Individual and Institutional Strategies for Enabling Interdisciplinary Graduate Research and Training Programs

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My background

- BS, MS and PhD in Materials Science and Engineering
- Current interdisciplinary field: Engineering education
- Research on STEM interdisciplinary graduate education, academic research groups, and teaching teamwork
- Experience as Associate Dean for Interdisciplinary Graduate Education

Team publications, patents and size are increasing over time
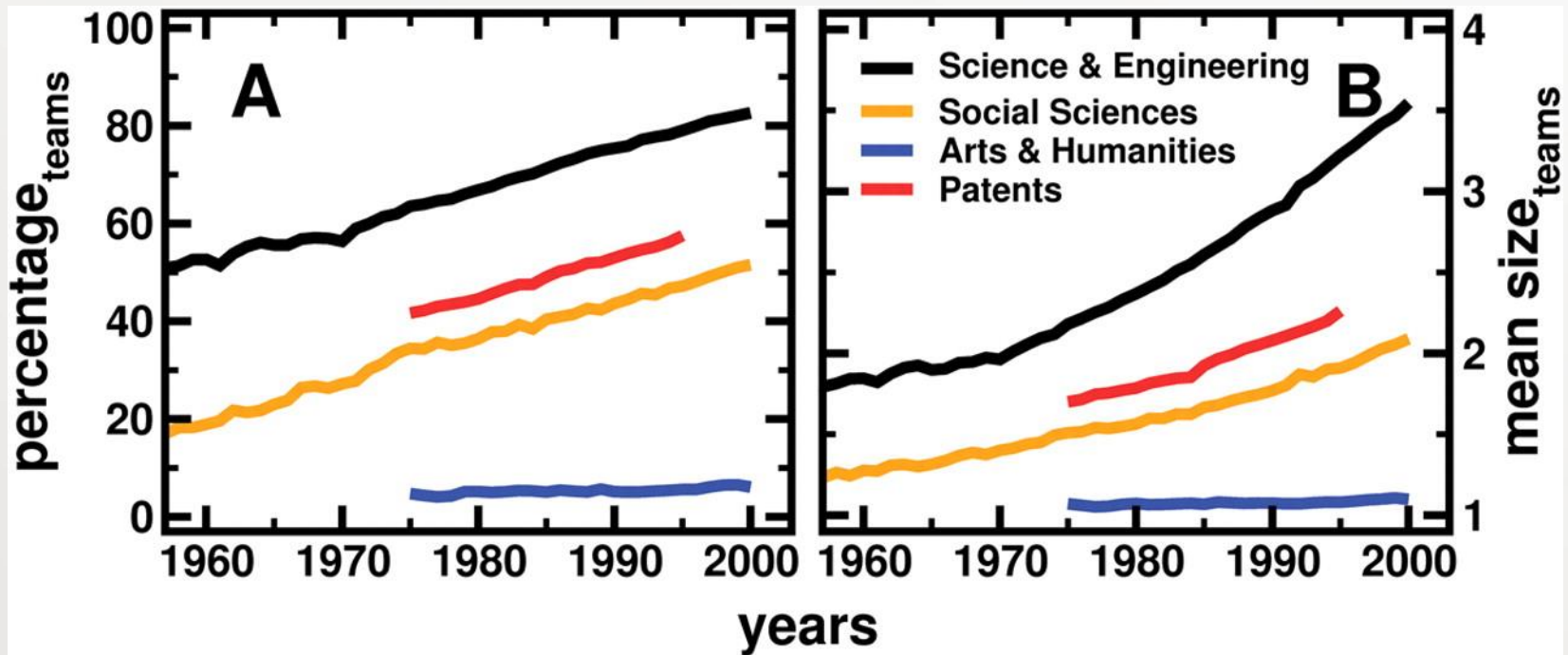
Wuchty S, Jones B, Uzzi B. The Increasing Dominance of Teams in Production of Knowledge. Science. 2007 May 18;316(5827):1036-1039.
20 million papers and 2 million patents

# Benefits of graduate students on interdisciplinary teams

Discuss with your neighbors: what are some of the benefits of including graduate students on interdisciplinary teams?

Benefits of graduate students on interdisciplinary teams

- Help to make connections between departments, disciplines and people through coursework and friends

- Contribute to diversity and creativity, not burdened with strong disciplinary norms

- Students learn intellectual and practical aspects of conducting IDR

- Research and writing gets done

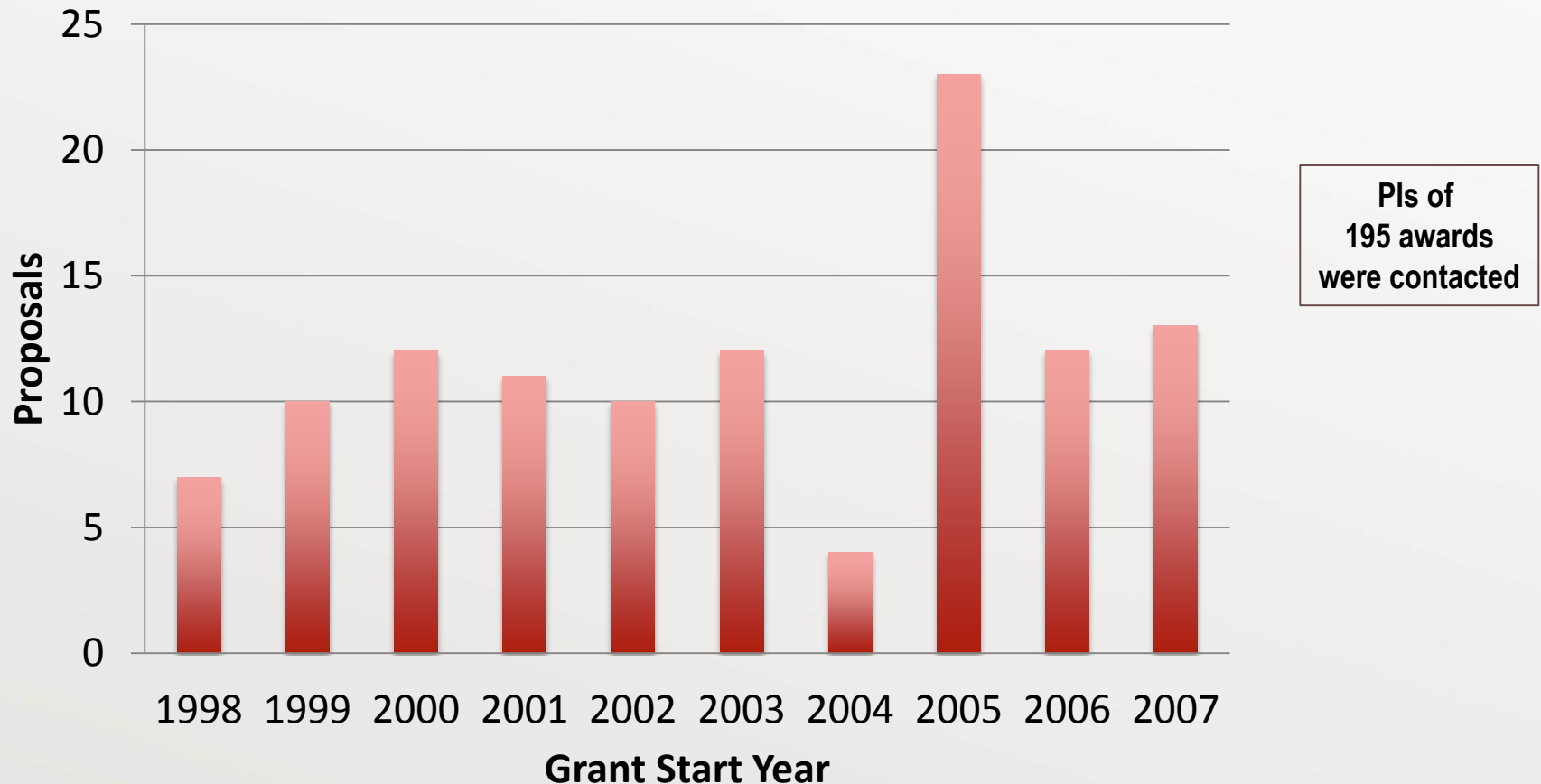# Interdisciplinary learning outcomes

Method overview

Grant Proposal

new understanding
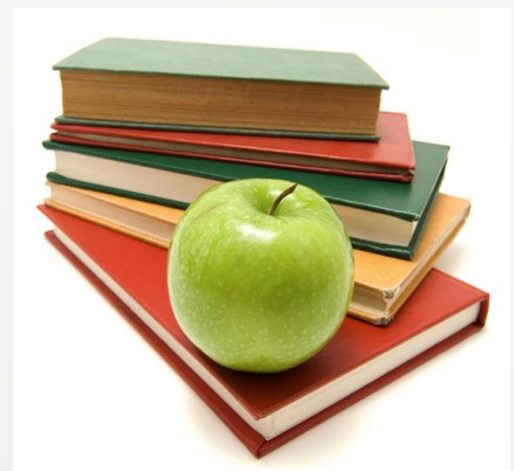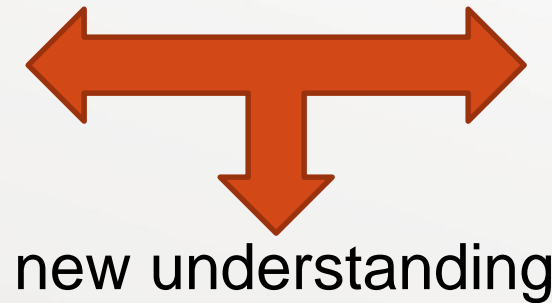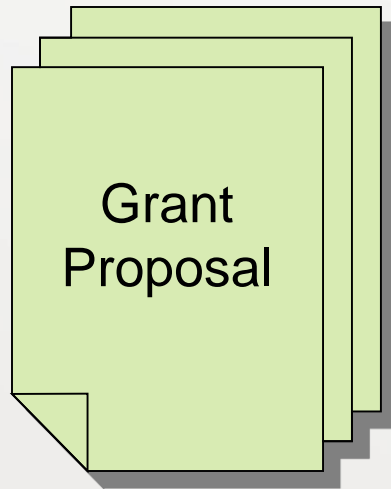
Values and experience
of science and engineering
faculty members

Theory, conceptualization
and some empirical studies
from interdisciplinary studies
(humanities)

Collected and analyzed 130 successful NSF IGERT proposals

Pls of
195 awards
were contacted

Borrego, M., & Newswander, L. K. (2010). Definitions of interdisciplinary research: Toward graduate-level interdisciplinary learning outcomes. *The Review of Higher Education, 34(1), 61-84.*

Perspective/multiple disciplines

- "Students must demonstrate basic competence in mathematics, molecular genetics, computer science, and statistics."

- "appropriate literature, methodologies, principles, and vocabulary necessary to integrate the relevant perspectives."

- "…create an appreciation of the intellectual challenges faced by the respective disciplines, the methodology used to pursue these challenges, and the ability to formulate and solve interdisciplinary problems effectively."

Teamwork

- "a multidisciplinary team that approaches difficult issues from a range of perspectives can make exciting advances that no single group of investigators could accomplish."

- "most successful multi-disciplinary research takes place collaboratively, in small or large teams"

- "Ph.D. graduates are increasingly required to work in multidisciplinary, and often geographically distributed, teams"

Interdisciplinary communication

- "We want our students to be capable of communicating their research to scientists who are not specialists in their particular field."

- "communicate effectively, in writing and orally, with both subject area experts and the layperson."

- "As disciplinary language is often a barrier to collaboration and understanding, Fellows will learn to 'speak one another's languages' by studying the approaches, methods, terminology, and questions of other disciplines"

Steps in interdisciplinary research

1. Identifying relevant disciplines,
2. Developing adequacy in relevant disciplines,
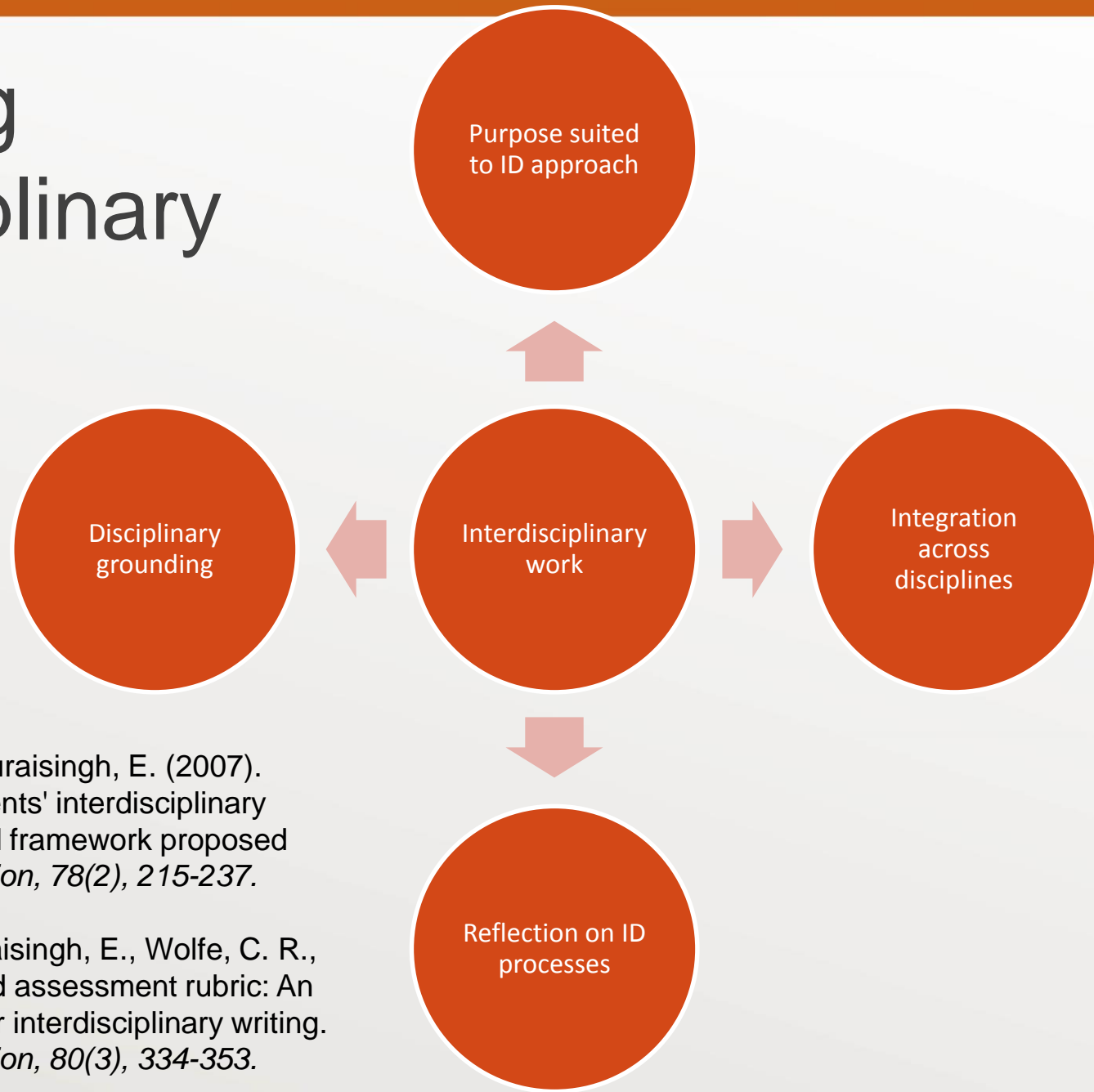3. Analyzing the problem and evaluating each insight into it,
4. Identifying conflicts in insights,
5. Creating (or discovering) common ground, and
6. Integrating insights and producing an interdisciplinary understanding.

Repko, A. F. (2008). *Interdisciplinary Research. Thousand Oaks, CA: SAGE.*
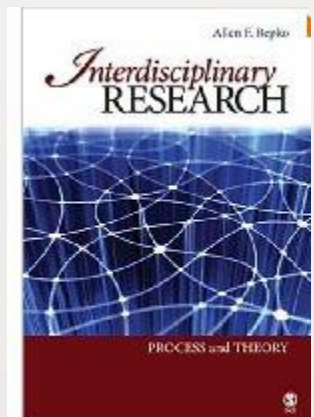
Assessing interdisciplinary work

Purpose suited to ID approach

Disciplinary grounding

Interdisciplinary work

Integration across disciplines

Reflection on ID processes

Boix Mansilla, V., & Dawes Duraisingh, E. (2007). Targeted assessment of students' interdisciplinary work: An empirically grounded framework proposed *The Journal of Higher Education, 78(2), 215-237.*

Boix Mansilla, V., Dawes Duraisingh, E., Wolfe, C. R., & Haynes, C. (2009). Targeted assessment rubric: An empirically grounded rubric for interdisciplinary writing. *The Journal of Higher Education, 80(3), 334-353.*

Combined list of outcomes

Engineering & Science

Broad perspective of multiple disciplines

Teamwork

Interdisciplinary communication

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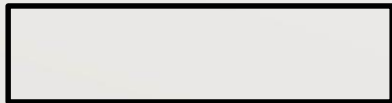
Disciplinary grounding

Integration

Teamwork

Communication

Critical awareness

ID Studies

Disciplinary grounding

Integration

[ ]

Communication across boundaries

Critical awareness

Training and education interventions

How can we better train graduate students to develop skills in

- – Integration,
- – Teamwork,
- – Communication, and
- – Critical awareness ?

Training and education interventions

- Courses, with team projects (proposal writing)
- Lab rotations
- Multiple advisors or broad set of qualified advisors
- Internships
- Seminars across disciplines
- Retreats, orientation
- Workshops, symposia, conferences across disciplines
- Common space (across disciplines)

Borrego, M., & Cutler, S. (2010). Constructive alignment of interdisciplinary graduate curriculum in engineering and science: An analysis of successful IGERT proposals. *Journal of Engineering Education, 99(4), 355-369.*

Institutional structures and change efforts to support interdisciplinary work
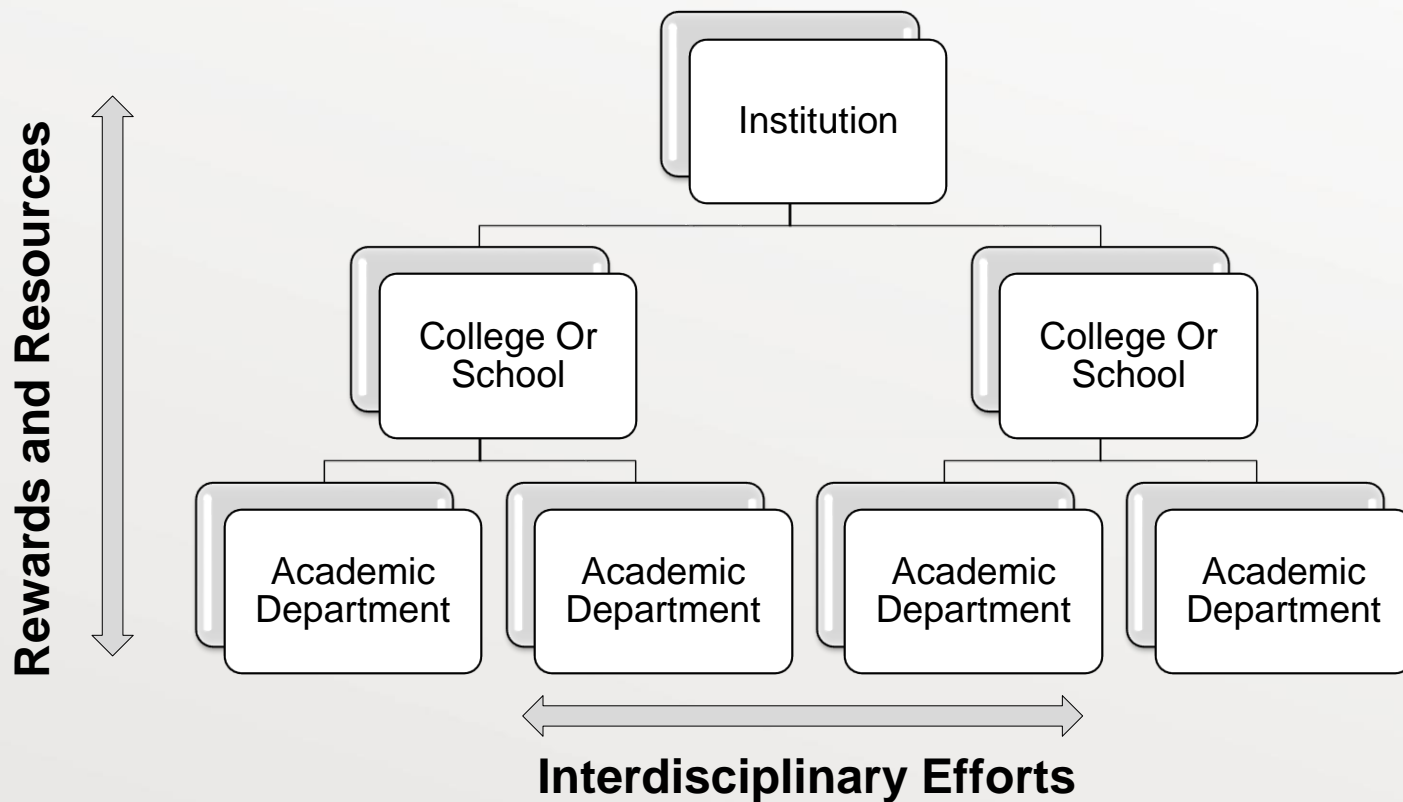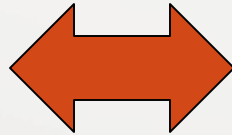
One concept from organizational change theories

**Formal
written policies**

**What people think is
(or should be)
done**

Kezar, A. J. (2001). Understanding and Facilitating Organizational Change in the 21st Century: Recent Research and Conceptualizations. ASHE-ERIC Higher Education Report Volume 28, Number 4. San Francisco, CA: Jossey-Bass.

Primary institutionalization mechanisms (annual reports to NSF)

- Courses, curriculum, teaching load
  - Few solutions for team/ID teaching load
- Graduate education policies
  - Flexibility to fund and advise ID students
- Internal funding
  - Interdisciplinary fellowships
- Faculty hires and policies
  - 253 new ID hires reported in annual reports
- Space, centers and new funding
  - 33-45% of projects reporting center funding (rising)

Process and advocacy

- IGERT raises the profile for interdisciplinary work on campus
  - More IGERT submissions
  - Advisory committees to provost, president, etc.
- IGERT PIs come together to share best practices, advocate to change policies
- Student organizations are formed
- PIs and Co-PIs move into administration (expand successful programs)

Borrego, M., Boden, D., & Newswander, L. K. (2014). Sustained change: Institutionalizing interdisciplinary graduate education *Journal of Higher Education, 85(6), 858-885. doi: 10.1353/jhe.2014.0033*

THE UNIVERSITY OF TEXAS AT AUSTIN

Policies and change initiatives

- Courses centrally listed or crosslisted
- Advisor eligibility broader than dept
- "Support groups" of interdisciplinary program leaders
  – Focus on policies at UTEP, not specific domain
- External awards to raise awareness and legitimacy – publicize them!
- Promotion, tenure and productivity reporting
- Graduate dean/students as altruistic motivation and allies

Borrego, M., Boden, D., & Newswander, L. K. (2014). Sustained change: Institutionalizing interdisciplinary graduate education *Journal of Higher Education, 85(6), 858-885. doi: 10.1353/jhe.2014.0033*

Strategies

- Be creative about institutionalizing grant components
- Use evaluation data to identify and demonstrate effectiveness of most critical components
- PIs and directors, prepare to be experts, leaders, spokespeople for interdisciplinary research
- Develop campus coalitions supporting interdisciplinarity
- Work with graduate dean as an advocate of interdisciplinary graduate education
- Focus on changing <u>policies</u> and <u>attitudes</u> to enable interdisciplinary work

Bringing it all home

- Which strategies resonate most with you?

- What policies do you most want changed at your institution to facilitate interdisciplinary research?

- What can you do in the next month to promote interdisciplinary research in material systems at your institution?

Resources

- Collaboration and Team Science: a Field Guide at <u>teamscience.nih.gov</u>
  - Practical advice for collaboration agreements and evaluating contributions for P&T and authorship
- <u>Teamscience.net</u> online training
- <u>AAAS Facilitating Interdisciplinary Research and Education: A Practical Guide</u>
- Many more at <u>www.teamsciencetoolkit.cancer.gov</u>
  - Articles, reports, guides, templates, training tools