Cooperative Learning: A Pedagogy for Diversity

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Joint International IGIP-SEFI
Annual Conference – Trnava, Slovakia

September 2010

Diversity unifies – Diversity in Engineering Education

- Guiding Question: How can we prepare engineering graduates to thrive in an interdependent world?
  - embrace diversity,
  - develop collaborative advantage, and
  - navigate complexity
- Interdependence based pedagogy for diversity

http://www.ce.umn.edu/~smith/links.html

Conferences/Presentations/Papers

- Joint International IGIP-SEFI Conference - Trnava, Slovakia - 2010
  - Plenary - Cooperative Learning: A Pedagogy for Diversity
    - Slides [Smith-IGIP-SEFI_Plenary-v6.pdf]
    - Supporting Document [Smith-Cooper_Robinson-Interdependence-8.pdf]

Age of Interdependence

Tom Boyle of British Telecom calls this the age of interdependence; he speaks of the importance of people's NQ, or network quotient – their capacity to form connections with one another, which, Boyle argues is now more important than IQ, the measure of individual intelligence.

Cohen, Don & Prusak, Laurence. 2001. *In good company: How social capital makes organizations work*. Cambridge, MA: Harvard Business School Press.

Sunday
JANUARY 13, 2002

Opinion

A17
Editorials, A18

A selection of voices from the community, nation and world

Living in an interdependent world

Former President Bill Clinton addresses the question: Is the age of interdependence going to be good or bad for humanity? He thinks it will turn out to be good — but he cautions that the West must help those who are being left behind.

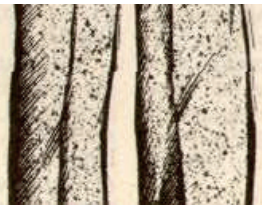
The great question of this new century is whether the age of interdependence is going to be good or bad for humanity. The answer depends upon whether we in the wealthy nations spread the benefits and reduce the burdens of the modern world, on whether the poor nations enact the changes necessary to make progress possible, and on whether we all can develop a level of consciousness high enough to understand our obligations and responsibilities to each other.

By William Jefferson Clinton

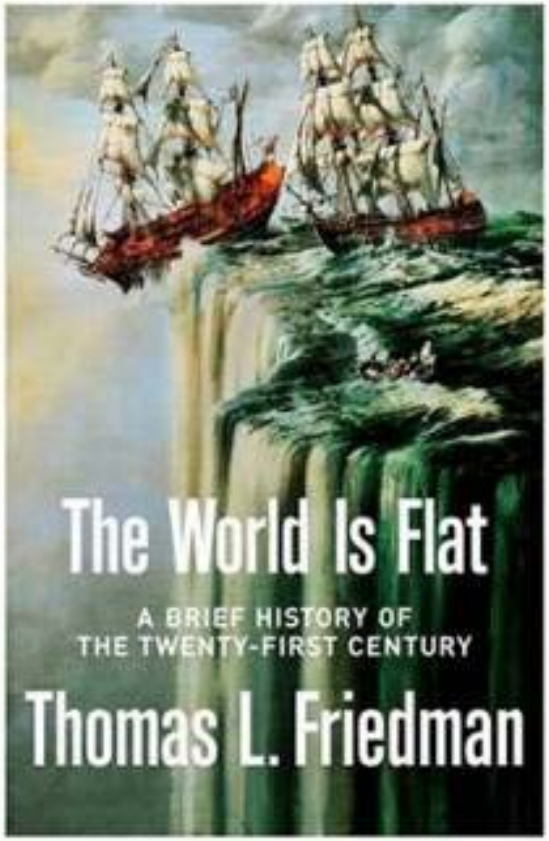
NEW YORK — The great question of this new century is whether the age of interdependence is going to be good or bad for humanity. The answer depends upon whether we in the

Fourth, from a political point of view, you might have said the dominant factor of the 21st-century world will be the explosion of democracy and diversity.

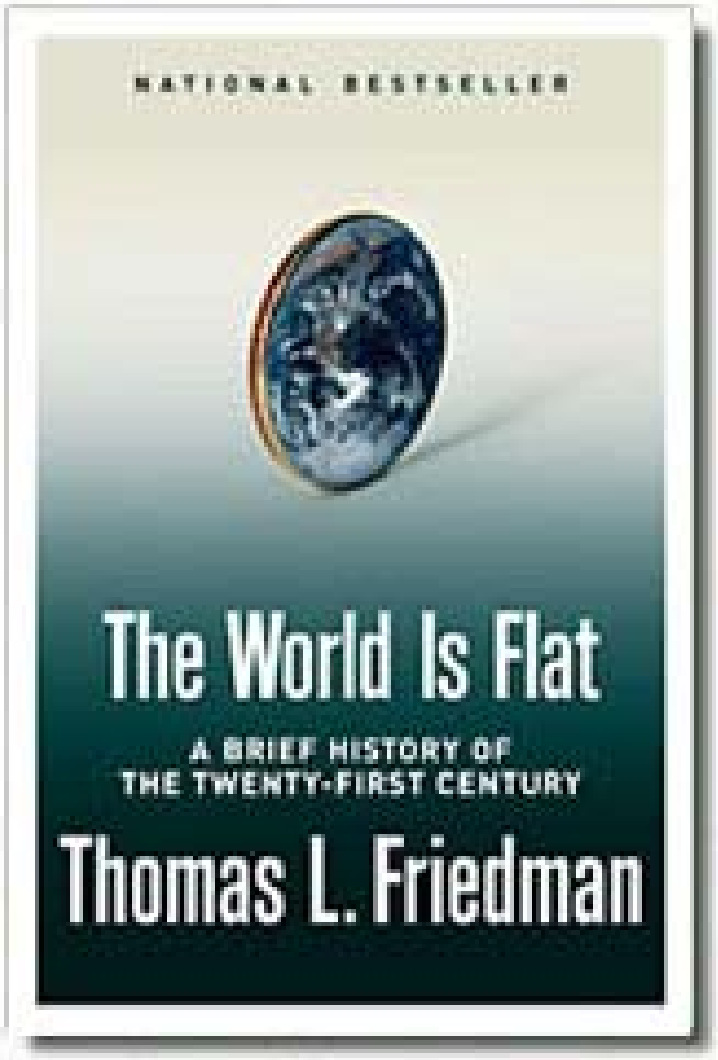
For the first time in the history of humanity, more than half of the



The World is Flat



"Clearly, it is now possible for more people than ever to collaborate and compete in real-time, with more people, on more kinds of work, from more corners of the planet, and on a more equal footing, than at any previous time in the history of the world"



Platform for Collaboration
(1st Three Flatteners):

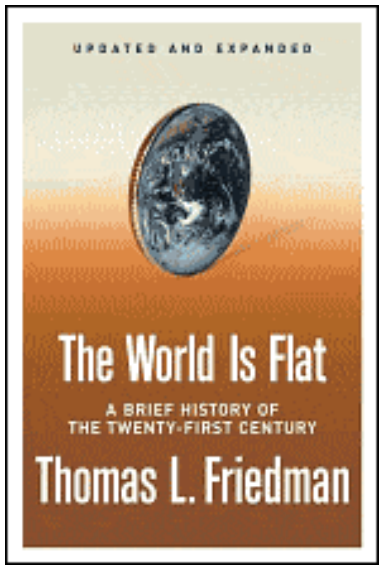
1. 11/9/89
2. 8/9/95
3. Work Flow Software

NYTimes MAGAZINE April 3, 2005
It's a Flat World, After All
By THOMAS L. FRIEDMAN

Video – Think Global Series:
http://minnesota.publicradio.org/radio/features/2005/05/collaboration/

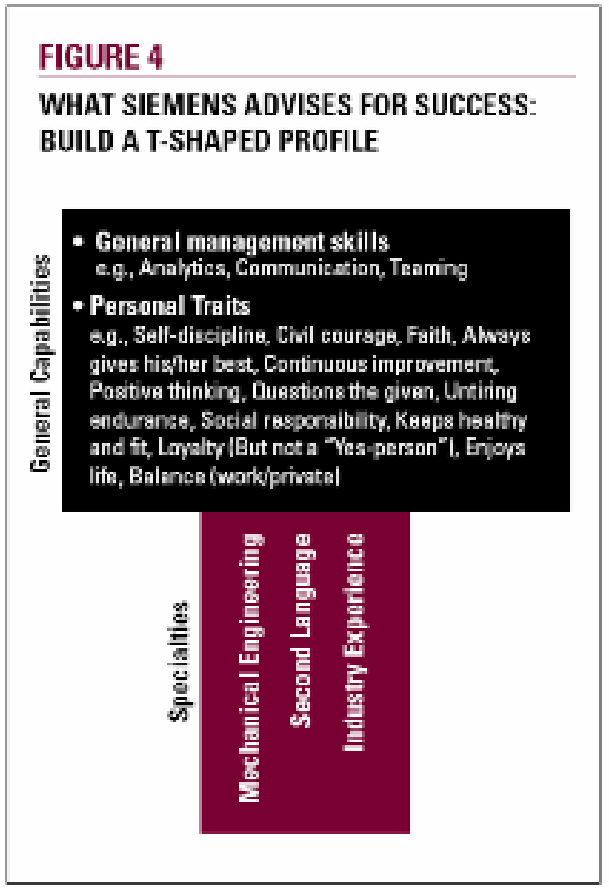
Design Thinking

Discipline Thinking



Tom Friedman
Horizontalize
Ourselves

CQ+PQ>IQ



AAC&U *College Learning For the New Global Century*

John F. Kennedy Moon Speech - Rice Stadium

September 12, 1962

Apollo 8 – 12/24/68

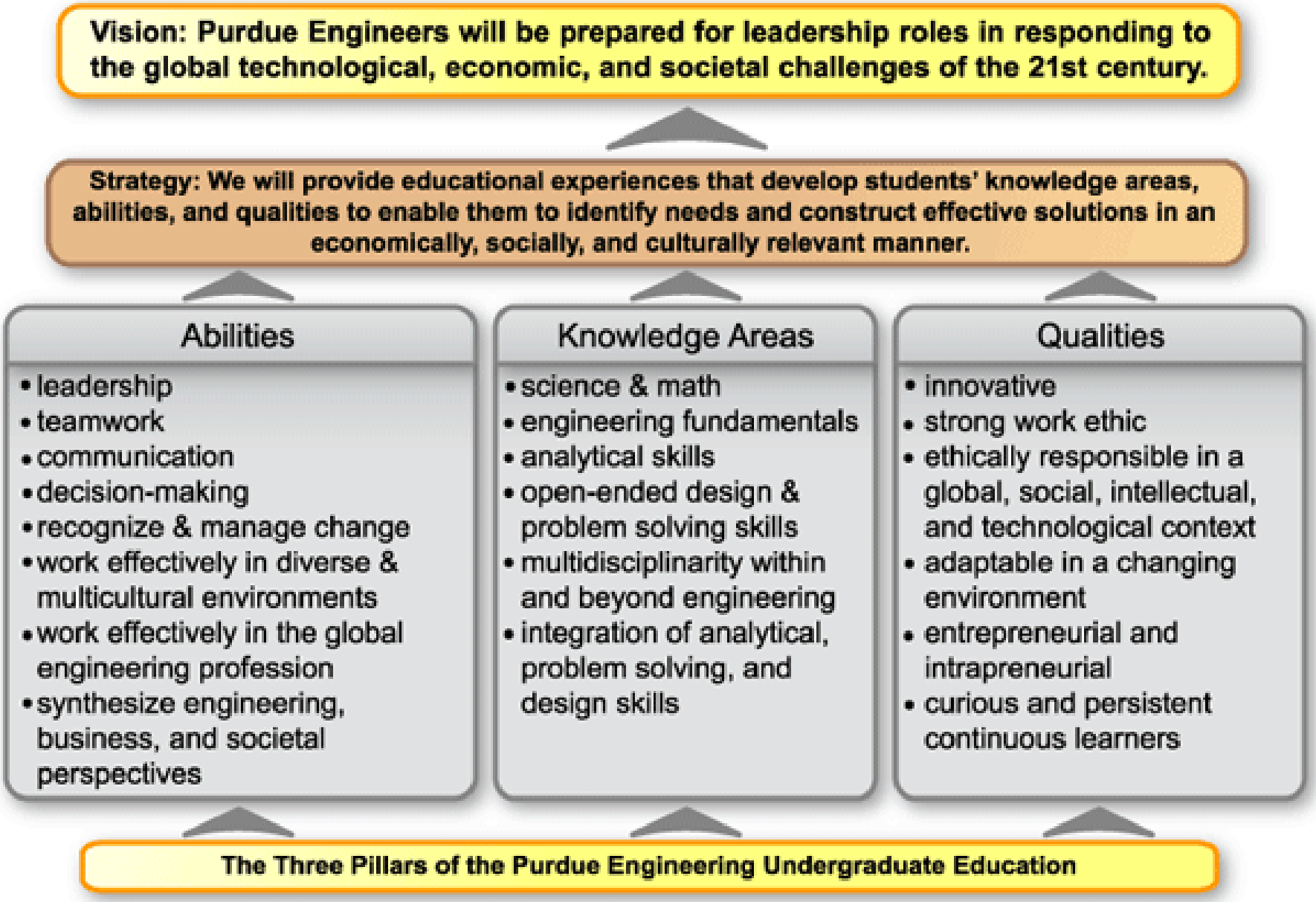
Interdependent World

- Essential knowledge, skills, and habits of mind for an interdependent world?
  - embrace diversity
  - develop collaborative advantage
  - navigate complexity
- Examples

Desired Attributes of a Global Engineer*

- A multidisciplinary, systems perspective, along with a product focus
- **An awareness of the boundaries of one's knowledge, along with an appreciation for other areas of knowledge and their interrelatedness with one's own expertise**
- **An awareness of and strong appreciation for other cultures and their diversity, their distinctiveness, and their inherent value**
- A strong commitment to team work, including extensive experience with and understanding of team dynamics
- High ethical standards (honesty, sense of personal and social responsibility, fairness, etc)
- An ability to think both critically and creatively, in both independent and cooperative modes

*A Manifesto for Global Engineering Education, Summary Report of the Engineering Futures Conference, January 22-23, 1997. The Boeing Company & Rensselaer Polytechnic Institute.



https://engineering.purdue.edu/Engr/Academics/Engineer2020/?pp=1

Successful Attributes for the Engineer of 2020

- Possess strong analytical skills
- Exhibit practical ingenuity; posses creativity
- Good communication skills with multiple stakeholders
- Business and management skills; Leadership abilities
- High ethical standards and a strong sense of professionalism
- Dynamic/agile/resilient/flexible
- Lifelong learners

Lynn & Salzman – The Real Global Technology Challenge & Collaborative Advantage

THE REAL GLOBAL TECHNOL CHALLENGE

BY LEONARD LYNN AND HAROLD SALZMAN

At one of the renowned Indian Institutes of Technology, we recently asked a class of 80 engineering and science undergraduates how many wanted to go to the United States for graduate school or a job. A decade ago nearly everyone in the classroom would have a hand in the air. Now, not a single hand was raised. "Why go to the U.S.," they asked, "when all the opportunity is in India?"

In China when we visited software, telecommunications, and heavy-equipment companies owned by U.S. multinational corporations, we met managers born and raised in Asia but with U.S. engineering degrees. They had expected to spend their entire working lives in the United States. So why had they gone back to China? Because these days not only were the new career opportunities there as good as those in the U.S., but the technology-development projects were even more challenging.

Clearly the U.S. is no longer the universally preferred home for the global technology elite. Increasing numbers of scientists and engineers who were educated and have built successful careers here are returning to China, India, and other countries. Many in the younger generation never come here in the first place.

Leonard Lynn is a professor of management policy at Case Western Reserve University, where he specializes in research on technology policy and management. Harold Salzman is a sociologist and senior research associate at the Urban Institute in Washington, D.C. His research focuses on labor markets, workplace restructuring, skill requirements, and globalization of innovation, engineering, and technology design. Over the past five years, Lynn and Salzman have led several multinational teams in a series of projects looking at the impacts of the globalization of technology on emerging and first-world economies, multinational enterprises, entrepreneurs, and education systems. The authors retain the copyright for this article.

CHANGE • JULY/AUGUST 2007

Collaborative Advantage: New Horizons for a Flat World – *Issues in Science & Technology*

*www.nsf.gov/attachments/105652/public/**Collaborative-Advantage**-1205.pdf*

Collaborative Advantage

The days of U.S. technological domination are over. The nation must learn to thrive through working with others.

Michael Sonatchin, Community Involution 01. Acrylic on canvas, 36 x 72 inches, 2004.

NEW HORIZONS FOR A FLAT WORLD

LEONARD LYNN
HAL SALZMAN

Almost daily, news reports feature multinational companies—many based in the United States—that are establishing technology development facilities in China, India, and other emerging economies. General Electric, General Motors, IBM, Intel, Microsoft, Motorola—the list grows steadily longer. And these new facilities no longer focus on low-level technologies to meet Third World conditions. They are doing the cutting-edge research once done only in the United States, Japan, and Europe. Moreover, the multinationals are being joined by new firms, such as Huawei, Lenovo, and Wipro, from the emerging economies. This current globalization of technology development is, we believe, qualitatively different from globalization of the past. But the implications of the differences have not sunk in with key U.S. decisionmakers in government and industry.

It is not that the new globalization has gone unnoticed. Many observers are concerned that the United States is beginning to fall into a vicious cycle of disinvestment in and weakening of its innovation systems. As U.S. firms move their engineering and R&D activities offshore, they may be disinvesting not just in their own facilities but also in colleges and regions of the country that now form critical innovation clusters. These forces may combine to dissolve the bonds that form the basis of U.S. innovation leadership.

A variety of policies have been proposed to protect and restore the preeminent position of U.S. technology. Some of these proposals are most concerned with building up U.S. science and technology (S&T) human resources by strengthening the nation's education system from kindergarten through high school; encouraging more U.S. students to study engineering and science, specifically inducing more women and minorities to pursue science and technology careers; and easing visa restrictions that form barriers to talented foreigners who want to enter U.S. universities and industries. Other proposals include measures to outbid other countries as they offer benefits to attract R&D activities. Still others call for funneling public funds into the

Issues in Science and Technology
(National Academies of Science www.issues.org)
The research this paper is based on was generously supported by the National Science Foundation, Societal Dimensions of Engineering, Science, and Technology (SDEST) Program, Grant #0431735, and the Kauffman Foundation.

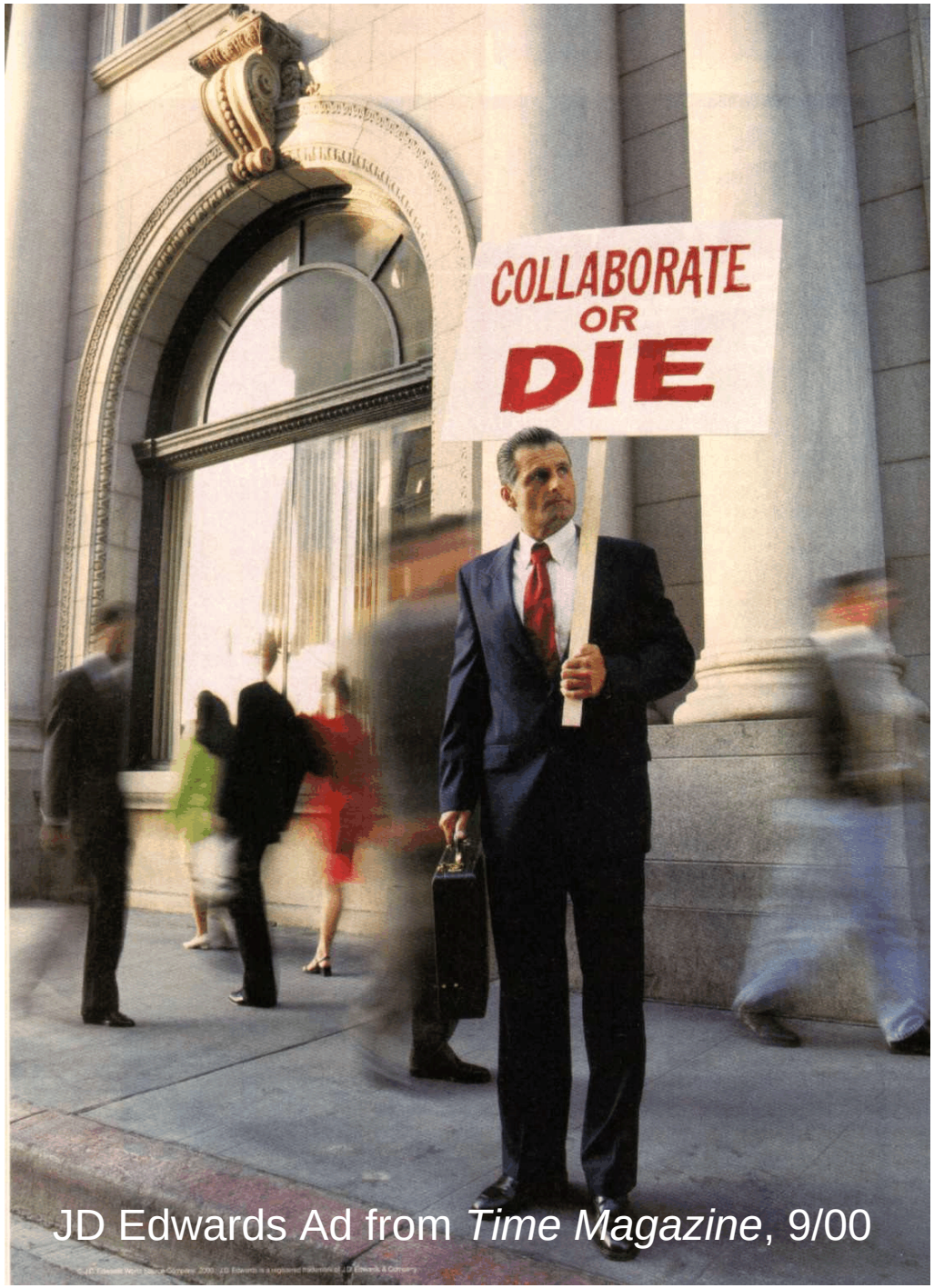
WINTER 2006 75

Change Magazine – July/August 2007

Collaborative Advantage
(Lynn & Salzman, 2006)

The United States should move away from an almost certainly futile attempt to maintain dominance and toward an approach in which leadership comes from developing and brokering mutual gains among equal partners. Such 'collaborative advantage,' as we call it, comes not from self-sufficiency or maintaining a monopoly on advanced technology, but from **being a valued collaborator at various levels in the international system of technology development**." (p. 76).

Among their three goals for the United States they argue that "the United States needs to develop a science and technology education system that teaches **collaborative competencies** rather than just technical knowledge and skills." (p.81).



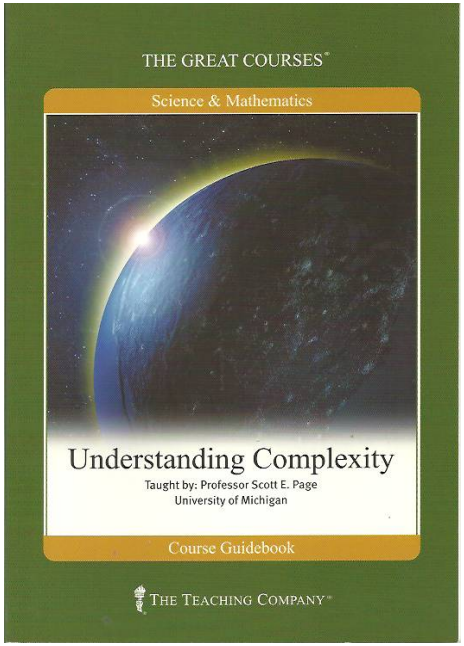
JD Edwards Ad from *Time Magazine*, 9/00

Preparing Students for an Interdependent World

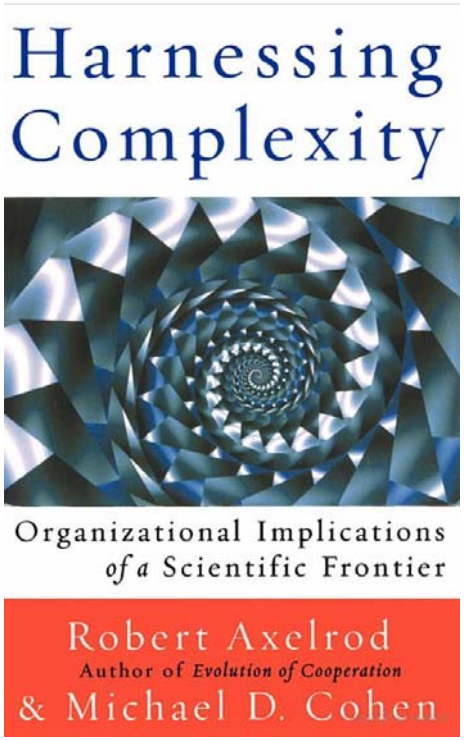
"If we cannot end now our differences, at least we can help make the world safe for diversity."

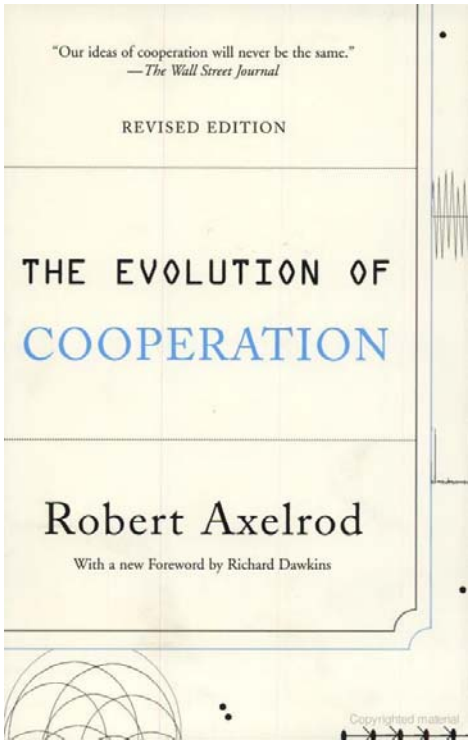
U.S. President John F. Kennedy, Commencement Address, American University, June 10, 1963.

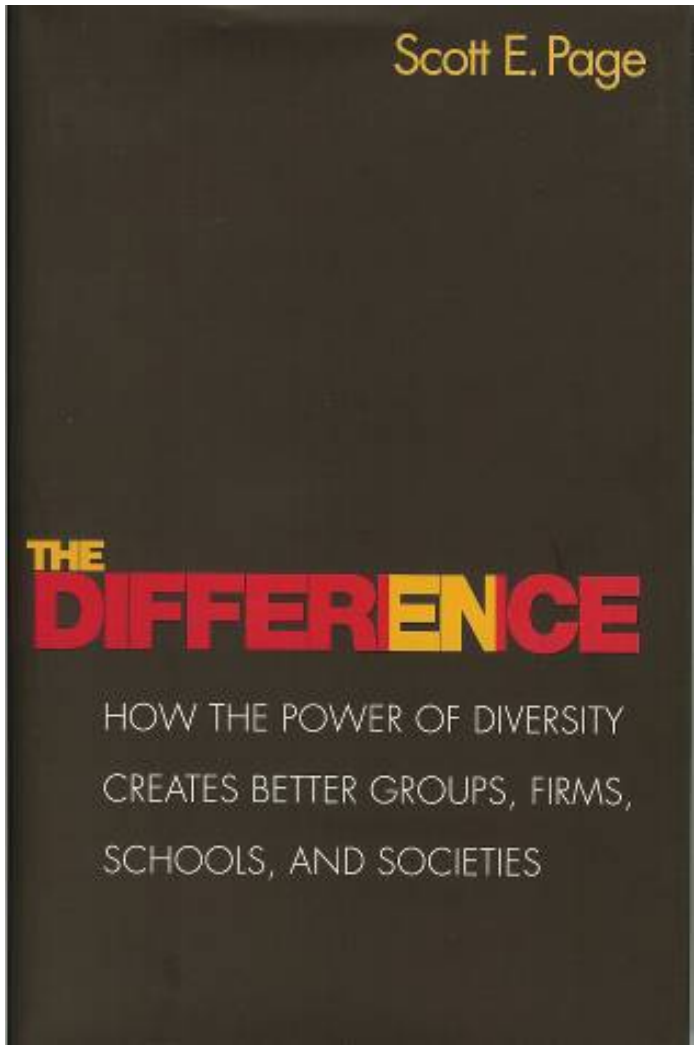
Cited in Harlan Cleveland, *Nobody in charge: Essays on the future of leadership*, Jossey-Bass, 2002.



a system can be considered complex if its agents meet four qualifications: diversity, connection, interdependence, and adaptation (Page, 2009).







Progress depends as much on our collective differences as it does on our individual IQ scores…

The claim that diversity should get equal billing with ability is a controversial one…

I show with modest rigor how diverse perspectives, heuristics, interpretations, and mental models improve our collective ability to solve problems and make predictions. (p. xx)

Safe for Diversity

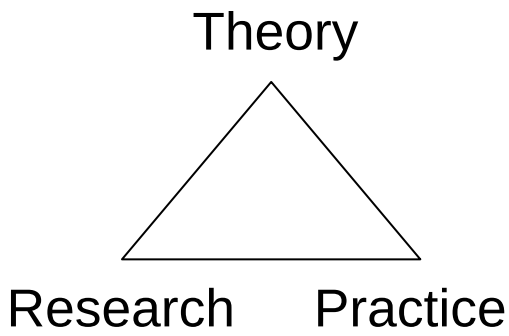
The required solvent for civilization is respect for differences. The art is to *be different together.*

Civilization will be built by cooperation and compassion, in a social climate in which people of different groups can deal with each other in ways that respect their cultural differences.

Harlan Cleveland, *Nobody in charge: Essays on the future of leadership*, Jossey-Bass, 2002.

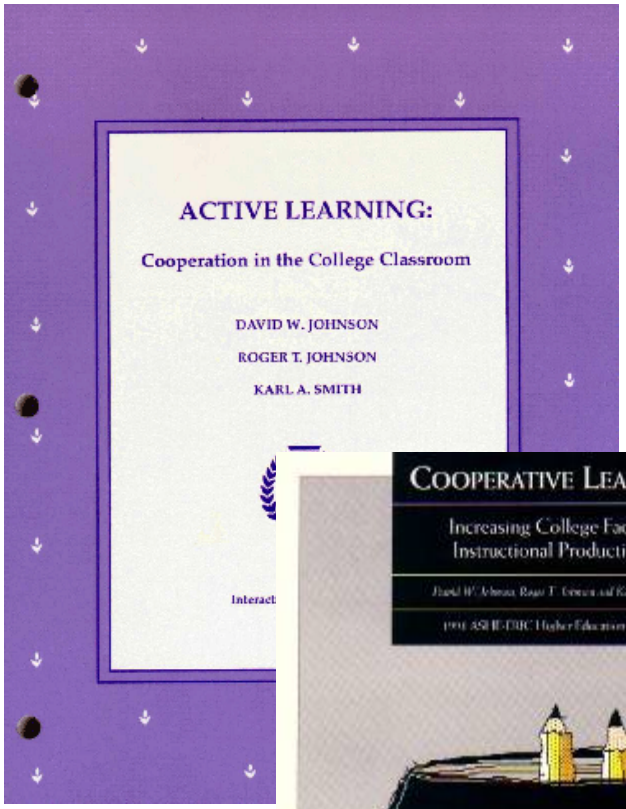
Cooperative Learning

- Theory – Social Interdependence – Lewin – Deutsch – Johnson & Johnson
- Research – Randomized Design Field Experiments
- Practice – Formal Teams/Professor's Role



Kurt Lewin's Contributions

- Social Interdependence Theory (~1935)
- Founded field of social psychology
- Action Research
- Force-Field analysis
- B = f(P,E)
- "There is nothing so practical as a good theory"



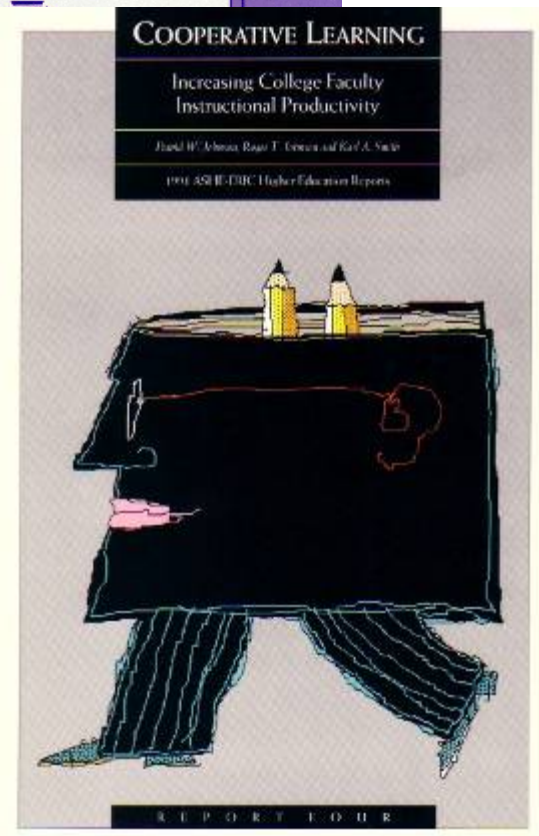
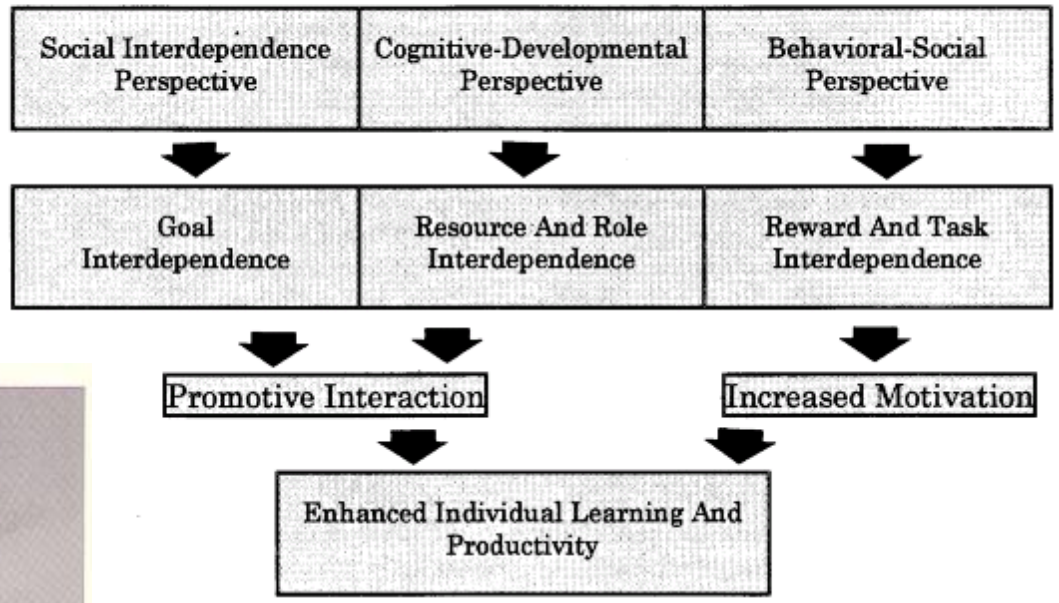


Figure A.1 A General Theoretical Framework



Cooperative Learning

- Positive Interdependence
- Individual and Group Accountability
- Face-to-Face Promotive Interaction
- Teamwork Skills
- Group Processing

Cooperative Learning Research Support

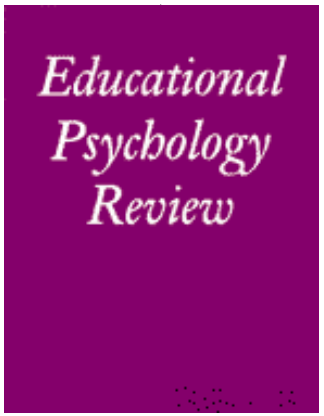
Johnson, D.W., Johnson, R.T., & Smith, K.A. 1998. Cooperative learning returns to college: What evidence is there that it works? *Change*, *30* (4), 26-35.

- Over 300 Experimental Studies
- First study conducted in 1924
- High Generalizability
- Multiple Outcomes

Outcomes

1. Achievement and retention
2. Critical thinking and higher-level reasoning
3. **Differentiated views of others**
4. **Accurate understanding of others' perspectives**
5. Liking for classmates and teacher
6. Liking for subject areas
7. Teamwork skills

January 2005



March 2007

Small-Group Learning: Meta-analysis

Springer, L., Stanne, M. E., & Donovan, S. 1999. Effects of small-group learning on undergraduates in science, mathematics, engineering, and technology: A meta-analysis. Review of Educational Research, 69(1), 21-52.

Small-group (predominantly cooperative) learning in postsecondary science, mathematics, engineering, and technology (SMET). 383 reports from 1980 or later, 39 of which met the rigorous inclusion criteria for meta-analysis.

The main effect of small-group learning on achievement, persistence, and attitudes among undergraduates in SMET was significant and positive. Mean effect sizes for achievement, persistence, and attitudes were 0.51, 0.46, and 0.55, respectively.

The American College Teacher:

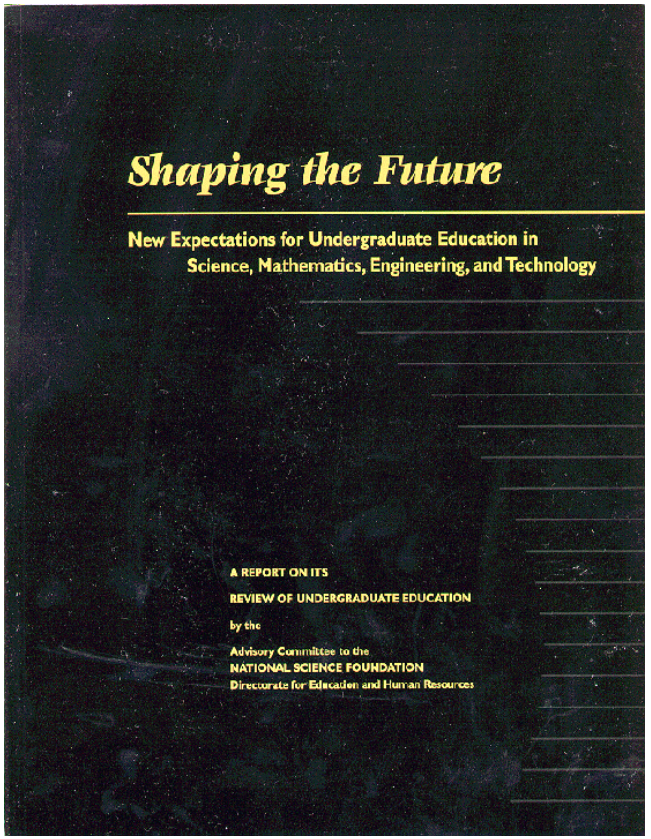
National Norms for 2007-2008

Methods Used in “All” or “Most”	All – 2005	All – 2008	Assistant - 2008
Cooperative Learning	48	59	66
Group Projects	33	36	61
Grading on a curve	19	17	14
Term/research papers	35	44	47

http://www.heri.ucla.edu/index.php

Shaping the Future: New Expectations for Undergraduate Education in Science, Mathematics, Engineering and Technology – **National Science Foundation, 1996**

Goal – All students have access to supportive, excellent undergraduate education in science, mathematics, engineering, and technology, and all students learn these subjects by direct experience with the methods and processes of inquiry.

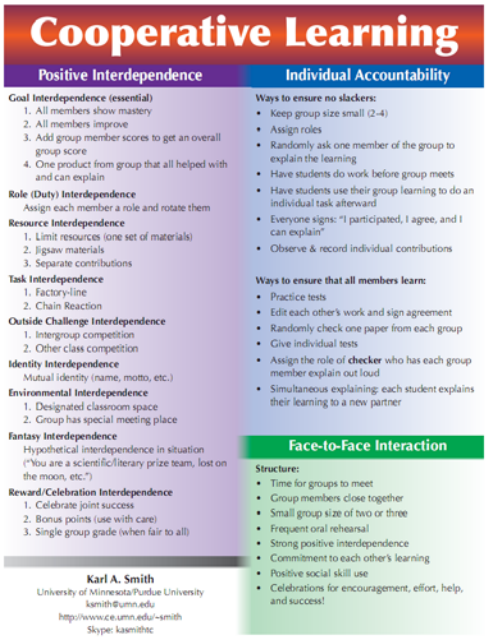


Recommend that SME&T faculty: Believe and affirm that every student can learn, and model good practices that increase learning; starting with the student's experience, but have high expectations within a supportive climate; and build inquiry, a sense of wonder and the excitement of discovery, plus communication and teamwork, critical thinking, and life-long learning skills into learning experiences.

Cooperative Learning is instruction that involves people working in teams to accomplish a common goal, under conditions that involve both *positive interdependence* (all members must cooperate to complete the task) and *individual and group accountability* (each member is accountable for the complete final outcome).

Key Concepts

- Positive Interdependence
- Individual and Group Accountability
- Face-to-Face Promotive Interaction
- Teamwork Skills
- Group Processing



Cooperative Learning

Positive Interdependence

Goal Interdependence (essential)
1. All members show mastery
2. All members improve
3. Add group member scores to get an overall group score
4. One product from group that all helped with and can explain

Role (Duty) Interdependence
Assign each member a role and rotate them

Resource Interdependence
1. Limit resources (one set of materials)
2. Jigsaw materials
3. Separate contributions

Task Interdependence
1. Factory-line
2. Chain Reaction

Outside Challenge Interdependence
1. Intergroup competition
2. Other class competition

Identity Interdependence
Mutual identity (name, motto, etc.)

Environmental Interdependence
1. Designated classroom space
2. Group has special meeting place

Fantasy Interdependence
Hypothetical interdependence in situation ("You are a scientific/literary prize team, lost on the moon, etc.")

Reward/Celebration Interdependence
1. Celebrate joint success
2. Bonus points (use with care)
3. Single group grade (when fair to all)

Individual Accountability

Ways to ensure no slackers:
- Keep group size small (2-4)
- Assign roles
- Randomly ask one member of the group to explain the learning
- Have students do work before group meets
- Have students use their group learning to do an individual task afterward
- Everyone signs: "I participated, I agree, and I can explain"
- Observe & record individual contributions

Ways to ensure that all members learn:
- Practice tests
- Edit each other's work and sign agreement
- Randomly check one paper from each group
- Give individual tests
- Assign the role of **checker** who has each group member explain out loud
- Simultaneous explaining: each student explains their learning to a new partner

Face-to-Face Interaction

Structure:
- Time for groups to meet
- Group members close together
- Small group size of two or three
- Frequent oral rehearsal
- Strong positive interdependence
- Commitment to each other's learning
- Positive social skill use
- Celebrations for encouragement, effort, help, and success!

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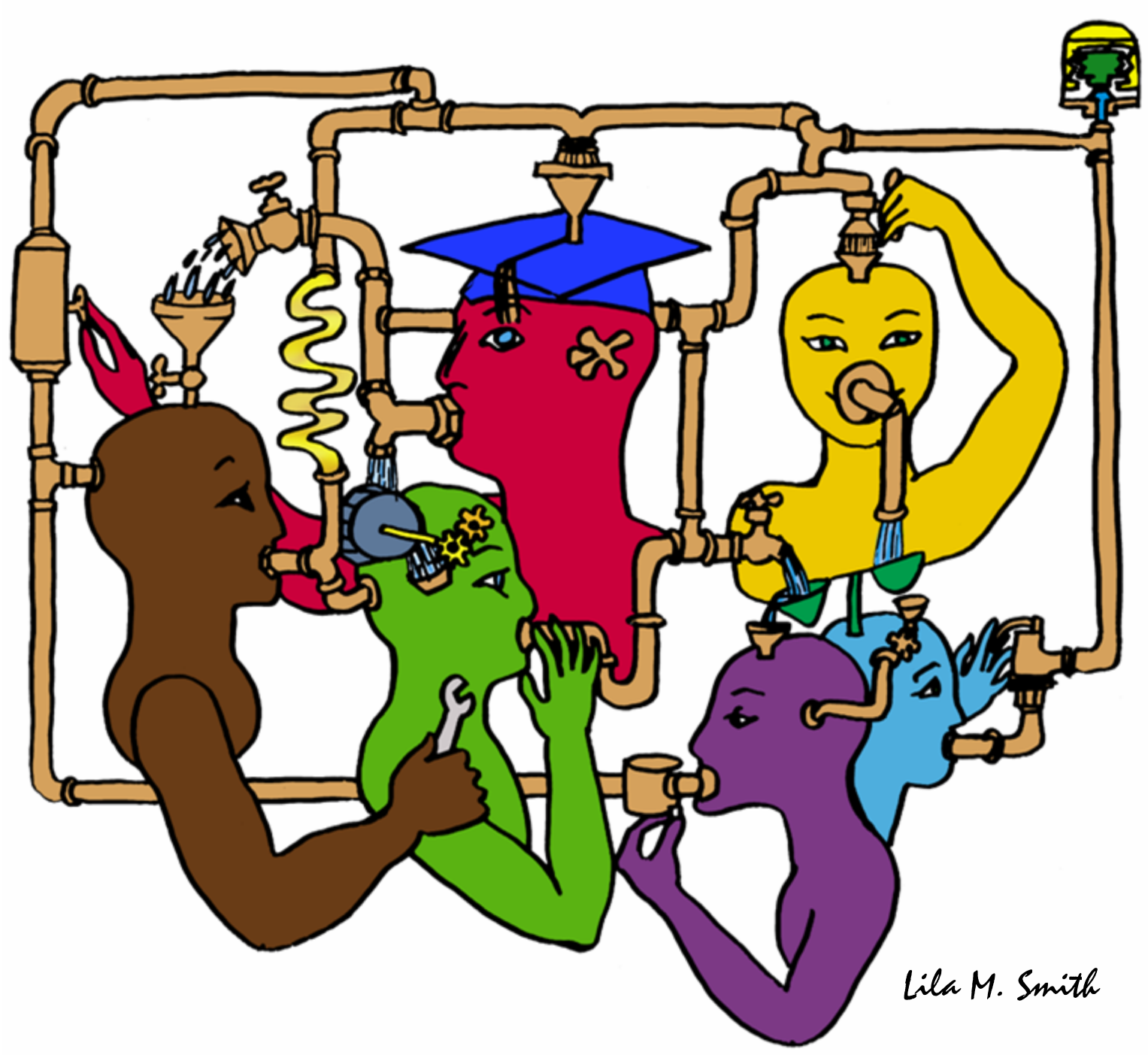
http://www.ce.umn.edu/~smith/docs/Smith-CL%20Handout%2008.pdf

Cooperative Learning: A Pedagogy of Engagement for Diversity

Grounded in

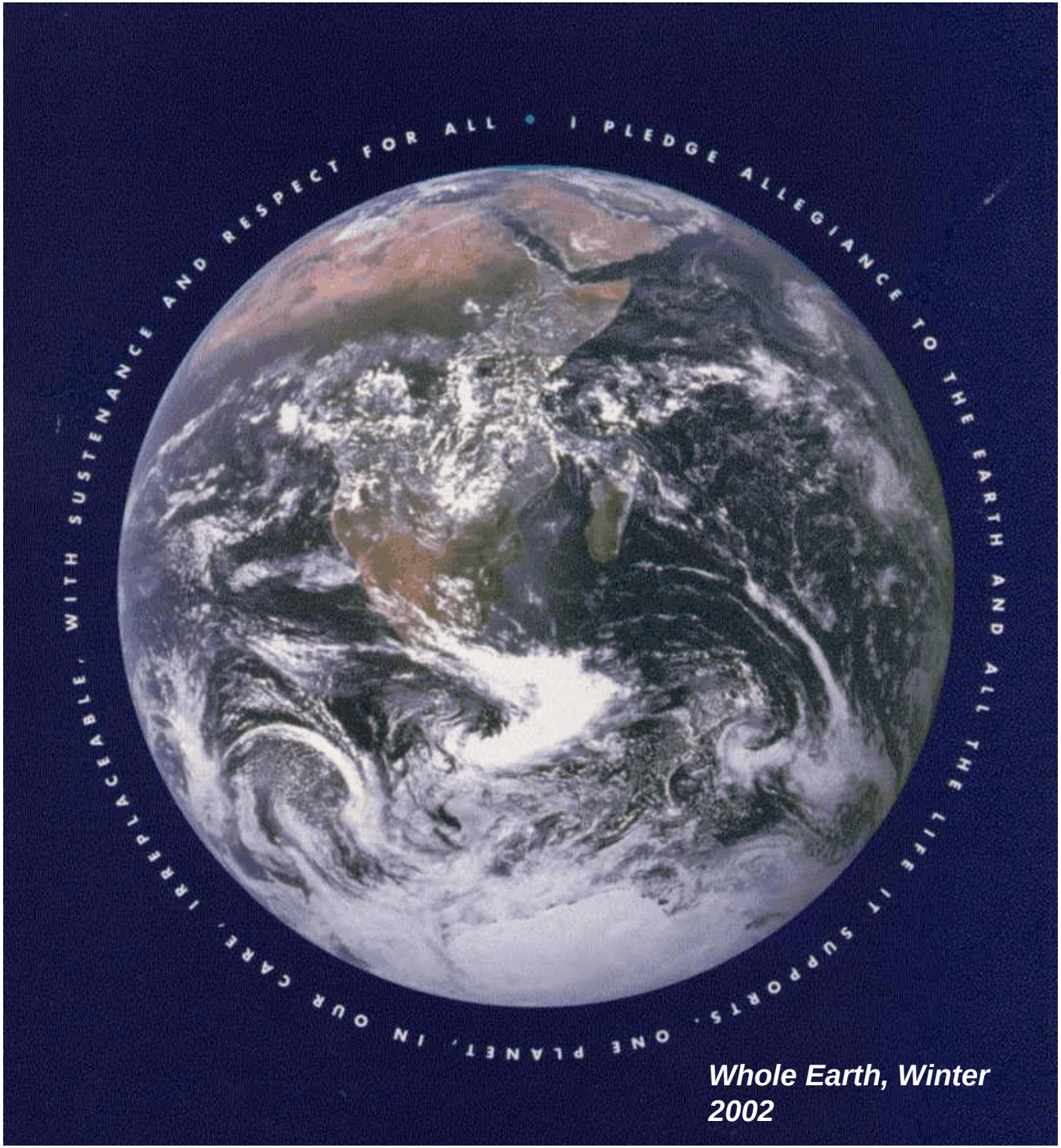
Social Interdependence Theory

Lila M. Smith

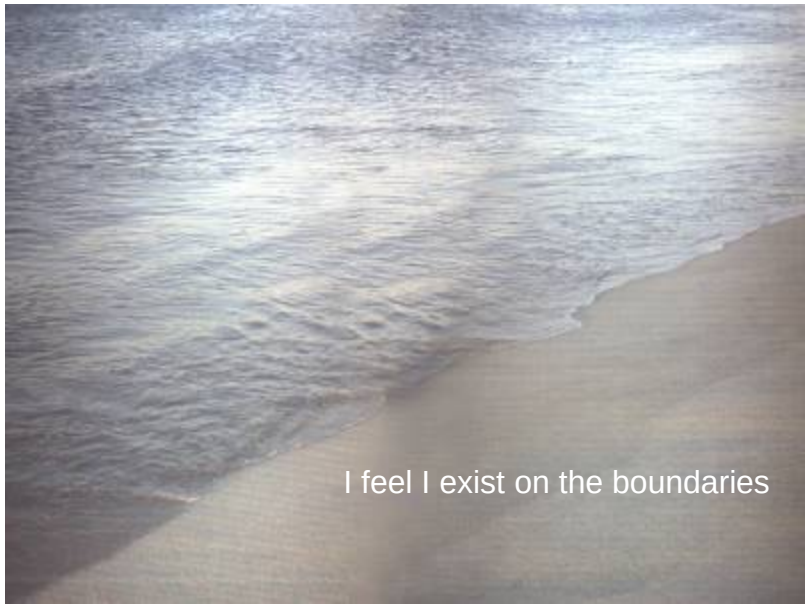

Lila M. Smith

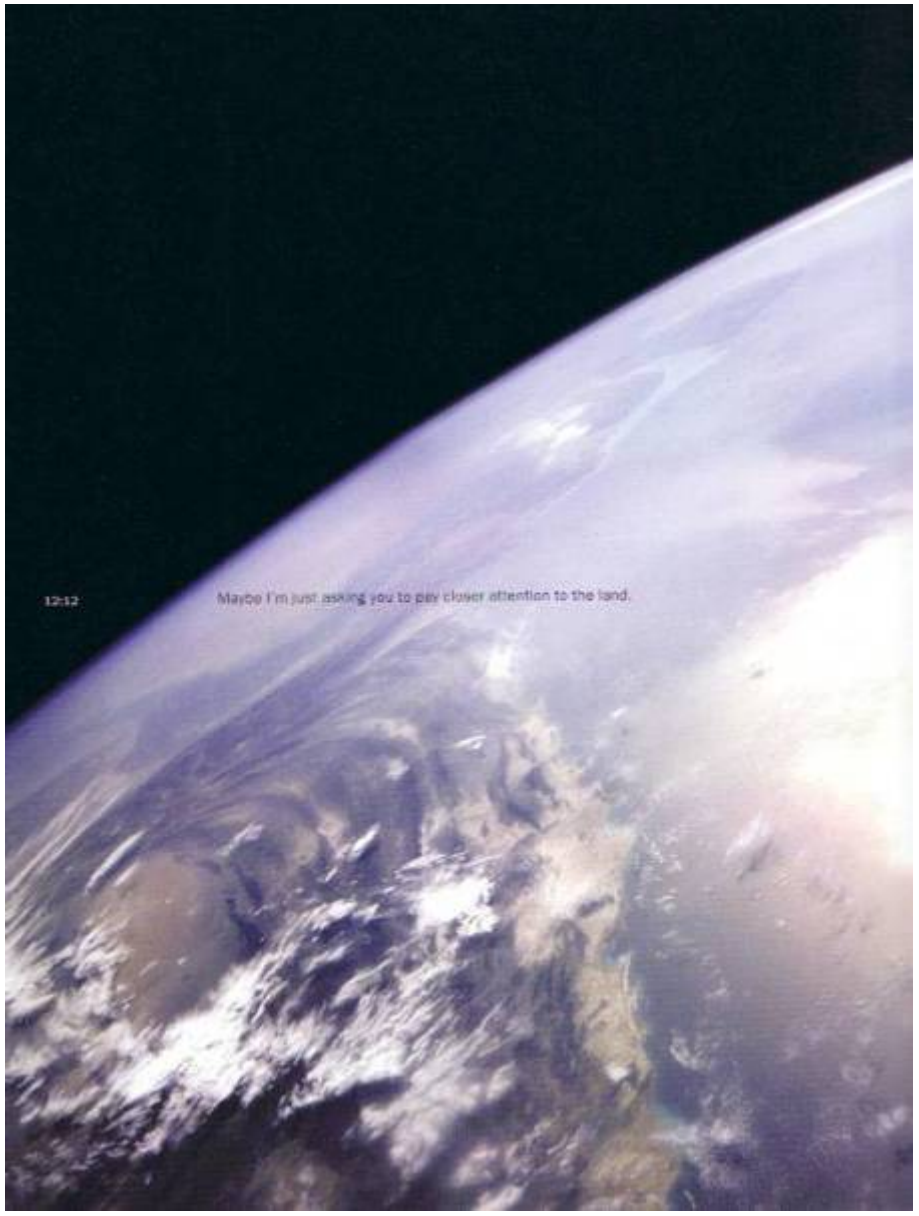
It could well be that faculty members of the twenty-first century college or university will find it necessary to set aside their roles as teachers and instead become designers of learning experiences, processes, and environments.

James Duderstadt, 1999 [Nuclear Engineering Professor; Dean, Provost and President of the University of Michigan]



Whole Earth, Winter 2002





Maybe I’m just asking you to pay closer attention to the land