

The Pros & Cons of  
Interdisciplinary  
Research

Stephen Gilbert, Ph.D.

Human Computer Interaction  
Industrial & Manufacturing  
Systems Engineering  
Psychology

April 4, 2014

If your research question is:

“Why are most U.S. elementary teachers female?”

Which data are more useful?

24 personal journals from teachers



statistics on teacher hiring

etent	39	78	39	78	40	74	35	73	36	67	42	81	43	83	42	85	30	72	37	75	46	83	40	80	31	69	40	79	
at competent	48	20	50	21	44	24	52	26	46	28	50	18	46	16	48	14	52	26	50	23	45	16	47	19	50	29	49	20	
ompetent	11	1	10	1	15	2	12	1	15	3	7	1	10	1	10	1	17	2	11	2	9	1	11	0	18	2	10	1	
ompetent	1	0	1	0	1	1	0	0	2	1	1	0	0	0	1	0	1	1	2	0	0	0	1	0	1	1	1	0	
ompetent	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	
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etent	26	77	25	78	30	70	28	72	28	72	23	83	22	80	28	82	23	70	26	76	24	78	29	82	16	76	28	77	
ompetent	53	22	55	20	47	29	53	26	51	27	55	15	56	19	55	17	57	29	50	22	57	20	53	18	61	22	52	22	
ompetent	19	1	18	1	21	1	18	1	21	1	20	2	20	2	15	0	18	1	22	2	17	2	16	0	20	2	18	1	
ompetent	2	0	1	0	2	0	1	0	1	0	1	0	2	0	2	0	2	0	2	0	2	0	2	0	3	0	1	0	
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at competent	49	15	49	13	45	20	43	23	43	16	48	11	60	7	47	7	44	25	45	14	51	10	53	12	47	18	48	14	
ompetent	22	1	22	1	19	1	22	1	26	2	22	0	16	0	23	0	26	1	25	1	17	0	20	1	30	1	20	1	
ompetent	3	0	2	0	5	0	2	0	5	0	2	1	2	0	3	0	2	1	3	0	2	1	4	0	4	1	3	0	
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ompetent	24	1	24	1	21	1	23	2	28	2	24	0	20	1	23	0	26	2	24	2	21	0	23	1	27	1	23	1	
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ompetent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	
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etent	35	85	35	87	35	78	38	81	30	81	34	91	32	88	35	91	33	81	38	88	34	84	33	88	23	78	37	86	
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ompetent	14	0	14	0	16	1	14	0	14	1	15	0	14	0	16	0	15	0	14	0	15	1	16	0	22	1	14	0	
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ompetent	44	15	45	15	36	15	39	14	45	20	41	14	48	12	47	14	42	13	39	16	45	13	45	15	50	19	42	14	
ompetent	10	1	9	1	7	2	7	1	11	1	10	0	12	1	8	1	5	2	11	0	10	1	12	1	14	3	8	1	
ompetent	2	0	2	0	1	0	0	0	3	0	0	3	0	2	0	1	0	1	0	2	0	2	0	1	0	2	0	2	0
ompetent	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	
administrative																													
etent	32	73	30	73	44	73	46	75	25	69	29	73	26	73	30	71	36	72	36	75	30	70	30	73	21	64	36	74	
ompetent	45	24	46	24	39	24	38	23	47	27	49	22	49	24	44	26	40	25	45	22	48	26	43	25	45	31	44	22	

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competent	11	1	10	1	15	2	12	1	15	3	7	1	10	1	10	1	17	2	11	2	9	1	11	0	18	2	10	1	
not competent	1	0	1	0	1	1	0	0	2	1	1	0	0	0	1	0	1	1	2	0	0	0	1	0	1	1	1	0	
competent	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	
management																													
elementary	26	77	25	78	30	70	28	72	28	72	23	83	22	80	28	82	23	70	26	76	24	78	29	82	16	76	28	77	
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competent	19	1	18	1	21	1	18	1	21	1	20	2	20	2	15	0	18	1	22	2	17	2	16	0	20	2	18	1	
not competent	2	0	1	0	2	0	1	0	1	0	1	0	2	0	2	0	2	0	2	0	2	0	2	0	3	0	1	0	
competent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	
management																													
elementary	27	84	27	86	31	79	32	76	27	82	29	89	21	92	27	92	28	74	28	85	30	89	23	87	19	80	29	85	
not competent	49	15	49	13	45	20	43	23	43	16	48	11	60	7	47	7	44	25	45	14	51	10	53	12	47	18	48	14	
competent	22	1	22	1	19	1	22	1	26	2	22	0	16	0	23	0	26	1	25	1	17	0	20	1	30	1	20	1	
not competent	3	0	2	0	5	0	2	0	5	0	2	1	2	0	3	0	2	1	3	0	2	1	4	0	4	1	3	0	
competent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	
discipline																													
elementary	25	78	25	80	30	70	30	70	25	73	25	79	23	85	24	89	26	71	25	76	30	81	23	83	18	74	27	78	
not competent	48	21	48	18	44	28	44	28	42	25	49	20	53	14	48	11	44	27	47	22	46	19	50	15	50	24	46	20	
competent	24	1	24	1	21	1	23	2	28	2	24	0	20	1	23	0	26	2	24	2	21	0	23	1	27	1	23	1	
not competent	4	0	3	0	5	0	3	0	5	1	3	1	4	0	3	0	3	1	4	0	3	1	4	0	5	1	4	0	
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instruction																													
elementary	35	85	35	87	35	78	38	81	30	81	34	91	32	88	35	91	33	81	38	88	34	84	33	88	23	78	37	86	
not competent	49	15	50	13	45	21	46	19	54	19	50	9	52	12	48	8	51	19	45	12	50	16	51	12	53	21	48	14	
competent	14	0	14	0	16	1	14	0	14	1	15	0	14	0	16	0	15	0	14	0	15	1	16	0	22	1	14	0	
not competent	2	0	1	0	3	0	2	0	2	0	1	0	1	0	1	0	1	0	2	0	2	0	1	0	2	0	1	0	
competent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	
collaboration																													
elementary	44	84	43	84	56	84	54	85	42	79	49	86	36	86	42	84	53	85	49	83	43	86	40	83	35	78	48	85	
not competent	44	15	45	15	36	15	39	14	45	20	41	14	48	12	47	14	42	13	39	16	45	13	45	15	50	19	42	14	
competent	10	1	9	1	7	2	7	1	11	1	10	0	12	1	8	1	5	2	11	0	10	1	12	1	14	3	8	1	
not competent	2	0	2	0	1	0	0	0	3	0	0	3	0	2	0	1	0	1	0	2	0	2	0	1	0	2	0	2	0
competent	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	
administrative																													
elementary	32	73	30	73	44	73	46	75	25	69	29	73	26	73	30	71	36	72	36	75	30	70	30	73	21	64	36	74	
not competent	45	24	46	24	39	24	38	23	47	27	49	22	49	24	44	26	40	25	45	22	48	26	43	25	45	31	44	22	

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ompetent	11	1	10	1	15	2	12	1	15	3	7	1	10	1	10	1	17	2	11	2	9	1	11	0	18	2	10	1	
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ompetent	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0
anage time																													
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ompetent	53	22	55	20	47	29	53	26	51	27	55	15	56	19	55	17	57	29	50	22	57	20	53	18	61	22	52	22	
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ompetent	2	0	1	0	2	0	1	0	1	0	1	0	2	0	2	0	2	0	2	0	2	0	2	0	3	0	1	0	
ompetent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
anagement																													
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ompetent	22	1	22	1	19	1	22	1	26	2	22	0	16	0	23	0	26	1	25	1	17	0	20	1	30	1	20	1	
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ompetent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
etent	25	79	25	80	30	70	30	70	25	75	25	75	25	85	24	80	26	71	25	76	30	81	25	83	16	74	27	78	
ompetent	48	21	48	19	44	24	48	24	42	26	49	20	45	14	48	11	44	27	47	12	46	19	50	15	50	24	46	20	
ompetent	24	1	24	1	21	1	23	2	24	0	20	1	23	0	26	2	24	2	24	3	21	0	23	1	27	1	23	1	
ompetent	4	0	3	0	5	0	3	0	5	0	3	1	4	0	3	0	3	1	4	0	3	1	4	0	5	1	4	0	
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ompetent	10	1	9	1	7	2	7	1	11	1	10	0	12	1	8	1	5	2	11	0	10	1	12	1	14	3	8	1	
ompetent	2	0	2	0	1	0	0	0	3	0	0	3	0	2	0	1	0	1	0	2	0	2	0	1	0	2	0	2	0
ompetent	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0
administrative																													
etent	32	73	30	73	44	73	46	75	25	69	29	73	26	73	30	71	36	72	36	75	30	70	30	73	21	64	36	74	
ompetent	45	24	46	24	39	24	38	23	47	27	49	22	49	24	44	26	40	25	45	22	48	26	43	25	45	31	44	22	

Differences in research methods

Resilient  
Interdependent  
Infrastructure  
Processes and  
Systems

...principal investigators should represent **three or more** distinct disciplinary areas as described in this solicitation (computer science; engineering; social, economic, and behavioral sciences).

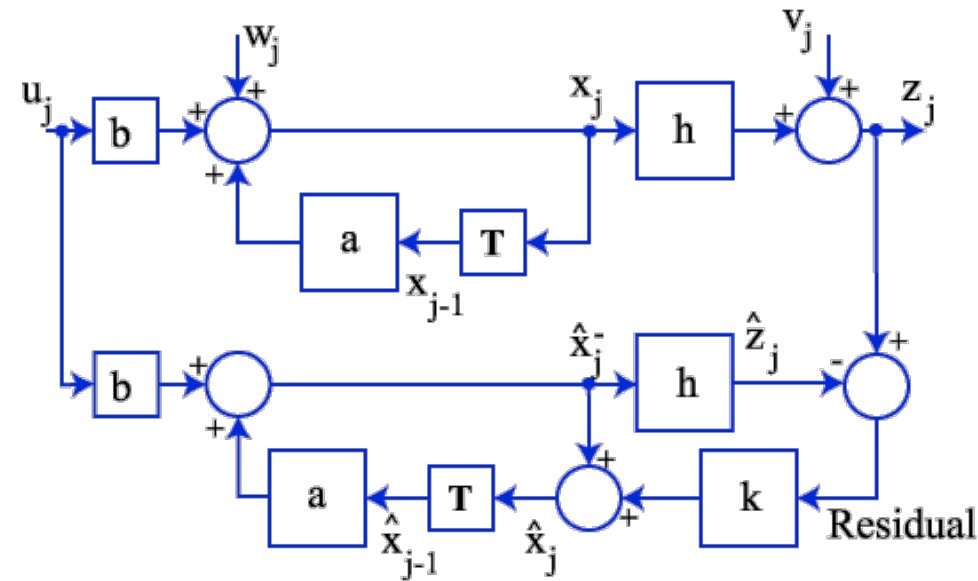


Resilient  
Interdependent  
Infrastructure  
Processes and  
Systems



Differences in knowledge and skills

...principal investigators should represent **three or more** distinct disciplinary areas as described in this solicitation (computer science; engineering; social, economic, and behavioral sciences).



“Kalman Filter”

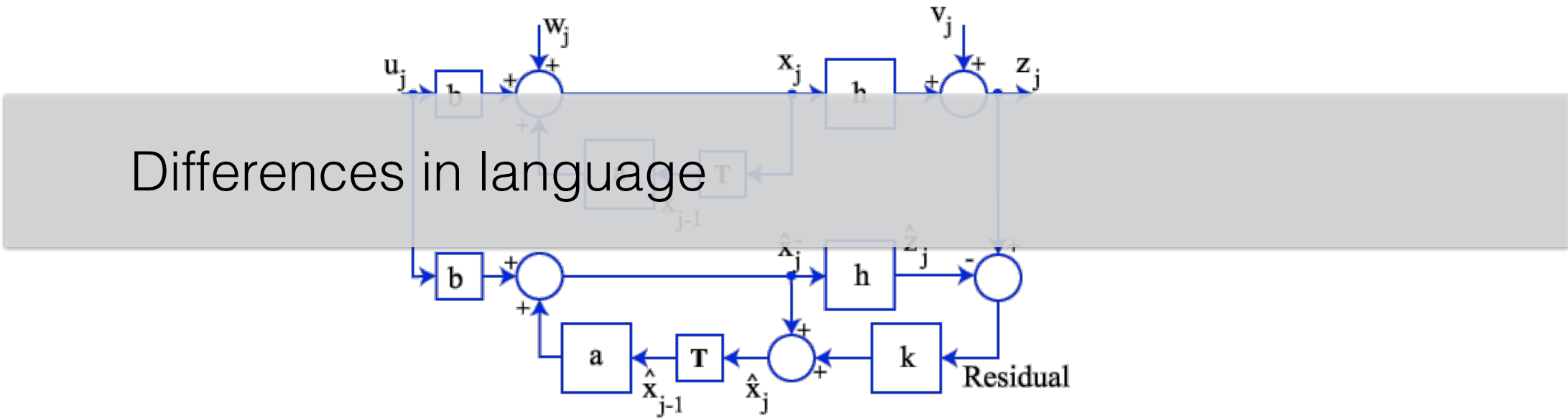
“dynamic Bayesian network”

*engineering*

*statistics*

“Unfortunately, much of the published literature on KF is in the engineering journals...and uses a language, notation, and style that is alien to statisticians.”

*Meinhold & Singpurwalla (1983)*



“Kalman Filter”

“dynamic Bayesian network”

*engineering*

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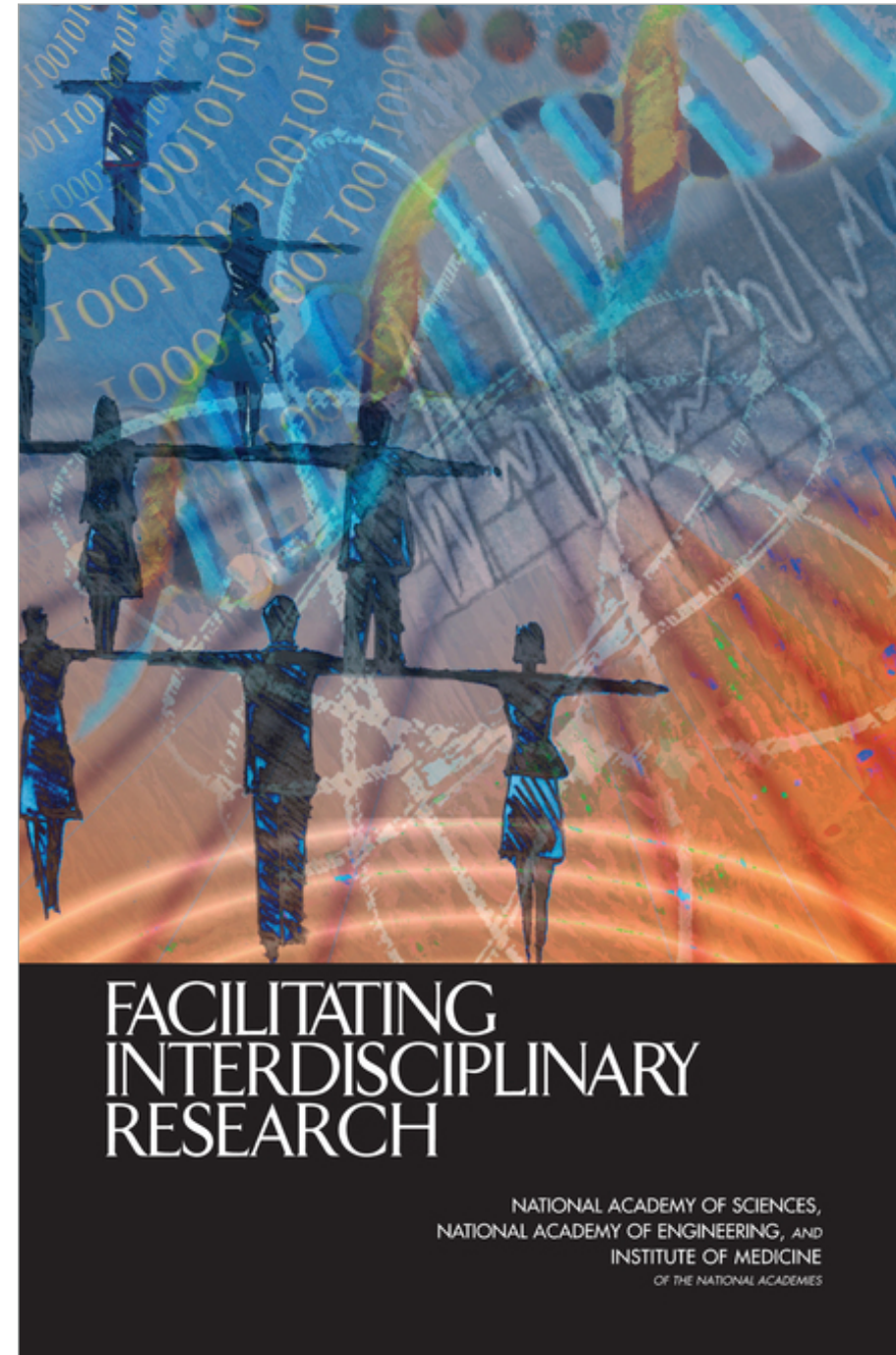
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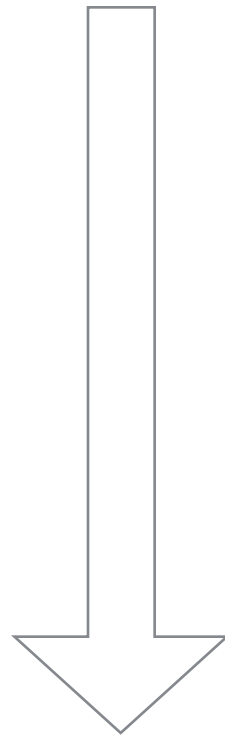
# What is Interdisciplinary Research (IDR)?

Interdisciplinary research is a mode of research by **teams** or individuals that **integrates** information, data, techniques, tools, perspectives, concepts, and/or theories **from two or more disciplines** or bodies of specialized knowledge **to advance fundamental understanding or to solve problems** whose solutions are beyond the scope of a single discipline or area of research practice.



NAS, 2004

# 300s BC: Aristotle



Theoretical

theology, mathematics, physics

Practical

ethics, politics

Productive

fine arts, poetics, engineering

# 300s BC: Aristotle

Philosophy

Theoretical

theology, mathematics, physics

Practical

ethics, politics

Productive

fine arts, poetics, engineering

300s BC – Aristotle  
Middle Ages

*Trivium*

grammar, rhetoric, dialectic

*Quadrivium*

arithmetic, astronomy, geometry, music

**Learn it all.** No disciplinary specialization.

300s BC – Aristotle

Middle Ages

1500s-1600s – Scientific Revolution

### New idea

You could gain new knowledge by limiting the questions you focus on.

300s BC – Aristotle

Middle Ages

1500s-1600s – Scientific Revolution

1700s – Enlightenment

### New idea

Humans can answer complex problems with their own reasoning.

So, let's organize knowledge systematically into categories.

Prototype of research university arises in Germany.

300s BC – Aristotle

Middle Ages

1500s-1600s – Scientific Revolution

1700s – Enlightenment

1880s-1890s

25 disciplinary associations formed in U.S.

U.S. universities restructure into disciplines,  
distinguish undergraduate and graduate.

Journals become arbiter of quality.

300s BC – Aristotle

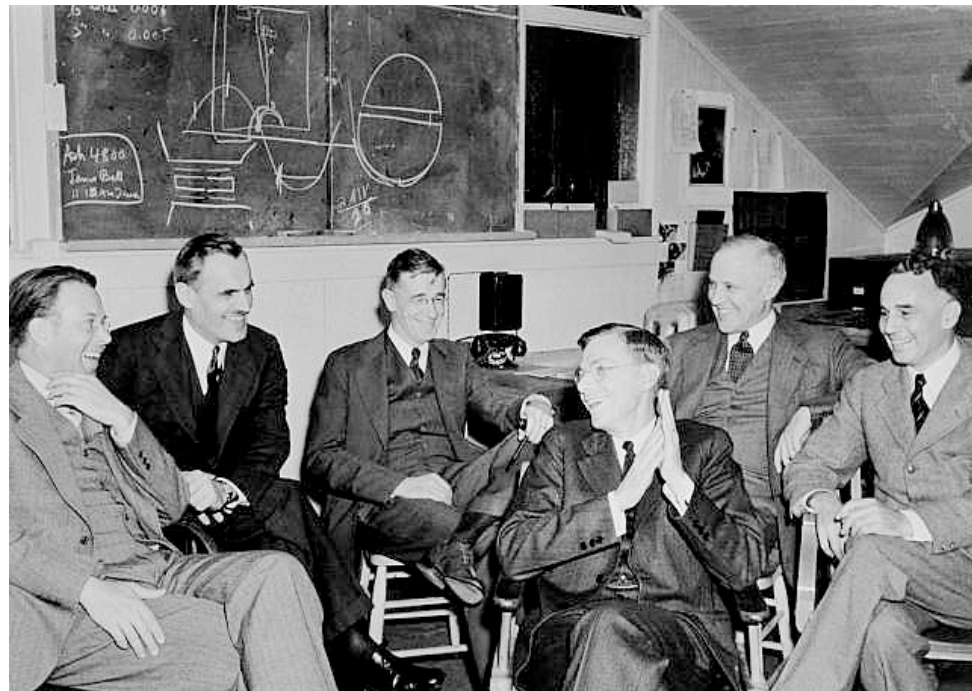
Middle Ages

1500s-1600s – Scientific Revolution

1700s – Enlightenment

1880s-1890s

1940s-1950s – Manhattan Project





300s BC – Aristotle

Middle Ages

1500s-1600s – Scientific Revolution

1700s – Enlightenment

1880s-1890s

1940s-1950s – Manhattan Project

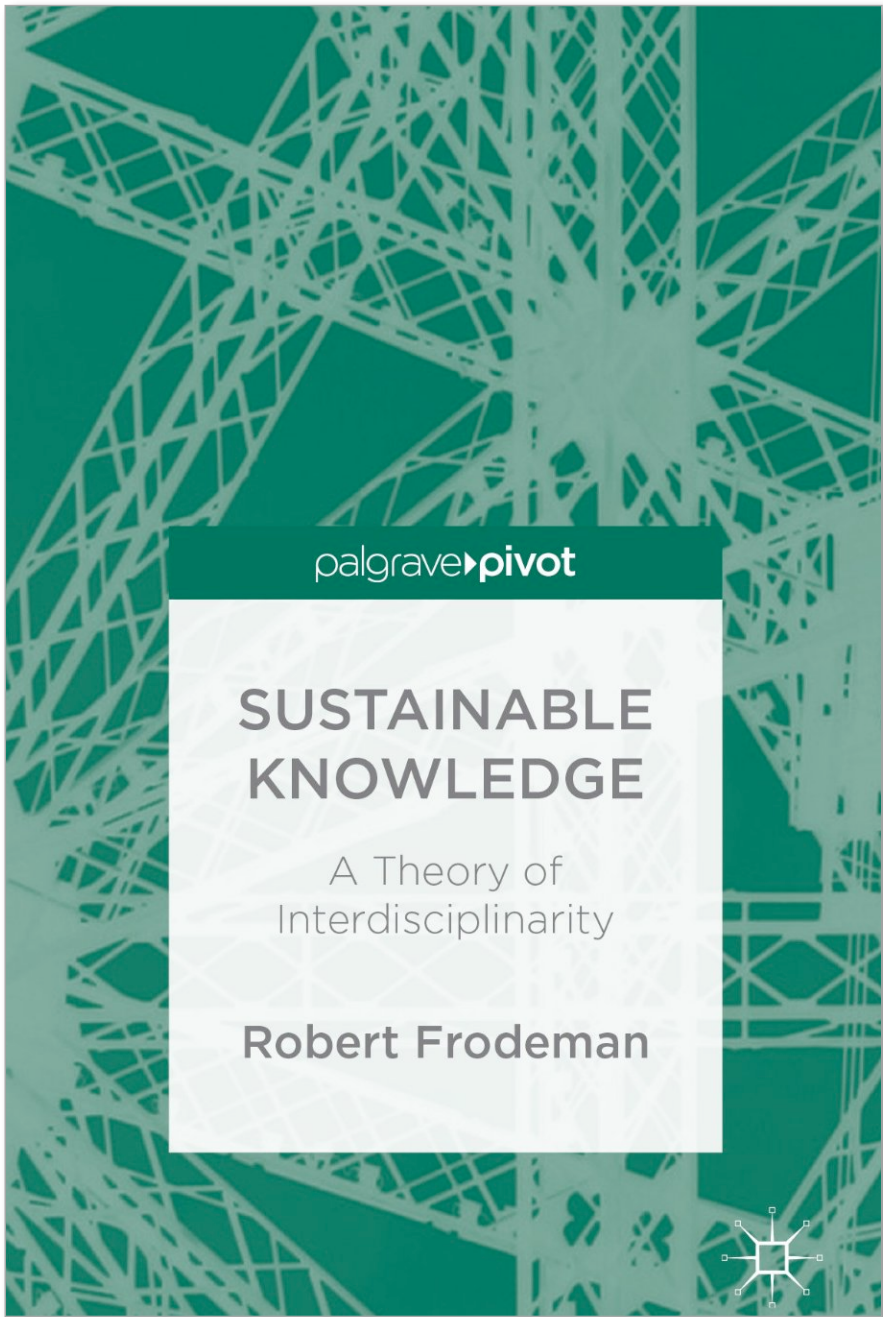
1970s-2000 – IDR growth

U.S. Interdisciplinary degree programs grew from 674 - 1,633 (250% increase).

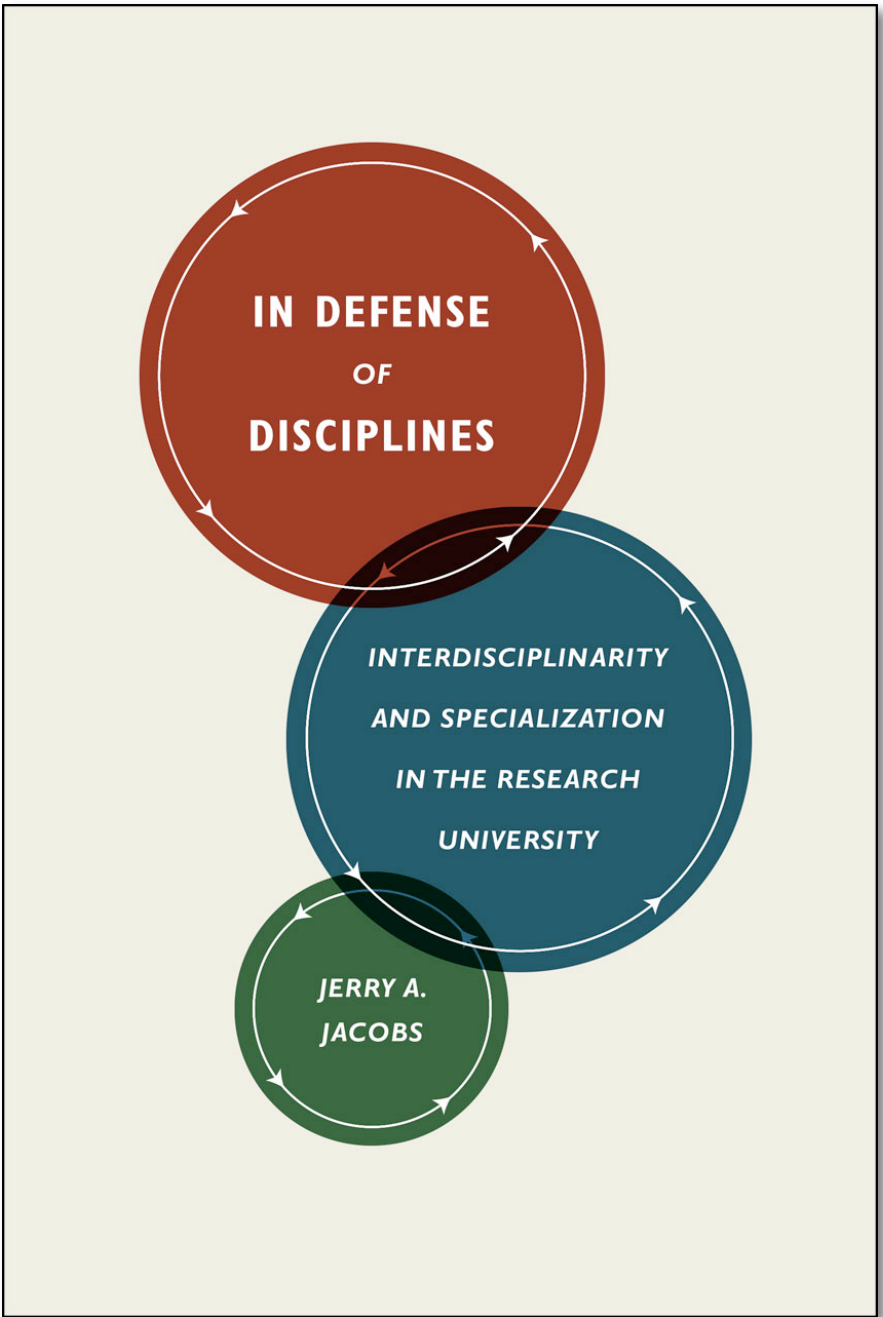
Enrollment grew only 18%.

Increased IDR funding, associations, journals.

2013



2013



# Fundamental Challenges of Society

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Education

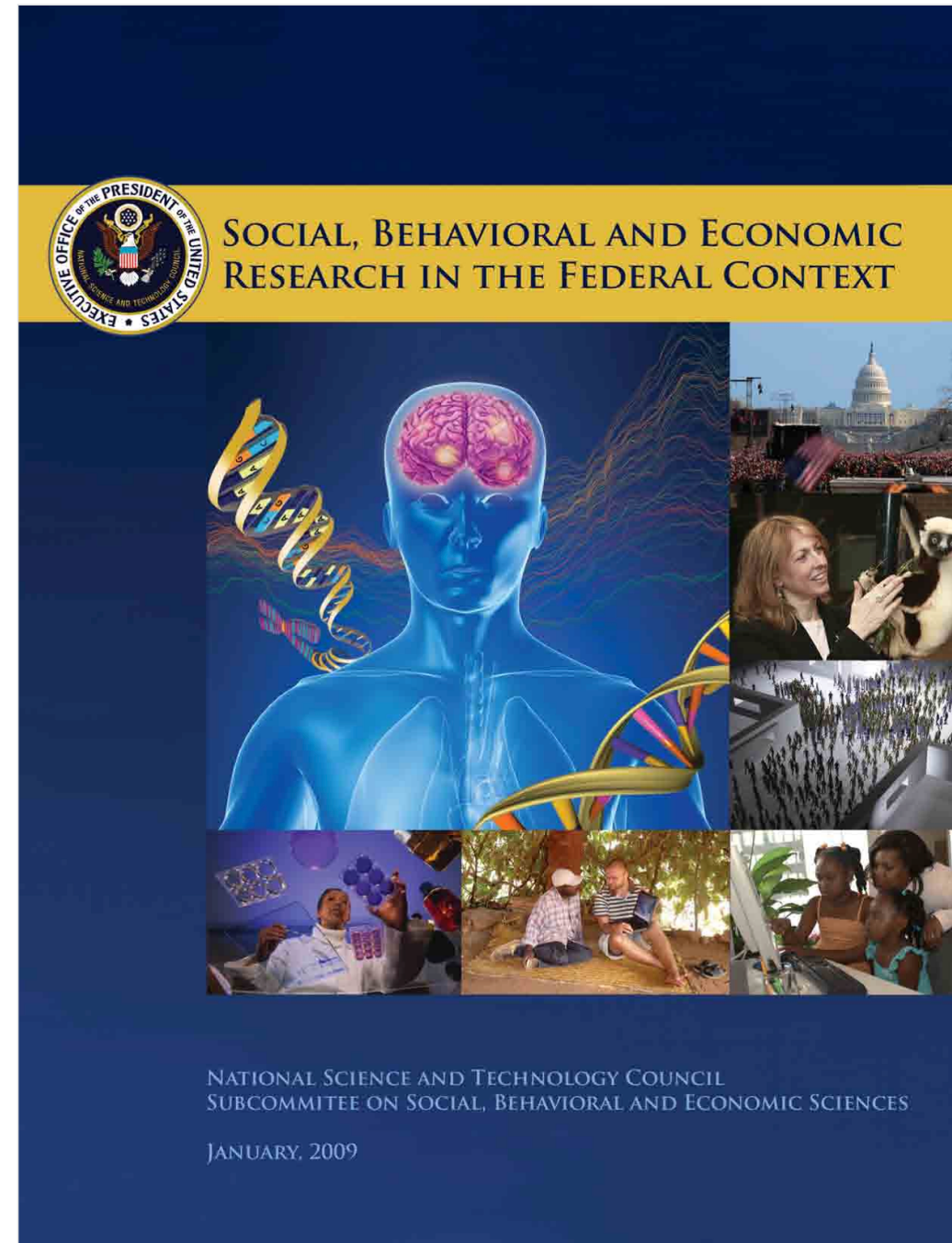
Health

Cooperation and Conflict

Societal Resilience and  
Response to Threats

Creativity and Innovation

Energy, Environment and  
Human Dynamics



NSTC, 2009

What makes IDR hard?

# What makes IDR hard?

Learning each other's disciplines.

Four founders of Stanford's Bio X met **weekly for two years** before beginning collaborative projects.

The screenshot shows the Stanford Bio-X website homepage. On the left is a navigation menu with the following items: NEWS & EVENTS, ABOUT, CLARK CENTER, FACULTY, SHARED FACILITIES, GRANT PROGRAMS, EDUCATION & COURSES, BIO-X CORPORATE FORUM, CONTACT & LINKS, and BIO-X VENTURES. The main content area features a central vertical column of six circular images: a person at a microscope, a coral reef, a 3D molecular model, a human skeleton, and a petri dish with colorful bacteria. To the right, there is a 'QUICK LINKS' dropdown menu, a message from the director about seed grants, and a large red banner with the word 'biology' in large white letters, surrounded by smaller text for 'engineering', 'information sciences', 'physics', 'chemistry', and 'medicine'. Below the banner is a mission statement and a yellow box for the 'BIO-X INTERDISCIPLINARY INITIATIVES SEED GRANTS PROGRAM' with a deadline of April 7, 2014.

**BIO-X**  
STANFORD UNIVERSITY

NEWS & EVENTS  
ABOUT  
CLARK CENTER  
FACULTY  
SHARED FACILITIES  
GRANT PROGRAMS  
EDUCATION & COURSES  
BIO-X CORPORATE FORUM  
CONTACT & LINKS  
BIO-X VENTURES

QUICK LINKS: ▾

Message from the Director | Bio-X Seed Grants for Success (IIP)  
| SUPPORT US

engineering information sciences  
**biology**  
physics  
chemistry medicine

**The Mission of Bio-X** is to catalyze discovery by crossing the boundaries between disciplines, to bring interdisciplinary solutions and to create new knowledge of biological systems, in benefit of human health.

**BIO-X INTERDISCIPLINARY INITIATIVES  
SEED GRANTS PROGRAM**

Request for Letters of Intent for Interdisciplinary Initiatives  
(Round 7)  
Deadline: April 7, 2014 at 5:00pm.

[Click here for details](#)



# What makes IDR hard?



Learning each other's disciplines.

Coordinating with each other.

Dividing up the money.

\$2,400,000 Grant, 3 yrs

---

Mary      2 Partner  
Juan      Universities

Nic  
Jasmine  
Riya      ~\$83,000/yr  
Dao

\$500,000 Grant, 3 yrs

---

Mary      ~\$83,000/yr  
Juan

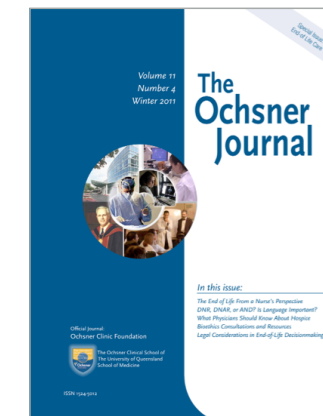
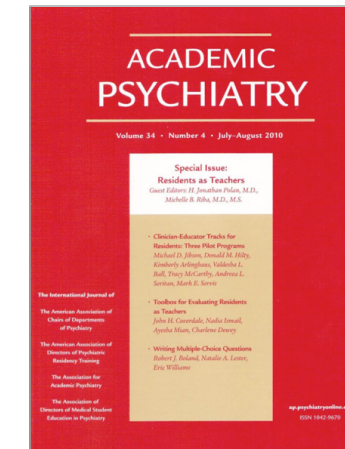
# What makes IDR hard?

Learning each other's disciplines.

Coordinating with each other.

Dividing up the money.

Difficulty publishing.





# What makes IDR hard?

Learning each other's disciplines.

Coordinating with each other.

Dividing up the money.

Difficulty publishing.

More complex tenure case.

She got external letters from **where?**



# What makes IDR hard?

Learning each other's disciplines.

Coordinating with each other.

Dividing up the money.

Difficulty publishing.

More complex tenure case.

Talking with IDR colleagues.

But I told him  
not to normalize  
the Gaussian!

Does he know he's  
mansplaining?



Strober's *Interdisciplinary Conversations*, 2011

# Sociolinguistic rules within communities

Hymes, 1972

Is interrupting ok?

How do you arrange speaking  
turns?

What do you say outright vs.  
subtly?

How do you question people?

Do you present with slides?  
Notes?



# Useful Traits of an IDR Researcher

Lyall et al., 2011

flexibility, adaptivity, creativity

**curiosity** about other disciplines

good communication & listening skills

willingness to **tolerate ambiguity**

ability to bridge theory & practice

good team-worker

willingness to **admit limitations** of your  
disciplinary knowledge



# IOWA STATE UNIVERSITY

## Strategic Plan

Goal:

Foster a university culture and work environment that ...  
inspires individuals to work together to achieve at the highest level of their abilities.



# IOWA STATE UNIVERSITY

## Strategic Plan

Goal:

Foster a university culture and work environment that ...  
inspires individuals to work together to achieve at the highest level of their abilities.

**ISU  
IN THE  
TOP 25!**

**Ph.D. students with  
dissertations in 2+  
fields**

Falkenheim, 2010

# IOWA STATE UNIVERSITY

## Strategic Plan

Goal:

Foster a university culture and work environment that ...  
inspires individuals to work together to achieve at the highest level of their abilities.

**CLUSTER  
HIRES!**

**12 faculty in Big Data**

**8 faculty in  
Translational Health**

# IOWA STATE UNIVERSITY

## 18 Interdisciplinary Graduate Programs

Biorenewable Chemicals | Bioinformatics & Computational Biology | Biorenewable Resources & Technology | Dietetics | Ecology & Evolutionary Biology | Engineering Management | Genetics | Human Computer Interaction | Immunobiology | Information Assurance | Molecular Cellular & Developmental Biology | Neuroscience | Nutritional Sciences | Plant Biology | Seed Technology & Business | Toxicology | Transportation | Wind Energy Science, Engineering & Policy

Interdisciplinary Graduate Studies



# IOWA STATE UNIVERSITY

## Presidential Initiative for Interdisciplinary Research



biomedical science + veterinary microbiology + animal medicine

seed science + animal science

chemistry + medicine + engineers + economists

applied linguistics + machine learning + education

# IOWA STATE UNIVERSITY



Larysa Nadolny  
School of Education

## SciEthics Interactive



pending

Eliot Winer  
Mechanical Engineering

Stephen Gilbert  
Industrial & Manufacturing Systems  
Engineering

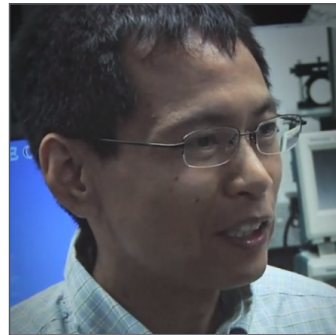
Matthew Pierlott  
Philosophy  
West Chester University

Seth Kahn  
English  
West Chester University

Brian J Arnold  
Information & Media Systems  
National University

Jodi Reeves  
Applied Engineering  
National University

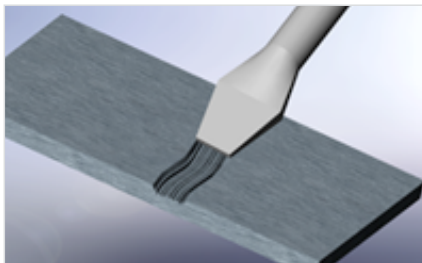
# IOWA STATE UNIVERSITY



Song Zhang  
Mechanical Engineering



Scott Chumbley  
Materials Science & Engineering



Manipulative virtual tools for tool  
mark characterization

# IOWA STATE UNIVERSITY

## Research Writing Tutor



Elena Cotos  
Graduate College

Carol Chapelle  
Applied Linguistics

Stephen Gilbert  
Industrial & Manufacturing Systems  
Engineering

Jivko Sinapov (postdoc)  
Computer Science & HCI

Evgeny Chukharev-Khudilaynen  
Applied Linguistics

Eliot Winer  
Mechanical Engineering

# IOWA STATE UNIVERSITY



Tom Holme  
Chemistry



Shana Carpenter  
Psychology

The transfer of testing effects  
in online test format in the  
general chemistry settings

# IOWA STATE UNIVERSITY



Sarah Nusser  
Statistics

Project Battuta:  
Bring emerging technologies  
to mobile field data  
collection.



Les Miller  
Computer Science

Mike Goodchild  
Geography  
UCSB

Keith Clarke  
Geography  
UCSB



# IOWA STATE UNIVERSITY

10+ REU Sites  
Research Experience for  
Undergraduates



# IOWA STATE UNIVERSITY

## Centers - just a few

Center for eDesign

Center for Biorenewable Chemicals (CBiRC)

Virtual Reality Applications Center (VRAC)

Pappajohn Center for Entrepreneurship

Leopold Center for Sustainable Agriculture

Center for Transportation Research and Education (CTRE)

Center for Food Security and Public Health (CFSPH)





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Center for Food Security and Public Health (CFSPH)



**What IDR will  
you do?**

# References

Committee on Facilitating Interdisciplinary Research, National Academy of Sciences, National Academy of Engineering, Institute of Medicine. (2005). *Facilitating Interdisciplinary Research*. Washington, D.C.: The National Academies Press.

Falkenheim, J. (2010) Interdisciplinary Dissertation Research. National Science Foundation: Directorate for Social, Behavioral, and Economic Sciences. *Science Resources Statistics*, 10-316.

Frodeman, R. (2013). *Sustainable Knowledge: A Theory of Interdisciplinarity*. Palgrave Macmillan.

Hymes, D. (1972). Models of the interaction of language and social life. In J. Gumperz & D. Hymes (Eds.), *Directions in Sociolinguistics: The Ethnography of Communication*. New York: Holt, Rinehart, Winston.

Jacobs, J. A. (2013) *In Defense of Disciplines*. University of Chicago Press.

Lyll, C., Bruce, A., Tait, J., & Meagher, L. (2011). *Interdisciplinary Research Journeys: Practical Strategies for Capturing Creativity*. FT Press.

Meinhold, R. J., & Singpurwalla, N. D. (1983). Understanding the Kalman filter. *The American Statistician*, 37(2), 123-127.

National Research Council. (2004) *Facilitating Interdisciplinary Research*. Washington, DC: The National Academies Press.

National Science & Technology Council, Subcommittee on Social, Behavioral and Economic Sciences. (2009). *Social, Behavioral and Economic Research in the Federal Context*. January.

Oleson, A., & Voss, J. (1979). The organization of knowledge in modern America, 1860-1920. *Bulletin of the American Academy of Arts and Sciences*, 10-31.

Strober, M. (2010). *Interdisciplinary conversations: Challenging habits of thought*. Stanford University Press.

# Thank you

Stephen Gilbert  
gilbert@iastate.edu

Handwritten mathematical derivations for beam deflection and stress analysis.

**Top Section:**

$$\Delta u = \int \frac{1}{E} \frac{d^2 u}{dx^2} dx = \int \frac{1}{E} \frac{d}{dx} \left( \frac{du}{dx} \right) dx = \frac{1}{E} \left( \frac{du}{dx} \right) \Big|_0^l = \frac{1}{E} \left( \frac{du}{dx} \Big|_l - \frac{du}{dx} \Big|_0 \right)$$

$$\Delta u = \frac{1}{E} \left( \frac{du}{dx} \Big|_l - \frac{du}{dx} \Big|_0 \right) = \frac{1}{E} \left( \frac{du}{dx} \Big|_l - \frac{du}{dx} \Big|_0 \right)$$

**Middle Section (Problem 4):**

Diagram of a beam of length  $l$  with a point load  $P$  at distance  $e$  from the left end. The deflection curve is shown as  $y = 4 \frac{P}{E} \frac{x^2}{l} (l-x)$ .

$$\Delta \sigma_B(x) = \frac{-\Delta P}{AB} \frac{\Delta P - y^2(x)}{J_B} + \frac{M_y y(x)}{J_B}$$

$$\Delta \epsilon_B(x) = \frac{\Delta \sigma_B(x)}{E_B} = \frac{1}{E_B} \left[ \frac{-\Delta P}{AB} \frac{\Delta P - y^2(x)}{J_B} + \frac{M_y y(x)}{J_B} \right]$$

$$\Delta \epsilon = \int_0^l \Delta \epsilon_B(x) dx = \frac{1}{E_B} \left[ \int_0^l \frac{-\Delta P}{AB} \frac{\Delta P - y^2(x)}{J_B} dx + \int_0^l \frac{M_y y(x)}{J_B} dx \right]$$

$$= \frac{1}{E_B} \left[ \frac{-\Delta P}{AB} \frac{\Delta P}{J_B} l - \frac{\Delta P}{J_B} \frac{8}{15} \int_0^l y^2 dx + \frac{1}{15} \frac{q l^2 f}{J_B} \right]$$

$$E_S \frac{\Delta \epsilon}{E_S} = \frac{\Delta P}{A_B} \frac{1}{E_S} = \frac{\Delta \epsilon}{E_B} = \frac{1}{E_B} \left[ \frac{-\Delta P}{AB} \frac{\Delta P}{J_B} l - \frac{8}{15} \frac{\Delta P}{J_B} \int_0^l y^2 dx + \frac{q}{15 J_B} \int_0^l y^2 dx \right]$$

$$\Delta P = \frac{q \cdot \alpha \cdot f \cdot B}{15 J_B} \cdot \frac{1}{\frac{1}{A_B} + \frac{\alpha}{A_B} + \frac{8}{15} \frac{J_B \cdot \alpha}{J_B}}$$

$$\alpha = \frac{E_S}{E_B} = \frac{100000}{2.65 \cdot 10^7}$$

**Bottom Section (Problem 6):**

Diagram of a beam of length  $l$  with a point load  $P$  at distance  $e$  from the left end. The deflection curve is shown as  $y = \frac{P}{E} \frac{x^2}{l} (l-x)$ .

$$\sigma_B = \frac{P - \Delta P}{AB} + \frac{(P - \Delta P) \cdot l^2}{J_B}$$

$$\Delta \epsilon_B = \frac{\sigma_B}{E_B} = \frac{1}{E_B} \left[ \frac{P - \Delta P}{AB} + \frac{(P - \Delta P) \cdot l^2}{J_B} \right] = \frac{P - \Delta P}{E_B} \left[ \frac{1}{AB} + \frac{l^2}{J_B} \right]$$

$$\Delta \epsilon_S = \frac{\Delta \sigma_S}{E_S} = \frac{\Delta P}{A_S} \frac{1}{E_S}$$

$$\Delta \epsilon_S = \Delta \epsilon_B \Rightarrow \frac{\Delta P}{A_S E_S} = \frac{P - \Delta P}{E_B A_B} \left( 1 + \frac{e^2}{l^2} \right)$$

$$\Delta P = (P - \Delta P) \left( 1 + \frac{e^2}{l^2} \right) \cdot \frac{A_S E_S}{A_B E_B} \Rightarrow \Delta P = \frac{P \left( 1 + \frac{e^2}{l^2} \right)}{1 - \left( 1 + \frac{e^2}{l^2} \right) \frac{A_S E_S}{A_B E_B}}$$

**Right Margin:**

5)  $\Delta u = \int \frac{1}{E} \frac{d^2 u}{dx^2} dx = \frac{1}{E} \left( \frac{du}{dx} \right) \Big|_0^l = \frac{1}{E} \left( \frac{du}{dx} \Big|_l - \frac{du}{dx} \Big|_0 \right)$

6)  $\Delta u = \int \frac{1}{E} \frac{d^2 u}{dx^2} dx = \frac{1}{E} \left( \frac{du}{dx} \right) \Big|_0^l = \frac{1}{E} \left( \frac{du}{dx} \Big|_l - \frac{du}{dx} \Big|_0 \right)$