come from 20% of the effort (or 20% own 80%)
- Advised Mussolini but turned down government seat offer
- Concept of Pareto optimality

# Francis Ysidro Edgeworth (1845-1926)



- Irish economist
- Developed indifference curves
- MCDM Society gives Edgeworth-Pareto award



# Georg Cantor (1845-1918)



- German mathematician
- Invented set theory, major contributions to number theory
- Laid the mathematical foundations of MCDM
- MCDM Society's G. Cantor awards

# Ragnar Frisch (1895-1973)



- Norwegian-Won the first Nobel in Econ. in 1969
- Ordinal, cardinal utility, 1926
- Eliciting utility function, 1961

# Frank P. Ramsey (1903–1930)



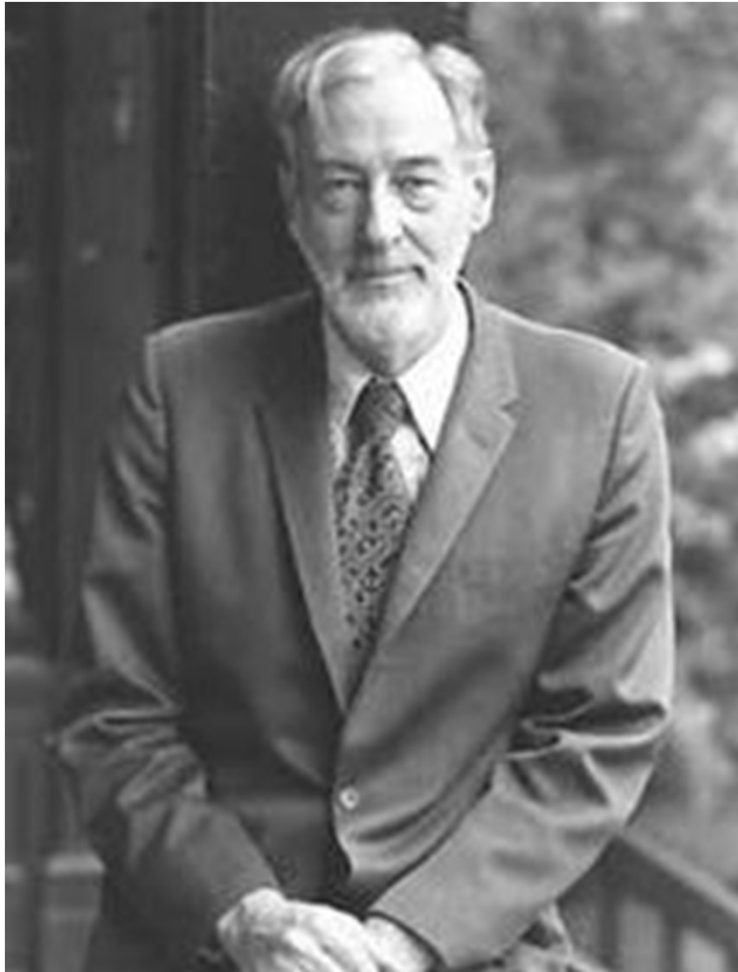
- British mathematician and philosopher
- Developed expected utility theory
- Published after his death in 1931
- Suffered from depression
- Died from liver disease

# John von Neumann (1903-1957)



- Hungarian-American
- One of the greatest mathematicians
- Developed the basis of utility theory
- “Theory of Games and Economic Behavior” with O. Morgenstern

# Tjalling C. Koopmans (1910-1985)



- Born in Netherlands
- Defined “efficient vector” in resource allocation
- Nobel laureate, 1975

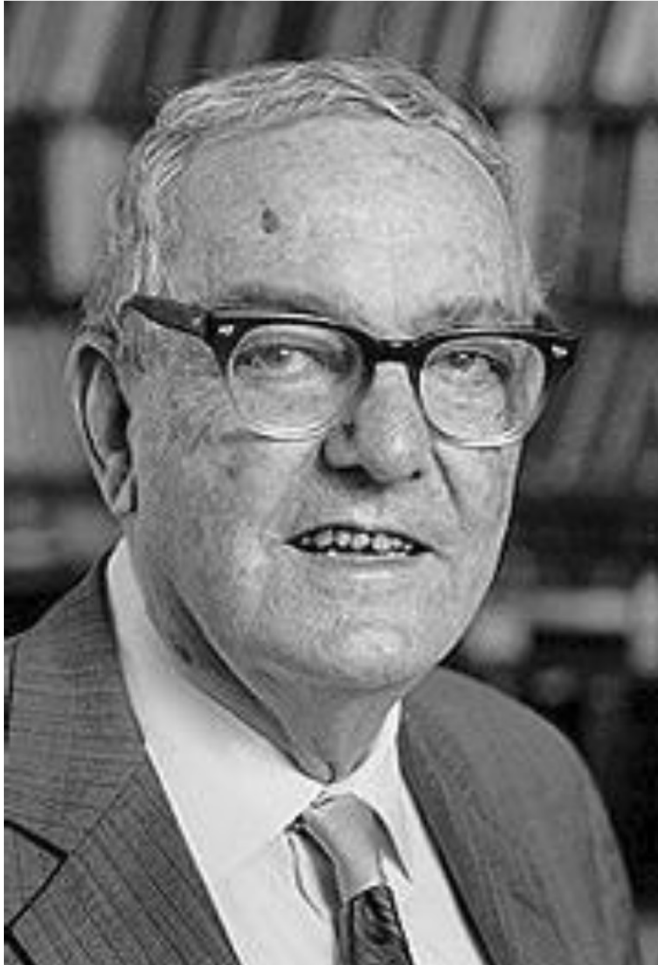
# Paul Samuelson (1915-2009)



- Revealed preference, 1938
- Nobel Prize in Econ, 1970
- Said: “Wall Street indexes predicted nine out of the last five recessions!”



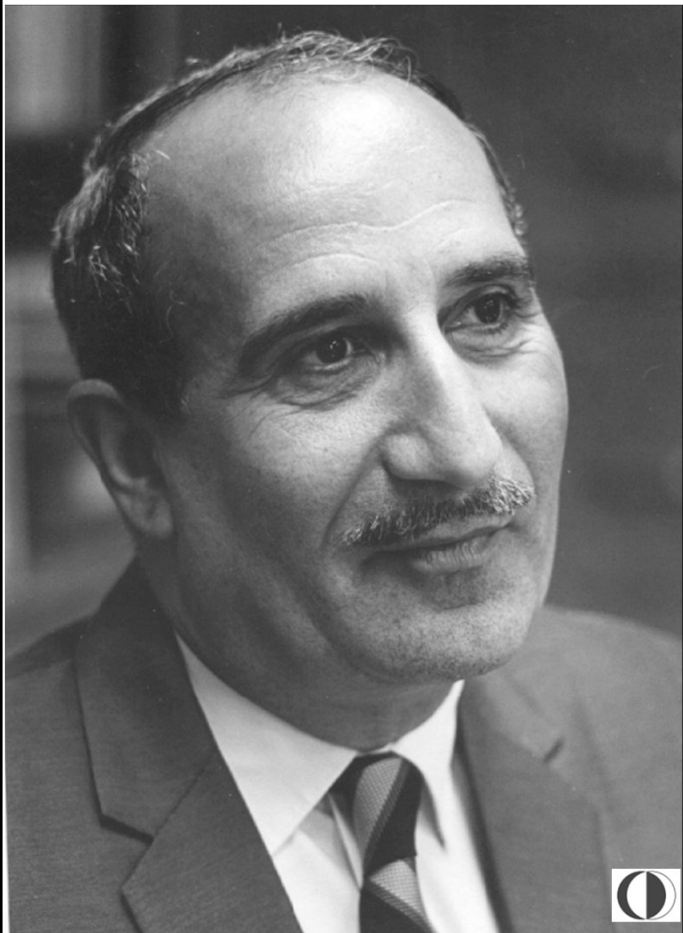
# Herbert A. Simon (1916-2001)



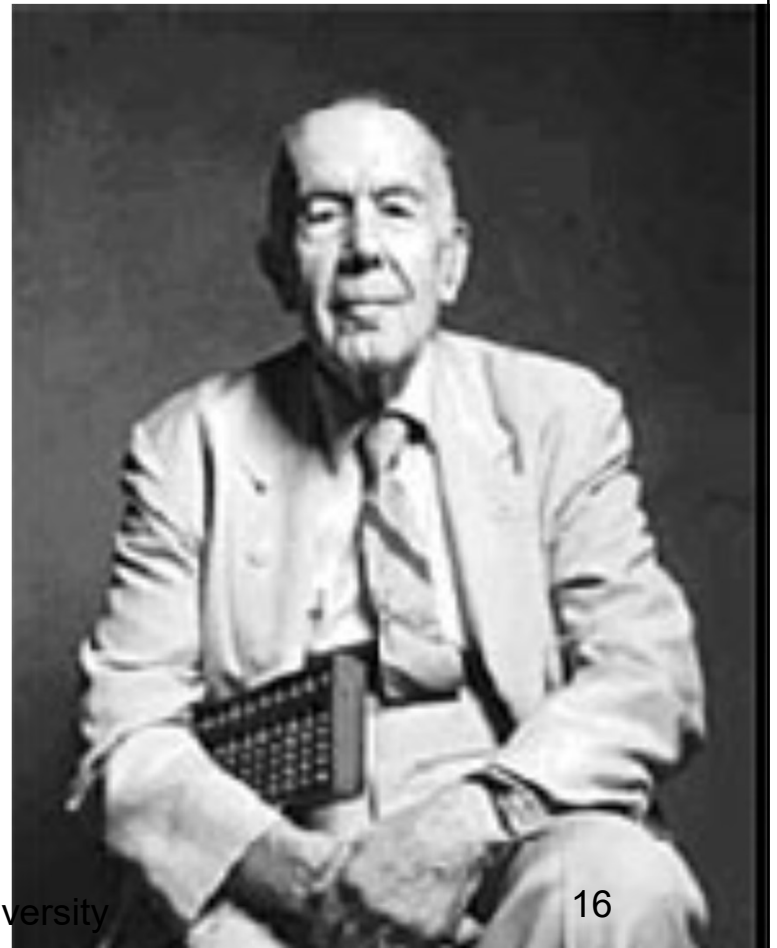
- Bounded rationality
- Satisficing
- Nobel laureate, 1978

# Charnes and Cooper

Abraham Charnes  
(1917-1992)



William W. Cooper  
(1914-2012)





# Charnes and Cooper

## ● Cooper

- Never completed high school
- Graduated from University of Chicago
- Did graduate work at Columbia University, but did not get a degree
- Got MCDM Gold Medal 2004

## ● Developed Goal Programming (1961), Data Envelopment Analysis (1978)



# Goal Programming

$$\text{Minimize } \sum_i w_i d_i^- + \sum_m w_m d_m^+ + \sum_k (w_k d_k^- + w'_k d_k^+)$$

$$f_j(x) + d_j^- - d_j^+ = g_j \quad j = 1, \dots, p$$

$$Ax \leq b$$

$$x \geq 0, d_i^-, d_i^+ \geq 0 \quad i = 1, \dots, p$$

where

$f_j$  : objective  $j$

$g_j$  : goal  $j$

$d_j^-$  and  $d_j^+$  : negative and positive deviations from goal  $j$



## **GP poem by Mihajlo Mesarovic (At 1963 conference at Case Inst. Of Tech.)**

Programming sticks upon the shoals  
Of incommensurate multiple goals,  
And where the tops are no one knows  
When all our peaks become plateaus  
The top is anything we think  
When measuring makes the mountain shrink.

The upshot is, we cannot tailor  
Policy by a single scalar,  
Unless we know the priceless price  
Of Honor, Justice, Pride, and Vice.  
This means a crisis is arising  
For simple-minded maximizing.



# Gerard Debreu (1921-2004)



- French-US economist, mathematician
- Major contributor to utility theory
- Nobel laureate (1983)



# Raiffa and Keeney

Howard Raiffa  
(1924-2016)



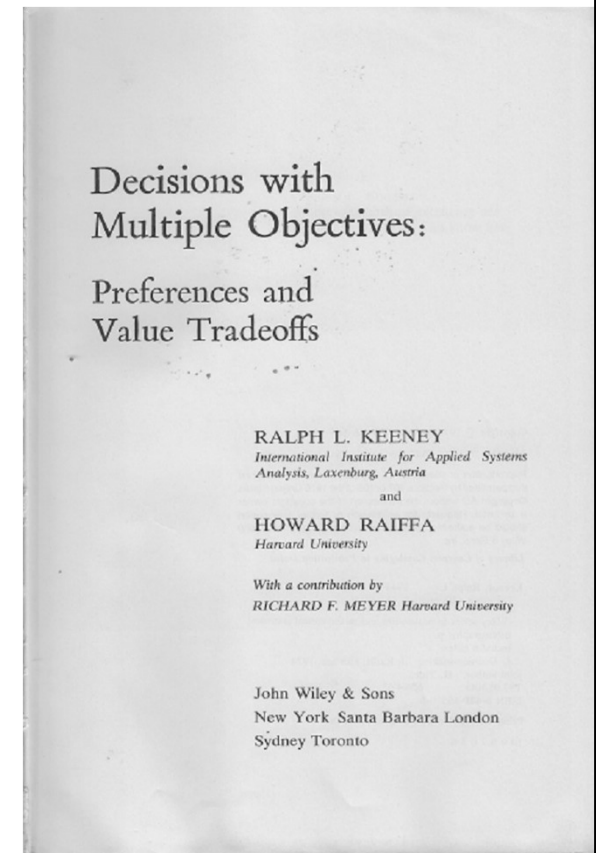
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Ralph Keeney  
(Born in 1944)

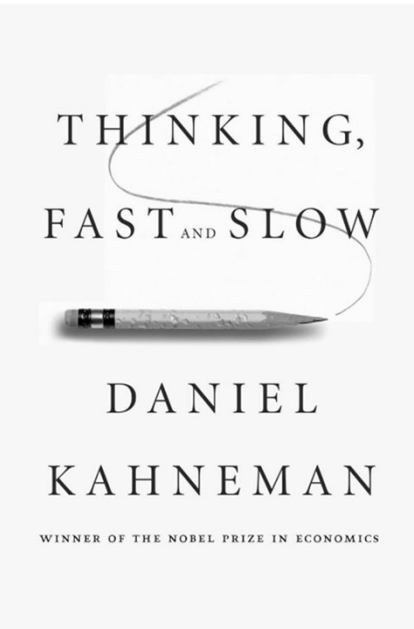
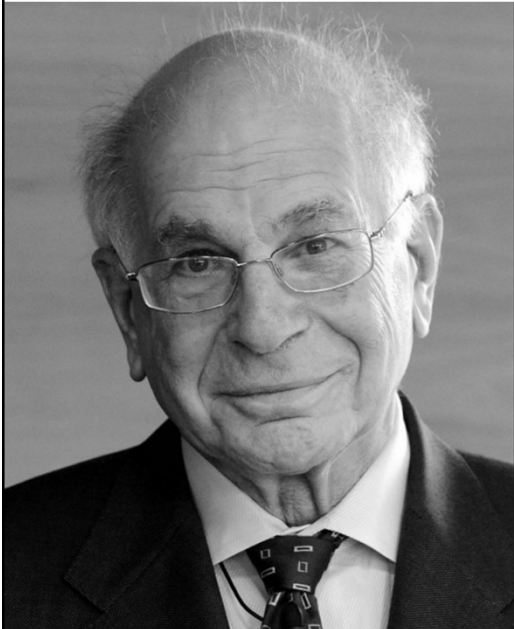


# Raiffa and Keeney

- Major contributors to Utility Theory
- Decisions with Multiple Objectives, 1976 (a classic book)
- MCDM Gold Medal 1998



# Daniel Kahneman (Born in 1934)



- Born in Tel Aviv
- Behavioral Decision Theory
- Collaborated extensively with Amos Tversky
- Nobel laureate, 2002



A. Tversky  
1937-1996



# Bernard Roy (1934-2017)



- Founder of “French school”
- Developed “Outranking relations”
- MCDM Gold Medal 1995



# Thomas Saaty (1926-2017)



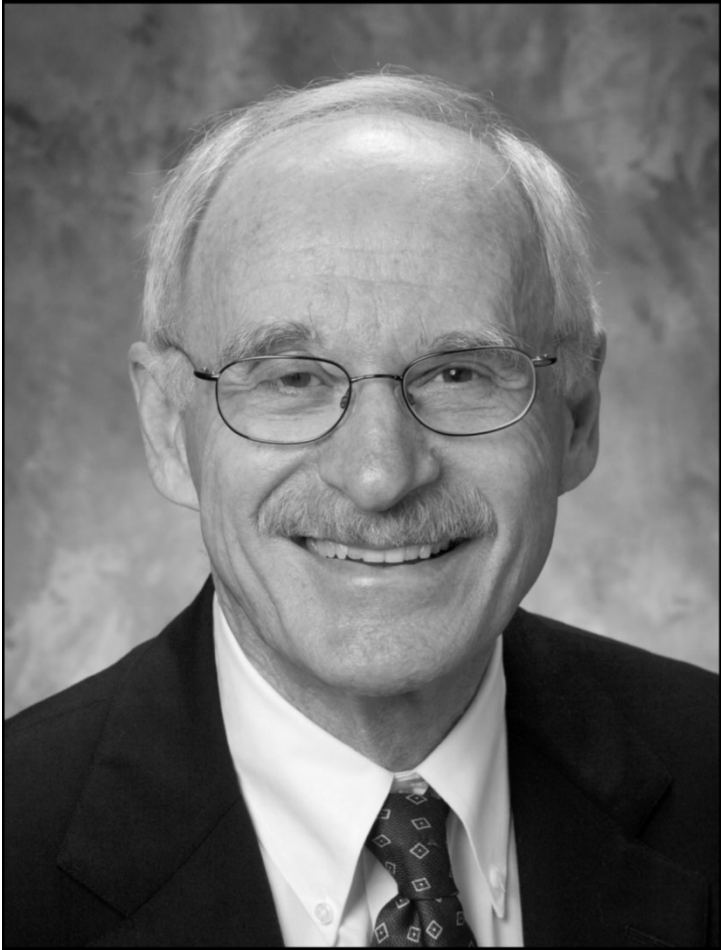
- Born in Mosul, Iraq
- A pioneer of OR; graph theory
- Developed AHP
- MCDM Gold Medal 2000

# Stanley Zionts (Born in 1937)

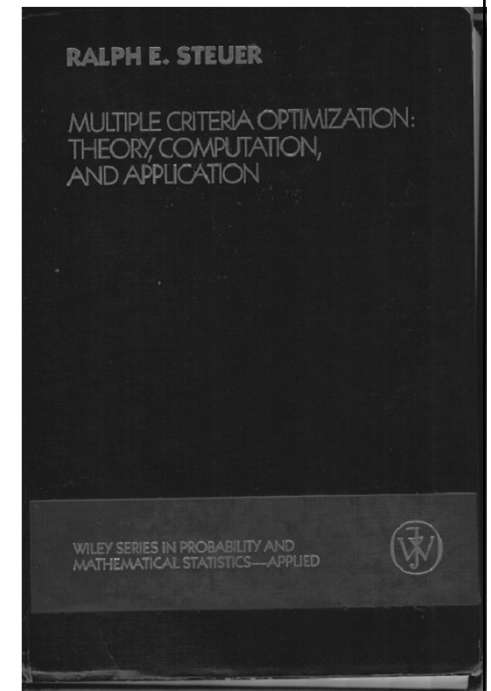


- Founded the MCDM Society and was the president for many years
- Organized the first MCDM conference in France
- Now a ski instructor
- MCDM Gold Medal 1992

# Ralph Steuer (Born in 1940)



- Multiple Criteria Optimization, 1986 - A classic book
- Past President, MCDM Society
- MCDM Gold Medal 1997



# Oleg Larichev (1934-2003)



- The Step method
- MCDM Gold Medal 1994
- Important contributions