

# Modeling Forum

## Results of the 1999 Mathematical Contest in Modeling

Frank Giordano, MCM Director

COMAP, Inc.

57 Bedford St., Suite 210

Lexington, MA 02420

f.giordano@mail.comap.com

### Introduction

A total of 479 teams of undergraduates, from 223 institutions in 9 countries, spent the first weekend in February working on applied mathematics problems. They were part of the 15th annual Mathematical Contest in Modeling (MCM). On Friday morning, the MCM faculty advisor opened a packet and presented each team of three students with a choice of one of two problems. After a weekend of hard work, typed solution papers were mailed to COMAP on Monday. Twelve of the top papers appear in this issue of *The UMAP Journal*.

A new feature this year was the inauguration of the Interdisciplinary Contest in Modeling (ICM), an extension of the MCM designed explicitly to stimulate participation by students from different disciplines and to develop and advance interdisciplinary problem-solving skills. The ICM featured a new kind of problem (Problem C) that in 1999 involved downloading and analyzing data and reflected a situation in which concepts from mathematics, chemistry, environmental science, and environmental engineering were useful. Each year's ICM announcement brochure advises which disciplines are likely to be helpful.

Results and winning papers from the first thirteen contests were published in special issues of *Mathematical Modeling* (1985–1987) and *The UMAP Journal* (1985–1998). The 1994 volume of *Tools for Teaching*, commemorating the tenth anniversary of the contest, contains the 20 problems used in the first ten years of the contest and a winning paper for each. Limited quantities of that volume and of the special MCM issues of the *Journal* for the last few years are available from COMAP.

---

*The UMAP Journal* 20 (3) (1999) 187–209. ©Copyright 1999 by COMAP, Inc. All rights reserved. Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice. Abstracting with credit is permitted, but copyrights for components of this work owned by others than COMAP must be honored. To copy otherwise, to republish, to post on servers, or to redistribute to lists requires prior permission from COMAP.

## Problem A: Deep Impact

For some time, the National Aeronautics and Space Administration (NASA) has been considering the consequences of a large asteroid impact on the earth.

As part of this effort, your team has been asked to consider the effects of such an impact were the asteroid to land in Antarctica. There are concerns that an impact there could have considerably different consequences than one striking elsewhere on the planet.

You are to assume that an asteroid is on the order of 1,000 m in diameter, and that it strikes the Antarctic continent directly at the South Pole.

Your team has been asked to provide an assessment of the impact of such an asteroid. In particular, NASA would like an estimate of the amount and location of likely human casualties from this impact, an estimate of the damage done to the food production regions in the oceans of the southern hemisphere, and an estimate of possible coastal flooding caused by large-scale melting of the Antarctic polar ice sheet.

## Problem B: Unlawful Assembly

Nany facilities for public gatherings have signs that state that it is “unlawful” for their rooms to be occupied by more than a specified number of people. Presumably, this number is based on the speed with which people in the room could be evacuated from the room’s exits in case of an emergency. Similarly, elevators and other facilities often have “maximum capacities” posted.

Develop a mathematical model for deciding what number to post on such a sign as being the “lawful capacity.” As part of your solution, discuss criteria—other than public safety in the case of a fire or other emergency—that might govern the number of people considered “unlawful” to occupy the room (or space). Also, for the model that you construct, consider the differences between a room with movable furniture such as a cafeteria (with tables and chairs), a gymnasium, a public swimming pool, and a lecture hall with a pattern of rows and aisles. You may wish to compare and contrast what might be done for a variety of different environments: elevator, lecture hall, swimming pool, cafeteria, or gymnasium. Gatherings such as rock concerts and soccer tournaments may present special conditions.

Apply your model to one or more public facilities at your institution (or neighboring town). Compare your results with the stated capacity, if one is posted. If used, your model is likely to be challenged by parties with interests in increasing the capacity. Write an article for the local newspaper defending your analysis.

## Problem C: Ground Pollution

### Background

Several practically important but theoretically difficult mathematical problems pertain to the assessment of pollution. One such problem consists in deriving accurate estimates of the location and amount of pollutants seeping inaccessibly underground, and the location of their source, on the basis of very few measurements taken only around, but not necessarily directly in, the suspected polluted region.

### Example

The data set (an Excel file at <http://www.comap.com/mcm/procdata.xls>, downloadable into most spreadsheets) shows measurements of pollutants in underground water from 10 monitoring wells (MW) from 1990 to 1997. The units are micrograms per liter ( $\mu\text{g}/\text{l}$ ). The location and elevation for eight wells are known and given in **Table 1**. The first two numbers are the coordinates of the location of the well on a Cartesian grid on a map. The third number is the altitude in feet above Mean Sea Level of the water level in the well.

**Table 1.**  
Locations for eight wells in Problem C.

Well Number	$x$ -Coordinate (ft)	$y$ -Coordinate (ft)	Elevation (ft)
MW-1	4187.5	6375.0	1482.23
MW-3	9062.5	4375.0	1387.92
MW-7	7625.0	5812.5	1400.19
MW-9	9125.0	4000.0	1384.53
MW-11	9062.5	5187.5	1394.26
MW-12	9062.5	4562.5	1388.94
MW-13	9062.5	5000.0	1394.25
MW-14	4750.0	2562.5	1412.00

The locations and elevations of the other two wells in the data set (MW-27 and MW-33) are not known. In the data set, you will also see the letter T, M, or B after the well number, indicating that the measurements were taken at the Top, Middle, or Bottom of the aquifer in the well. Thus, MW-7B and MW-7M are from the same well, but from the bottom and from the middle. Also, other measurements indicate that water tends to flow toward well MW-9 in this area.

### Problem One

Build a mathematical model to determine whether any new pollution has begun during this time period in the area represented by the data set. If so, identify the new pollutants and estimate the location and time of their source.

## Problem Two

Before the collection of any data, the question arises whether the intended type of data and model can yield the desired assessment of the location and amount of pollutants. Liquid chemicals may have leaked from one of the storage tanks among many similar tanks in a storage facility built over a homogeneous soil. Because probing under the many large tanks would be prohibitively expensive and dangerous, measuring only near the periphery of the storage facility or on the surface of the terrain seems preferable. Determine what type and number of measurements, taken only outside the boundary or on the surface of the entire storage facility, can be used in a mathematical model to determine whether a leak has occurred, when it occurred, where (from which tank) it occurred, and how much liquid has leaked.

## The Results

The solution papers were coded at COMAP headquarters so that names and affiliations of the authors would be unknown to the judges. Each paper was then read preliminarily by two "triage" judges at Southern Connecticut State University (Problem A), Carroll College (Montana) (Problem B), or University of New Hampshire (Problem C). At the triage stage, the summary and overall organization were important for judging a paper. If the judges' scores diverged for a paper, the judges conferred; if they still did not agree on a score, a third judge evaluated the paper.

Final judging took place at Harvey Mudd College, Claremont, California. The judges classified the papers as follows:

	Outstanding	Meritorious	Honorable Mention	Successful Participation	Total
Asteroid Impact	5	34	61	112	212
Lawful Capacity	5	39	72	91	207
Ground Pollution	<u>2</u>	<u>9</u>	<u>17</u>	<u>32</u>	<u>60</u>
	12	82	150	235	479

The twelve papers that the judges designated as Outstanding appear in this special issue of *The UMAP Journal*, together with commentaries. We list those teams and the Meritorious teams (and advisors) below; the list of all participating schools, advisors, and results is in the **Appendix**.

## Outstanding Teams

Institution and Advisor	Team Members
-------------------------	--------------

### Asteroid Impact Papers

<p>“Deep Impact” Harvey Mudd College Claremont, CA Michael Moody</p>	<p>Dominic Mazzone Matthew Fluet Joel Miller</p>
<p>“Asteroid Impact at the South Pole: A Model-Based Risk Assessment” Harvey Mudd College Claremont, CA Michael Moody</p>	<p>Michael Rust Paul Sangiorgio Ian Weiner</p>
<p>“Antarctic Asteroid Effects” Pacific Lutheran University Tacoma, WA Rachid Benkhalti</p>	<p>Nicholas R. Baeth Andrew M. Meyers Jacob E. Nelson</p>
<p>“Not an Armageddon” University of California–Berkeley Berkeley, CA Rainer K. Sachs</p>	<p>Mikhail Khlystov Ilya Shpitser Seth Sulivant</p>
<p>“The Sky Is Falling” University of Puget Sound Tacoma, WA Perry Fizzano</p>	<p>Daniel Forrest Garrett Aufdemberg Murray Johnson</p>

### Lawful Capacity Papers

<p>“Determining the People Capacity of a Structure” Duke University Durham, NC David P. Kraines</p>	<p>Samuel W. Malone W. Garrett Mitchener John Alexander Thacker</p>
<p>“Hexagonal Unpacking” Harvey Mudd College Claremont, CA Ran Libeskind-Hadas</p>	<p>David Rudel Joshua Greene Cameron McLeman</p>

“Don’t Panic!”

North Carolina School  
of Science and Mathematics  
Durham, NC  
Dot Doyle

Timothy Jones  
Jeremy Katz  
Allison Master

“Standing Room Only”

Rose-Hulman Institute of Technology  
Terre Haute, IN  
Aaron D. Klebanoff

Frederick D. Franzwa  
Jonathan L. Matthews  
James I. Meyer

“Room Capacity Analysis Using a Pair of  
Evacuation Models”

University of Alaska Fairbanks  
Fairbanks, AK  
Chris Hartman

Gregg A. Christopher  
Orion Lawler  
Jason Tedor

### Ground Pollution Papers

“Pollution Detection: Modeling an  
Underground Spill Through  
Hydro-Chemical Analysis”

Earlham College  
Richmond, IN  
Mic Jackson

James R. Garlick  
Savannah N. Crites

“Locate the Pollution Source”

Zhejiang University  
Hangzhou, China  
Zhang Chong

Shen Quan  
Yang Zhenyu  
He Xiaofei

### Meritorious Teams

#### Asteroid Impact Papers (34 teams)

Asbury College, Wilmore, KY (Kenneth P. Rietz)  
Beijing University of Post and Telecommunications, Beijing, China (He Zuguo)  
Beloit College, Beloit, WI (Philip D. Straffin)  
Brandon University, Brandon, Manitoba, Canada (Doug Pickering)  
California Polytechnic State University, San Luis Obispo, CA (two teams)  
(Thomas O’Neil)  
College of Wooster, Wooster, OH (Reuben Settergren)  
Governor’s School for Government and International Studies, Richmond, VA  
(two teams) (Crista Hamilton)  
Greenville College, Greenville, IL (Galen R. Peters)  
Harbin Institute of Technology, Harbin, Heilongjiang, China (Wang Yong)  
Hefei University of Technology, Hefei, Anhui, China (Jie Bao)

Lewis and Clark College, Portland, OR (Robert W. Owens)  
 Montclair State University, Upper Montclair, NJ (Mary Lou West)  
 North Carolina School of Science and Mathematics, Durham, NC (Dot Doyle)  
 Nanjing University of Science and Technology, Nanjing, Jiangsu, China  
 (Wu Xing Min)  
 National U. of Defence Technology, Chang Sha, Hunan, China (Wu MengDa)  
 National University of Ireland, Galway, Ireland (Martin Meere)  
 Pacific Lutheran University, Tacoma, WA (Rachid Benkhalti)  
 Rose-Hulman Institute of Technology, Terre Haute, IN (Frank Young)  
 South China University of Technology, Guangzhou, Guangdong, China  
 (Xie Lejun)  
 Trinity College Dublin, Dublin, Ireland (Timothy G. Murphy)  
 Trinity University, San Antonio, TX (Jeffrey Lawson)  
 U.S. Air Force Academy, USAF Academy, CO (Dawn Stewart)  
 U.S. Military Academy, West Point, NY (Charles C. Tappert)  
 University of Alaska Fairbanks, Fairbanks, AK (Chris Hartman)  
 University of Colorado, Colorado Springs, CO (Holly Zullo)  
 University of South Carolina, Aiken, SC (Nieves A. McNulty)  
 Virginia Western Community College, Roanoke, VA (Ruth Sherman)  
 Western Washington University, Bellingham, WA (Igor Averbakh)  
 Westminster College, New Wilmington, PA (Barbara Faires)  
 Wuhan University of Hydraulics and Engineering, Wuhan, Hubei, China  
 (Huang Chongchao)  
 Zhejiang University, Hangzhou, Zhejiang, China (Qifan Yang)  
 Zhong Shan University, Guonmgzhou, Guong, China (Wang Shousong)

#### **Lawful Capacity Papers (39 teams)**

Abilene Christian University, Abilene, TX (David Hendricks)  
 Asbury College, Wilmore, KY (Kenneth P. Rietz)  
 Baylor University, Waco, TX (Frank H. Mathis)  
 Beijing University of Chemical Technology, Beijing, China (Zhao Baoyuan)  
 Beloit College, Beloit, WI (Philip D. Straffin)  
 China University of Mining and Technology, Xuzhou, Jiangsu, China  
 (Zhang Xingyong)  
 Drake University, Des Moines, IA (Alexander F. Kleiner)  
 Eastern Mennonite University, Harrisonburg, VA (John L. Horst)  
 Gettysburg College, Gettysburg, PA (two teams) (James P. Fink)  
 Grinnell College, Grinnell, IA (Marc Chamberland)  
 Grinnell College, Grinnell, IA (William Case)  
 Hefei University of Technology, Hefei, Anhui, China (Youdu Huang)  
 Indiana University, Bloomington, IN (Russell Lyons)  
 James Madison University, Harrisonburg, VA (James S. Sochacki)  
 Macalester College, St. Paul, MN (Daniel Kaplan)  
 Michigan State University, E. Lansing, MI (C.R. MacCluer)  
 National University of Defence Technology, Chang Sha, Hunan, China  
 (Cheng LiZhi)  
 National University of Ireland, Galway, Ireland (Michael P. Tuite)  
 Rose-Hulman Institute of Technology, Terre Haute, IN (Aaron D. Klebanoff)  
 Seattle Pacific University, Seattle, WA (Steven D. Johnson)

Shanghai Jiaotong University, Shanghai, China (Song Baorui)  
Shanghai Jiaotong University, Shanghai, China (Zhou Gang)  
Trinity University, San Antonio, TX (Jeffrey Lawson)  
U.S. Military Academy, West Point, NY (Ed Connors)  
University of California, Berkeley, CA (Rainer K. Sachs)  
University of Dayton, Dayton, OH (Ralph C. Steinlage)  
University of New South Wales, Sydney, Australia (James Franklin)  
University of Puget Sound, Tacoma, WA (Robert A. Beezer)  
University of Richmond, Richmond, VA (Kathy W. Hoke)  
University of Science and Technology of China, Hefei, Anhui, China  
(Zhou Jingren)  
University of Washington, Seattle, WA (Randall J. LeVeque)  
Wake Forest University, Winston-Salem, NC  
(Stephen B. Robinson and Edward Allen)  
Western Washington University, Bellingham, WA (Igor Averbakh)  
Wheaton College, Wheaton, IL (Paul Isihara)  
Wisconsin Lutheran College, Milwaukee, WI (Marvin C. Papenfuss)  
Worcester Polytechnic Institute, Worcester, MA (Bogdan Vernescu)  
Xidian University, Xian, Shaanxi, China (Mao Yongcai)  
Youngstown State University, Youngstown, OH (Thomas Smotzer)

**Pollution Detection Papers** (9 teams)

East China University of Science and Technology, Shanghai, China  
(Shao Nianci)  
Eastern Oregon State College, LaGrande, OR (Jenny Woodworth)  
Harvey Mudd College, Claremont, CA (Michael Moody)  
Humboldt State University, Arcata, CA (Margaret Lang)  
South China University of Technology, Guangzhou, Guangdong, China  
(He Chunxiong)  
Tsinghua University, Beijing, China (Ye Jun)  
University of Science and Technology of China, Hefei, Anhui, China (Du Zheng)  
Xian Jiaotong University, Xian, Shaanxi, China (two teams) (Dai YongHong)

## Awards and Contributions

Each participating MCM advisor and team member received a certificate signed by the Contest Director and the appropriate Head Judge.

INFORMS, the Institute for Operations Research and the Management Sciences, gave a cash award and a three-year membership to each member of the teams from the University of Puget Sound (Asteroid Impact Problem), Duke University (Lawful Capacity Problem), and Zhejiang University (Ground Pollution Problem). Moreover, INFORMS gave free one-year memberships to all members of Meritorious and Honorable Mention teams.

The Society for Industrial and Applied Mathematics (SIAM) designated as SIAM Winners two teams from Harvey Mudd College—Mazzoni et al. (Aster-



oid Impact Problem) and Rudel et al. (Lawful Capacity Problem)—and the team from Earlham College (Ground Pollution Problem). Each of the team members was awarded a \$300 cash prize. Their school was given a framed certificate hand-lettered in gold leaf. The Harvey Mudd team presented its results at a special Minisymposium of the SIAM Annual Meeting in Atlanta, GA in May.

The Mathematical Association of America (MAA) designated as MAA Winners the teams from the University of Alaska Fairbanks (Lawful Capacity Problem) and Earlham College (Ground Pollution Problem). Both teams presented their solutions at a special session of the MAA Mathfest in Providence, RI in August. Each team member was presented a certificate by MAA President-Elect Thomas Banchoff.

## Judging

### *Director*

Frank R. Giordano, COMAP, Lexington, MA

### *Associate Directors*

Robert L. Borrelli, Mathematics Dept., Harvey Mudd College,  
Claremont, CA

William Fox, Chair, Dept. of Mathematics, Francis Marion University,  
Florence, SC

### **Asteroid Impact Problem**

#### *Head Judge*

Patrick Driscoll, Dept. of Mathematical Sciences, U.S. Military Academy  
(INFORMS)

#### *Associate Judges*

Ron Barnes, University of Houston–Downtown, Houston, TX (MAA)

Paul Boisen, Defense Dept., Ft. Meade, MD

Courtney Coleman, Mathematics Dept., Harvey Mudd College,  
Claremont, CA

Lisette de Pillis, Mathematics Dept., Harvey Mudd College, Claremont, CA

Patrick Driscoll, Dept. of Mathematical Sciences, U.S. Military Academy,  
West Point, NY (INFORMS)

Ben Fusaro, Mathematics Dept., Florida State University, Tallahassee, FL  
(SIAM/MAA)

Richard Haberman, Mathematics Dept., Southern Methodist University,  
Dallas, TX (SIAM)

Mario Juncosa, RAND Corporation, Santa Monica, CA

Mark Levinson, Edmonds, WA (SIAM)

Keith Miller, National Security Agency, Ft. Meade, MD

Jack Robertson, Head, Mathematics and Computer Science, Georgia College  
and State University, Milledgeville, GA (MAA)

Lee Seitelman, Glastonbury, CT

Robert M. Tardiff, Dept. of Mathematical Sciences,  
Salisbury State University, Salisbury, MD

Daniel Zwillinger, Zwillinger & Associates, Arlington, MA

### **Lawful Capacity Problem**

#### *Head Judge*

Maynard Thompson, Mathematics Dept., University of Indiana,  
Bloomington, IN

#### *Associate Judges*

John Boland, Center for Industrial and Applied Mathematics (CIAM),  
University of South Australia, Australia

Karen Bolinger, Dept. of Mathematics, Clarion University of Pennsylvania,  
Clarion, PA

Doug Faires, Dept. of Mathematics and Statistics, Youngstown State  
University, Youngstown, OH

Jerry Griggs, Dept. of Mathematics, University of South Carolina,  
Columbia, SC (SIAM)

Jeff Hartzler, Dept. of Mathematics, Penn State University,  
Middletown, PA (MAA)

Karla Hoffman, Chair, Dept. of Operations Research, George Mason University,  
Fairfax, VA (INFORMS)

Daphne Liu, Mathematics Dept., California State University, Los Angeles, CA

Veena Mendiratta, Lucent Technologies, Naperville, IL

Don Miller, Dept. of Mathematics, St. Mary's College, Notre Dame, IN

Peter Olsen, Charles Stark Draper Lab, Arlington, VA (INFORMS)

Mark Parker, Dept. of Mathematical Sciences,  
U.S. Air Force Academy, CO (SIAM)

Catherine Roberts, Northern Arizona University, Flagstaff, AZ (SIAM)

Michael Tortorella, Lucent Technologies, Holmdel, NJ

Marie Vanisko, Carroll College, Helena, MT (Triage)

Martin Wildberger, Electric Power Research Institute, Palo Alto, CA (SIAM)

### **Ground Pollution Problem**

#### *Head Judge*

David C. Arney, Dept. of Mathematical Sciences, U.S. Military Academy

#### *Associate Judges*

Kelly Black, Mathematics Dept., University of New Hampshire,  
Durham, NH (Triage)

James Case, Baltimore, Maryland (SIAM)

David L. Elliott, Institute for Systems Research, University of Maryland,  
College Park, MD (SIAM)

John Kobza, Industrial and Systems Engineering, Virginia Polytechnic  
Institute and State University, Blacksburg, VA (INFORMS)

John L. Scharf, Carroll College, Helena, MT

Kathleen M. Shannon, Salisbury State University, Salisbury, MD (MAA)

### **Triage Session**

#### **Asteroid Impact Problem**

##### *Head Triage Judge*

Theresa M. Sandifer, Southern Connecticut State University, New Haven, CT

##### *Associate Judges*

Therese L. Bennett, Southern Connecticut State University, New Haven, CT

Cynthia B. Gubitose, Western Connecticut State University, Danbury, CT

David Hahn

Ronald E. Kutz, Western Connecticut State University, Danbury, CT

Val Pinciu, Mathematics Dept., SUNY at Buffalo, Buffalo, NY

C. Edward Sandifer, Western Connecticut State University, Danbury, CT

#### **Lawful Capacity Problem**

(all from Mathematics Dept., Carroll College, Helena, MT)

##### *Head Triage Judge*

Marie Vanisko

##### *Associate Judges*

Peter Biskis, Terence J. Mullen, and Jack Oberweiser

#### **Ground Pollution Problem**

(all from Mathematics Dept., University of New Hampshire, Durham, NH)

##### *Head Triage Judge*

Kelly Black

##### *Associate Judges*

A.H. Copeland, John B. Geddes, Loren D. Meeker, Kevin Short, Lee L. Zia

## **Sources of the Problems**

Contributors of the problems were as follows:

- **Asteroid Impact Problem:** Jack Robertson, Mathematics Dept., Georgia College and State University.
- **Lawful Capacity Problem:** Joe Malkevitch, Mathematics Dept., York College, City University of New York.

- **Ground Pollution Problem:** Yves Nievergelt, Mathematics Dept., Eastern Washington University.

## Acknowledgments

The MCM was funded this year by the National Security Agency, whose support we deeply appreciate. The ICM received major funding also from the National Science Foundation. We thank Dr. Gene Berg of NSA for his coordinating efforts. The MCM is also indebted to INFORMS, SIAM, and the MAA, which provided judges and prizes.

I thank the MCM judges and MCM Board members for their valuable and unflagging efforts. Harvey Mudd College, its Mathematics Dept. staff, and Prof. Borrelli were gracious hosts to the judges.

## Cautions

*To the reader of research journals:*

Usually a published paper has been presented to an audience, shown to colleagues, rewritten, checked by referees, revised, and edited by a journal editor. Each of the student papers here is the result of undergraduates working on a problem over a weekend; allowing substantial revision by the authors could give a false impression of accomplishment. So these papers are essentially *au naturel*. Light editing has taken place: minor errors have been corrected, wording has been altered for clarity or economy, and style has been adjusted to that of *The UMAP Journal*. Please peruse these student efforts in that context.

*To the potential MCM Advisor:*

It might be overpowering to encounter such output from a weekend of work by a small team of undergraduates, but these solution papers are highly atypical. A team that prepares and participates will have an enriching learning experience, independent of what any other team does.

## Appendix: Successful Participants

## KEY:

P = Successful Participation

H = Honorable Mention

M = Meritorious

O = Outstanding (published in this special issue)

A = Asteroid Impact Problem

B = Lawful Capacity Problem

C = Ground Pollution Problem

INSTITUTION	CITY	ADVISOR	A	B	C
<b>ALASKA</b>					
Univ. of Alaska Fairbanks	Fairbanks	Chris Hartman	M	O	
<b>ARIZONA</b>					
Northern Arizona Univ.	Flagstaff	James W. Swift		H	
<b>CALIFORNIA</b>					
California Lutheran Univ.	Thousand Oaks	Cynthia J. Wyels	P		
Calif. Poly. State Univ.	San Luis Obispo	Thomas O'Neil	M,M		
California State Univ.	Bakersfield	Maureen E. Rush	P		
	Seaside	Daniel M. Fernandez	P		H
	Northridge	Gholam-Ali Zakeri	P	P	
	Fullerton	Mario U. Martelli		P	P
Harvey Mudd College	Claremont	Michael Moody	O,O		M
		Ran Libeskind-Hadas		O	
Humboldt State Univ.	Arcata	Margaret Lang			M
Loyola Marymount Univ.	Los Angeles	Thomas M. Zachariah		P,P	
Pepperdine University	Malibu	Jane Ganske			P
Pomona College	Claremont	Richard Elderkin			H
Shasta College	Redding	Cathy Anderson		P	
Sonoma State University	Rohnert Park	Clement E. Falbo	P		
Univ. of California	Berkeley	Rainer K. Sachs	O	M	
<b>COLORADO</b>					
Colorado College	Colorado Springs	Steven Janke	P		
Mesa State College	Grand Junction	Edward Bonan-Hamada	H,P		
Metro. State College	Denver	Thomas E. Kelley		P	
Regis University	Denver	Linda Duchrow		P	
U.S. Air Force Academy	USAF Academy	Jeff Boleng	P		
		Capt Kirsten Messer	H		
		Dawn Stewart	M		
Univ. of Colorado	Boulder	Anne Dougherty	H		
	Colorado Springs	Holly Zullo	M		
		Shannon Michaux	P		
Univ. of Southern Colo.	Pueblo	Bruce N. Lundberg	P		
		Paul R. Chacon	P		

INSTITUTION	CITY	ADVISOR	A	B	C
CONNECTICUT					
Connecticut College	New London	Kathy McKeon		P	
Sacred Heart Univ.	Fairfield	Antonio Magliaro	P		
Southern Conn. State Univ.	New Haven	Ross Gingrich	H		
		Theresa Sandifer	H		
Western Conn. State Univ.	Danbury	Ed Sandifer		H	
		Paul Hines		H	
DISTRICT OF COLUMBIA					
Georgetown University	Washington	Andrew Vogt	P	H	
FLORIDA					
Florida Southern College	Lakeland	Allen Wuertz		P	
Jacksonville University	Jacksonville	Lucinda B. Sonnenberg			P
		Paul R. Simony	H		
		Robert A. Hollister		P	
Stetson University	Deland	Daniel R. Plante		H	
University of North Florida	Jacksonville	Peter A. Braza	P		
GEORGIA					
Georgia College & State Univ.	Milledgeville	Craig Turner	P		
State Univ. of West Georgia	Carrollton	Scott Gordon	P		
IDAHO					
Boise State University	Boise	Stephen Brill	P	P	
Idaho State University	Pocatello	Jim Hoffman		H	
ILLINOIS					
Greenville College	Greenville	Galen R. Peters	M,P		
Illinois Wesleyan University	Bloomington	Zahia Drici	P		
Northern Illinois University	Dekalb	Hamid Bellout		P	
Wheaton College	Wheaton	Paul Isihara	P	M	
INDIANA					
Earlham College	Richmond	Charlie Peck	P		
		Mic Jackson			O
Goshen College	Goshen	David Housman	P		
		Patricia Oakley	P	H	
Indiana University	Bloomington	Russell Lyons		M,H	
	South Bend	Morteza Shafii-Mousavi		P	
		Steven Shore	P		
Rose-Hulman Inst. of Tech.	Terre Haute	Frank Young	M	P	
		Aaron D. Klebanoff		O,M	
Saint Mary's College	Notre Dame	Joanne Snow	H	H	
Wabash College	Crawfordsville	Esteban Poffald	P,P		

INSTITUTION	CITY	ADVISOR	A	B	C
IOWA					
Drake University	Des Moines	Alexander F. Kleiner		M	
		Luz M. De Alba	P		
Grinnell College	Grinnell	William Case		M,P	
		Marc Chamberland	H	M	
Iowa State University	Ames	Stephen J. Willson		H,H	
Luther College	Decorah	Reginald D. Laursen	P	H	
Marycrest Int'l Univ.	Davenport	Jeff Dickerson	P		
Mt. Mercy College	Cedar Rapids	Kent Knopp	P,P		
Simpson College	Indianola	David Olsgaard	H	P	
		M.E. Murphy Waggoner	H	H	
Univ. of Northern Iowa	Cedar Falls	Gregory M. Dotseth	P		
		Timothy L. Hardy	P		
Wartburg College	Waverly	Mariah Birgen			P
KANSAS					
Baker University	Baldwin City	Bob Fraga	P		P
Bethel College	North Newton	Monica Meissen	P,P		
KENTUCKY					
Asbury College	Wilmore	Kenneth P. Rietz	M	M	
Brescia College	Owensboro	Chris A. Tiaht		P	
LOUISIANA					
McNeese State Univ.	Lake Charles	Karen Aucoin	P		
		Robert Doucette		P	
MAINE					
Colby College	Waterville	Tom Berger		H	P
MARYLAND					
Loyola College	Baltimore	John Hennessey		P	P
Mt. St. Mary's College	Emmitsburg	Fred J. Portier		P	
		John August	P		
Salisbury State Univ.	Salisbury	Michael Bardzell	P		
MASSACHUSETTS					
Holy Cross College	Worcester	John Anderson			P
Simon's Rock College	Great Barrington	Allen B. Altman	P,P		
Smith College	Northampton	Yung Pin-Chen	P		
		Yung-Pin Chen and Cristina Suarez			P
Univ. of Massachusetts	Lowell	James Kiwi Graham-Eagle		H	
		Lou Rossi	P		
W. New England Coll.	Springfield	Eric Haffner	P		
Williams College	Williamstown	Stewart Johnson		P	
Worcester Poly. Inst.	Worcester	Arthur C. Heinricher	P		
		Bogdan Vernescu		M	

INSTITUTION	CITY	ADVISOR	A	B	C
MICHIGAN					
Albion College	Albion	Scott Dillery	P	P	
Eastern Michigan University	Ypsilanti	Christopher E. Hee	P,P		
Hillsdale College	Hillsdale	John P. Boardman		H,P	
Kettering University	Flint	Craig Andres	P		
Lawrence Technological Univ.	Southfield	Howard Whitston	H		
		Ruth G. Favro		H	
		Scott Schneider	H		
Michigan State University	E. Lansing	C. R. MacCluer		M,H	
		George Stockman			P
Siena Heights College	Adrian	Rick Trujillo	P		
Univ. of Michigan–Dearborn	Dearborn	David A. James	H		
MINNESOTA					
Augsburg College	Minneapolis	Rebekah Valdivia	P	P	
Macalester College	St. Paul	Susan Fox		P	
		Daniel Kaplan		M	
University of Minnesota	Morris	Peh Ng		H,P	
Winona State University	Winona	Barry A. Peratt		P	
MISSOURI					
Missouri Southern State Coll.	Joplin	Patrick Cassens	P	H	
Northeast Missouri State Univ.	Kirksville	Steven J. Smith		P	
Northwest Missouri State Univ.	Maryville	Russell N. Euler	P	P	
Southeast Missouri State Univ.	Cape Girardeau	Robert W. Sheets	P		
Univ. of Missouri	Rolla	Michael G. Hilgers		H	
Wentworth Military Academy	Lexington	Jacque Maxwell	P,P		
MONTANA					
Carroll College	Helena	Terence J. Mullen		H	
		Jack Oberweiser	P		
		Kevin Wolka	P		
NEBRASKA					
Nebraska Wesleyan Univ.	Lincoln	P. Gavin LaRose		H	
NEVADA					
University of Nevada	Reno	Mark M. Meerschaert	H		
NEW JERSEY					
Kean University	Union	Pablo Zafra			P
Montclair State University	Upper Montclair	Mary Lou West	M		
		Michael Jones		P	
NEW MEXICO					
New Mexico State University	Las Cruces	Marcus S. Cohen	H		



INSTITUTION	CITY	ADVISOR	A	B	C
NEW YORK					
Ithaca College	Ithaca	John C. Maceli	P		
Nazareth College	Rochester	Kelly M. Fuller	H,P		
		Joe Lanzafame			P
Niagara University	Niagara	Steven L. Siegel		P	
St. Bonaventure Univ.	St. Bonaventure	Maureen P Cox			P
		Albert G. White		P	
U.S. Military Academy	West Point	Ed Connors		M	
		James S. Rolf		H	
		Charles C. Tappert	M		
		Joanne E. Walser			P
Wells College	Aurora	Carol C. Shilepsky		H	
Westchester Comm. Coll.	Valhalla	Rowan Lindley	P		
		Sheela Whelan	P		
NORTH CAROLINA					
Appalachian State Univ.	Boone	Holly Hirst	H		
Duke University	Durham	David P. Kraines		O	
Elon College	Elon College	Todd Lee	P	P	
Mount Olive College	Mt Olive	Ollie J Rose			P
N.C. School of Sci. & Math	Durham	Dot Doyle	M	O	
North Carolina State Univ.	Raleigh	Joyce Hatch		H	
		Robert T. Ramsay		P	H
Salem College	Winston-Salem	Paula G. Young		P	P
Univ. of N. Carolina	Wilmington	Russell L. Herman	H	P	
Wake Forest University	Winston-Salem	Stephen B. Robinson and Edward Allen		M	
Western Carolina Univ.	Cullowhee	ulie Barnes	H		
		Kathy Ivey	H,	P	
OHIO					
Baldwin-Wallace College	Berea	Susan D Penko	P		
College of Wooster	Wooster	Reuben Settergren	M		
Hiram College	Hiram	Brad Gubser	A	P	
Miami University	Oxford	Doug Ward		H	
University of Dayton	Dayton	Ralph C. Steinlage		M	
Wright State University	Dayton	Thomas P. Svobodny	H		
Youngstown State Univ.	Youngstown	Stephen Hanzely	H		
		Robert Kramer		H	
		Scott Martin			P
		Thomas Smotzer	H	M	H

INSTITUTION	CITY	ADVISOR	A	B	C
<b>OKLAHOMA</b>					
Southeastern Okla. State Univ.	Durant	John McArthur	P		
		Karla Oty	P		
<b>OREGON</b>					
Eastern Oregon State College	LaGrande	David Allen	P		
		John Thurber		H	
		Anthony Tovar	P		
		Jenny Woodworth			M
Lewis and Clark College	Portland	Robert W. Owens	M		P
Southern Oregon State College	Ashland	Kemble R. Yates		H	
<b>PENNSYLVANIA</b>					
Carnegie Mellon University	Pittsburgh	Walker	P		
Clarion Univ. of Pennsylvania	Clarion	Michael Barrett	P		
		Jon Beal	P		
		Bill Krugh			H
Dickinson College	Carlisle	Lorelei Koss			P
Gettysburg College	Gettysburg	James P. Fink		M,M	
Haverford College	Haverford	Stephanie Singer		P	
Messiah College	Grantham	Lamarr C. Widmer			H
Shippensburg University	Shippensburg	Cheryl Olsen	P		
Westminster College	New Wilmington	Barbara Faires	M,P		
		Richard Sprow		P	
<b>SOUTH CAROLINA</b>					
Charleston Southern Univ.	Charleston	Stan Perrine		P	
Francis Marion University	Florence	C. Abbott	P		
Univ. of South Carolina	Aiken	Laurene Fausett		H	
		Nieves A. McNulty	M		
<b>SOUTH DAKOTA</b>					
Northern State University	Aberdeen	A.S. Elkhader			P
<b>TENNESSEE</b>					
Carson-Newman College	Jefferson City	Catherine Kong	H		
Christian Brothers University	Memphis	Cathy W. Carter		P	
Lipscomb University	Nashville	Mark A. Miller		H	
<b>TEXAS</b>					
Abilene Christian University	Abilene	David Hendricks		M	
Baylor University	Waco	Frank H. Mathis		M	
Southwestern University	Georgetown	T. Shelton		P	
Trinity University	San Antonio	Jeffrey Lawson	M	M	
		Fred Loxom		H	
University of Dallas	Irving	Pete McGill	P		
University of Houston	Houston	Barbara Lee Keyfitz	P		
University of Texas at El Paso	El Paso	Michael D. O'Neill	P		

INSTITUTION	CITY	ADVISOR	A	B	C
UTAH					
University of Utah	Salt Lake City	Don H. Tucker	H		
VERMONT					
Johnson State College	Johnson	Glenn D. Sproul	P	P	
VIRGINIA					
College of William & Mary	Williamsburg	Michael Trosset		H	
Eastern Mennonite Univ.	Harrisonburg	John L. Horst			P
Governor's School for Gov. & Int'l Studies	Richmond	John Barnes		H	
		Crista Hamilton	M,M		
James Madison University	Harrisonburg	Donna Fengya	P		
		James S. Sochacki		M	
Thomas Jefferson H.S. for Sci. & Tech.	Alexandria	John Dell		H	
University of Richmond	Richmond	Kathy W. Hoke		M	
Virginia Western Comm. Coll.	Roanoke	Ruth Sherman	M,P		
WASHINGTON					
Pacific Lutheran University	Tacoma	Rachid Benkhalti	O,M		
Seattle Pacific University	Seattle	Steven D. Johnson		M	
University of Puget Sound	Tacoma	Robert A. Beezer		M,H	
		Perry Fizzano	O,P		
Univ. of Washington	Seattle	Randall J LeVeque		M	
Washington State Univ.	Pullman	Richard Gomulkiewicz	P		
Western Washington Univ.	Bellingham	Igor Averbakh	M	M	P
		Saim Ural	P	P	
WISCONSIN					
Beloit College	Beloit	Philip D. Straffin	M	M	
Northcentral Technical Coll.	Wausau	Frank J. Fernandes	P		
		Robert J. Henning	P		
Univ. of Wisconsin	Madison	David Moulton	P		
	Platteville	Mike Penn			P
		Sheryl Wills	H		
	Stevens Point	Nathan Wetzel	H		
		Robert Kreczner	P		
Wisconsin Lutheran College	Milwaukee	Marvin C. Papenfuss		M	
AUSTRALIA					
Curtin University of Tech.	Perth	Yong Hong Wu	P		
Univ. of New South Wales	Sydney	Dr James Franklin		M	
Univ. of Southern Queensland	Toowoomba	Christopher J. Harman	H		
		Tony Roberts		P	

INSTITUTION	CITY	ADVISOR	A	B	C
CANADA					
Brandon University	Brandon, MB	Doug Pickering	M		
Memorial Univ. of Nfld	St. John's, NF	Andy Foster	P		
University of Calgary	Calgary, AB	David R. Westbrook		P	
University of Saskatchewan	Saskatoon, SK	Prof. Raj Srinivasan	H		
Univ. of Western Ontario	London, ON	C. Lindsay Dennison			P
		Peter H. Poole	H		P
York University	Toronto, ON	Juris Steprans		H,P	
CHINA					
Anhui University	Hefei, Anhui	Sjyang Shangjun		H	
		Wang Haixian			H
Anhui University	Hefei, Anhui	Zhang Quanbin		P	
Beijing Institute of Tech.	Beijing	Yang Guoxiao	P		
		Xiao Di Cui		H	
Beijing Union University	Beijing	Ren KaiLong	H		
		Wang Xinfeng	H		
		Xing Chun Feng		P	
		Zeng Qingli		P	
Beijing U. of Aero. & Astro.	Beijing	Peng Linping	P		
Beijing Univ. of Chem. Tech.	Beijing	Liu Damin		P	
		Shi Xiaoding			H
		Zhao Baoyuan		M	
Beijing U. of Post & Telecomm.	Beijing	He Zuguo	M	H	
		Luo Shoushan		P,P	
Central-South Inst. of Techn.	Hengyang, Hunan	Liu Yachun		P,P	
China Univ. of Mining & Techn.	Xuzhou, Jiangsu	Zhang Xingyong		M	
		Zhou Shengwu		H	
Chongqing University	Chongqing	Fu Li		H	
		Gong Qu	P		
		He Zhongshi		H	
		Liu Qionsen		P	
		Yang DaDi			H
Dalian University of Tech.	Dalian, Liaoning	He Mingfeng		P	P
		Yu Hongquan		H,H	
		Zhao Lizhong	H		P
E. China Univ. of Sci. and Tech.	Shanghai	Liu Zhaohui		H	
		Lu Xiwen			H
		Shao Nianci	H		M
		Lu Xiwen		P	
		Lu Yuanhong	H		

INSTITUTION	CITY	ADVISOR	A	B	C
Exp'l H.S. Beijing U. Normal	Beijing	Han Leqing		P	
		Zhangjilin	P		
First Middle School of Jiading District	Jiading, Shanghai	Xiexilin		H	
		Xurong		H	
Fudan University	Shanghai	Wan Huiling	P		
		Zhou Xi	H	P	
		Cai Zhijie		P,P	H
Harbin Engineering Univ.	Harbin, Heilongjiang	Luo Yuesheng			H
		Shen Jihong	H	P	
		Shi Jiuyu	P		
		Zhang Xiaowei		P	
Harbin Inst. of Technology	Harbin, Heilongjiang	Liu Jin	H		
		Shang Shouting	H	P	H
		Wang Yong	M		
		Yu Xiujuan			H
Hefei University of Tech.	Hefei, Anhui	Bao Jie	M		
		Du Xueqiao	P		
		Zhou Yongwu	H		
		Huang Youdu		M	
JianPing Senior High School	Shanghai	Huang Liangfu		H	
		Zhu Weizheng		H	
Jilin University	Changchun, Jilin	Lu Xian Vui	P		
Jilin University of Tech.	Changchun, Jilin	Fang Peichen	P		
		Liu Xiaoyu		H	
		Zhang Peiyuan		H	
Jinan University	Guangzhou, Guangdong	Ye Shiqi		P	
		Fan Suohai		H	
Mechanical Eng'ng Coll.	Shijiazhuang	Yang Pinghua	H		
		Zhao Ruiqing	H		
Nanjing Univ. of Sci. & Tech.	Nanjing, Jiang Su	Wu Xing min	M		
		Yang Xiaoping			P
Nankai University	Tianjin	Wang Bin		P	
		Huang Wuqun	H		
		Zhou XingWei		P	
		Chen Zenzqiang		P	
National U. of Defence Tech.	Chang Sha, HuNan	Cheng LiZhi		M	
		Wu MengDa	M		
Northwestern Polytech. Univ.	Xian, Shaanxi	Lu Xiao Dong		H	
		Nie Yu Feng	H		
		Wang MingYu		H	
		Xu Wei	H		

INSTITUTION	CITY	ADVISOR	A	B	C
Peking University	Beijing	Lei Gongyan	H,P		P
		Deng Minghua	P,P		P
Shandong University	Jinan, Shandong	Cui Yuquan		P	
Shanghai Jiaotong Univ.	Shanghai	Huang Jianguo		H	
		Song Baorui	H	M	
		Yang Bing			P
		Zhou Gang		M	H
Shanghai Maritime Univ.	Shanghai	Ding Songkang	P		
		Sheng Zining		P	
Shanghai Normal Univ.	Shanghai	Zhu Detong		P,P	
		Guo Shenghuan		P	
South China Univ. of Tech.	Guangzhou, Guangdong	Fu Hongzhuo			H
		Hao Zhifeng		H	
		He Chunxiong	H		M
		Xie Lejun	M		
Southeast University	Jiangsu, Nanjing	Zhu Fengfeng		H	
		He Lin and Wei Fangfang		P	
		Huang Jun	H		
		Zhou Jian hua	H		
		Zhu Dao-Yuan		P	
Tsinghua University	Beijing	Hu Zhiming		P,P	P
		Ye Jun		H,P	M
Univ. of Elec. Sci. & Tech.	Chengdu	Du Hongfei	P		
		Wang Jianguo		H	
		Xu Quanzhi		P	
		Zhong Erjie	H		
U. of Sci. and Tech. of China	Hefei, Anhui	Gao Jie			H
		Xu Qingqing		H	
		Du Zheng			M
		Guo Quji	P		
		Lai Junwen		H	
		Zhou Jingren		M	
Wuhan U. of Hydraul. & Eng'ng	Wuhan, Hubei	Cheng Guixing	H		
		Huang Chongchao	M,H		
		Peng Zhuzeng	H		
Xian Jiaotong University	Xian,Shaanxi	He Xiaoliang	H	P	
		Zhou Yicang		H,P	
Xidian University	Xian, Shaanxi	Dai YongHong			M,M
		Hu Yupu	H		
		Li Junmin		H	
		Mao Yongcai		M	

INSTITUTION	CITY	ADVISOR	A	B	C
Zhejiang University	Hangzhou, Zhejiang	Yang Qifan	M	P	
		He Yong	H	H	
		Zhang Chong			O
Zhengzhou Electr. Power Coll.	Zhengzhou, Henan	Cheng Ruizhong	H		
		Cui Yingjian		P	
Zhengzhou Univ. of Tech.	Zhengzhou, Henan	Wang Jinling		H	
		Wang Shubin	P		
Zhong Shan Univ.	Guonmgzhou, Guong	Jiang Xiaolong		H	
		Wang Shousong	M		
		Wang Yuan Shi		P	
		Yang Yin Zhao		H	
FINLAND					
Paivola College	Valkeakoski	Merikki Lappi		P,P	
HONG KONG					
Hong Kong Baptist Univ.	Kowloon	Chong Sze Tong		P,P	
IRELAND					
National Univ. of Ireland	Galway	Michael P. Tuite			M
		Martin Meere	M		
Trinity College Dublin	Dublin	Timothy G. Murphy	M,H		
University College Cork	Cork	Patrick Fitzpatrick	P		
		Jim Grannell		P	
		Michael Quinlan		H	
University College Dublin	Belfield, Dublin	Ted Cox		H	
		Maria Meehan	H,P		
LITHUANIA					
Vilnius University	Vilnius	Ricardas Kudzma		P	
		Antanus Mitasiunas	P		
		Saulius Ragaisis	P		
		Algirdas Zabulionis		P	
SOUTH AFRICA					
University of Stellenbosch	Matieland	J.H. Van Vuuren	P		

## Acknowledgment

The editor wishes to thank Chia Tzun Goh '01 of Beloit College for his help in identifying family names of team advisors from China, for whom the family name is listed first.

