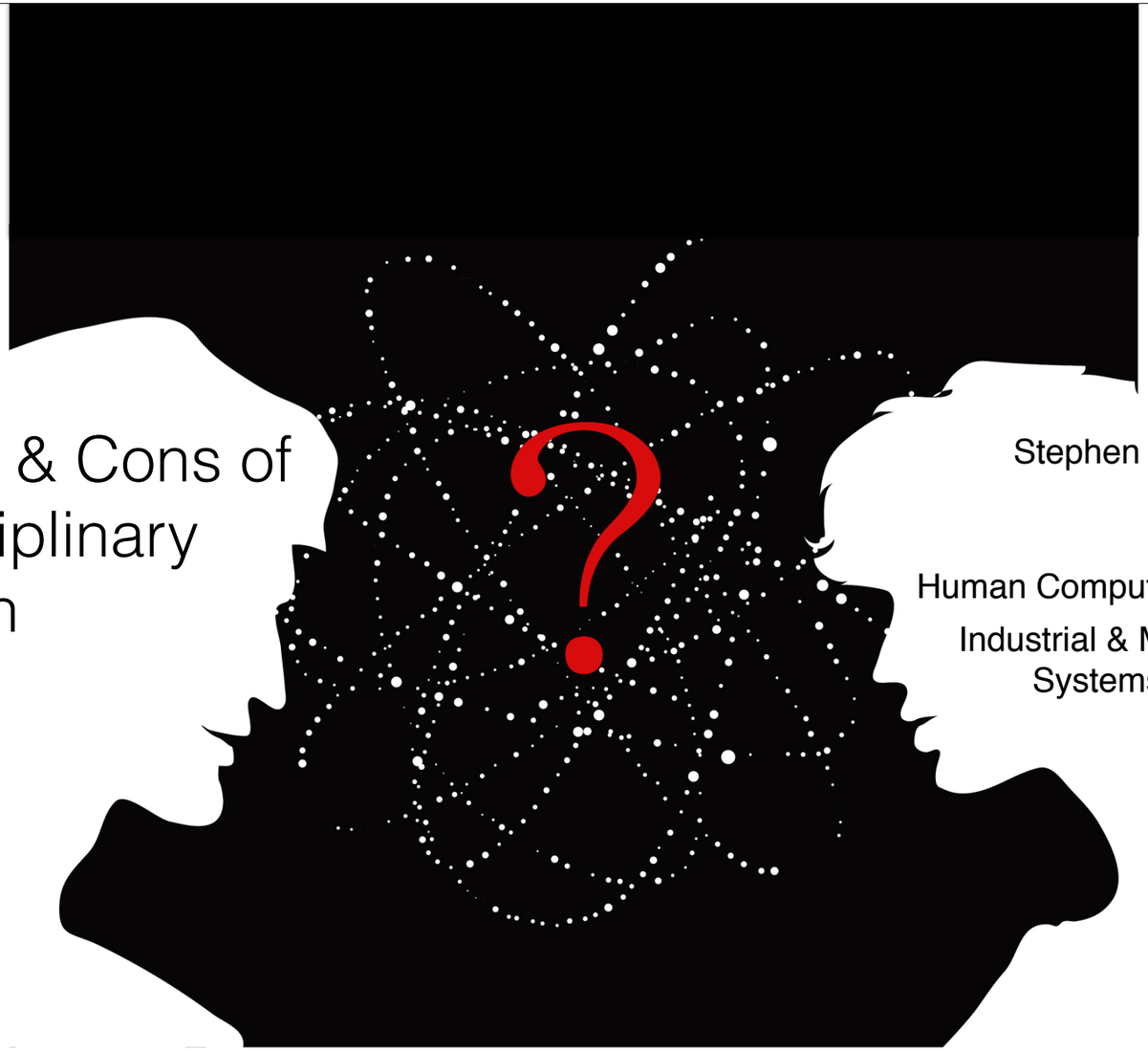
The Pros & Cons of Interdisciplinary Research



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

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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
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
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competent	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
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
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etent	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
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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	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
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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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
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
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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
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
competent	2	0	2	0	1	0	0	0	3	0	0	0	3	0	2	0	1	0	1	0	2	0	2	0	1	0	2	0
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administrative																												
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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

Strober, 2011

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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
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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
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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	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
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
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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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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

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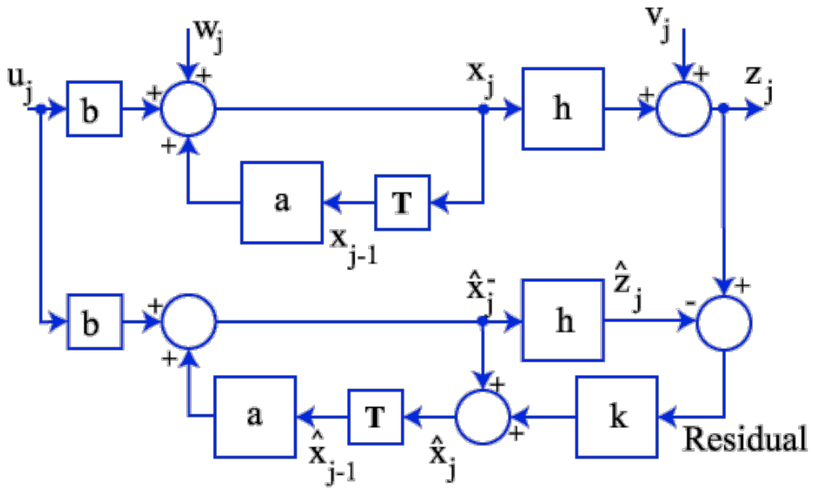


“Kalman Filter”

engineering

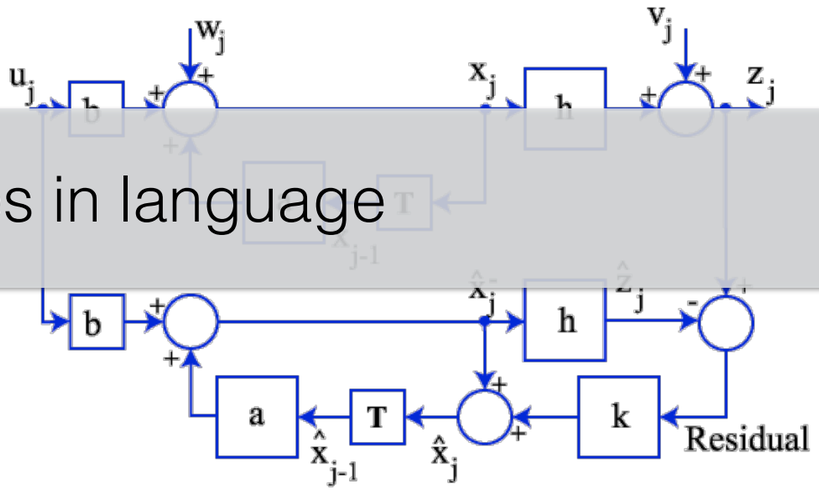
“dynamic Bayesian network”

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)

Differences in language



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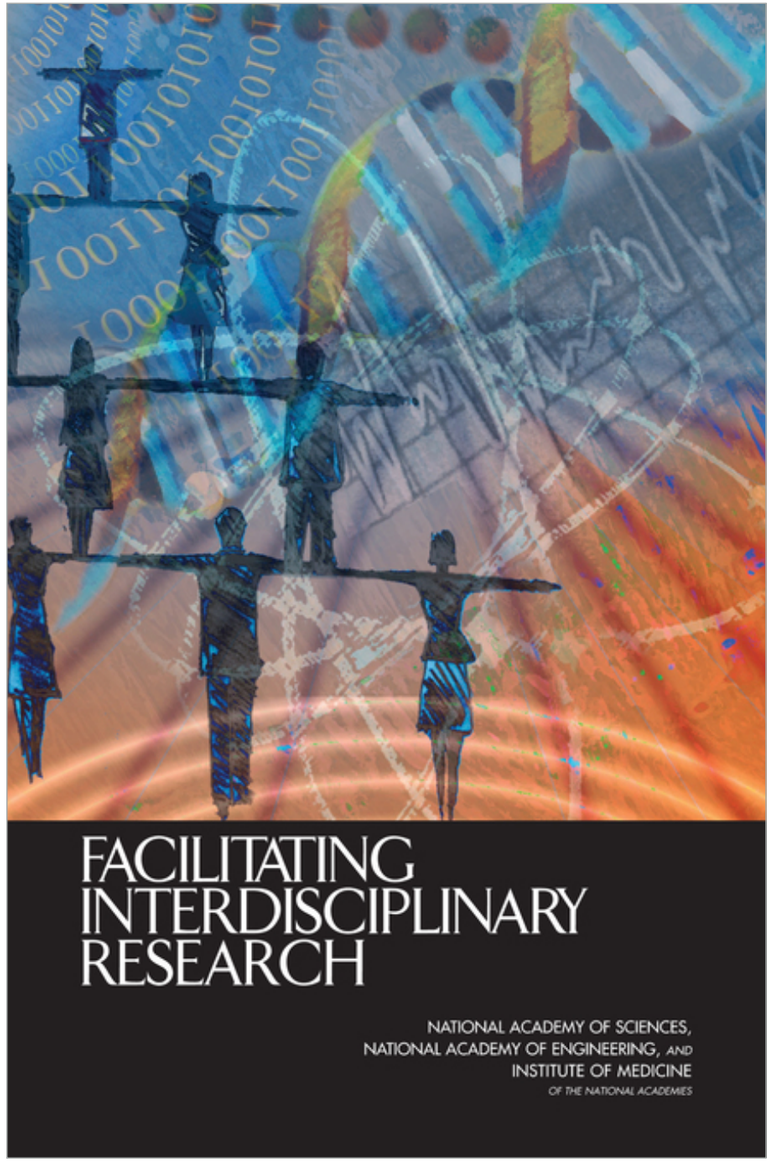
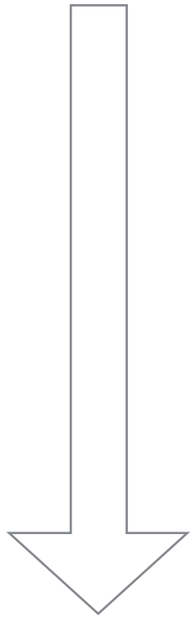
What is Interdisciplinary Research (IDR)?

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.

Oleson & Voss, 1979; Strober, 2011

300s BC – Aristotle

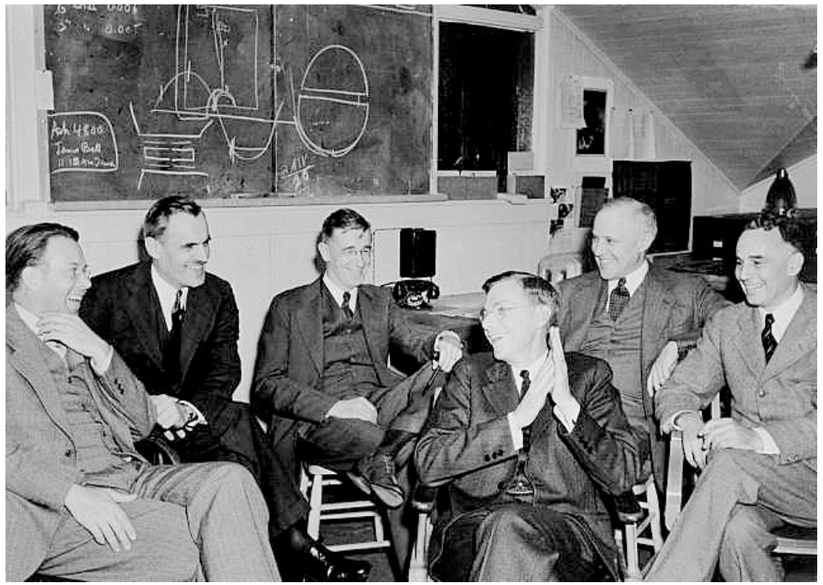
Middle Ages

1500s-1600s – Scientific Revolution

1700s – Enlightenment

1880s-1890s

1940s-1950s – Manhattan Project



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1880s-1890s

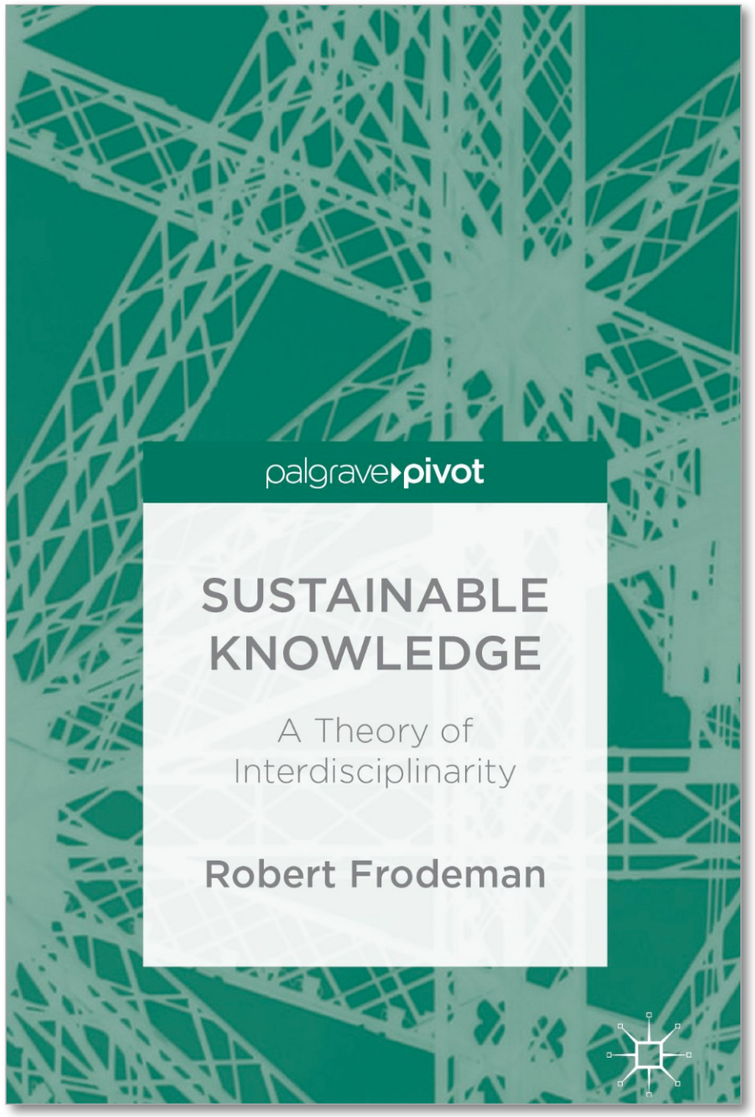
1940s-1950s – Manhattan Project

1970s-2000 – IDR growth

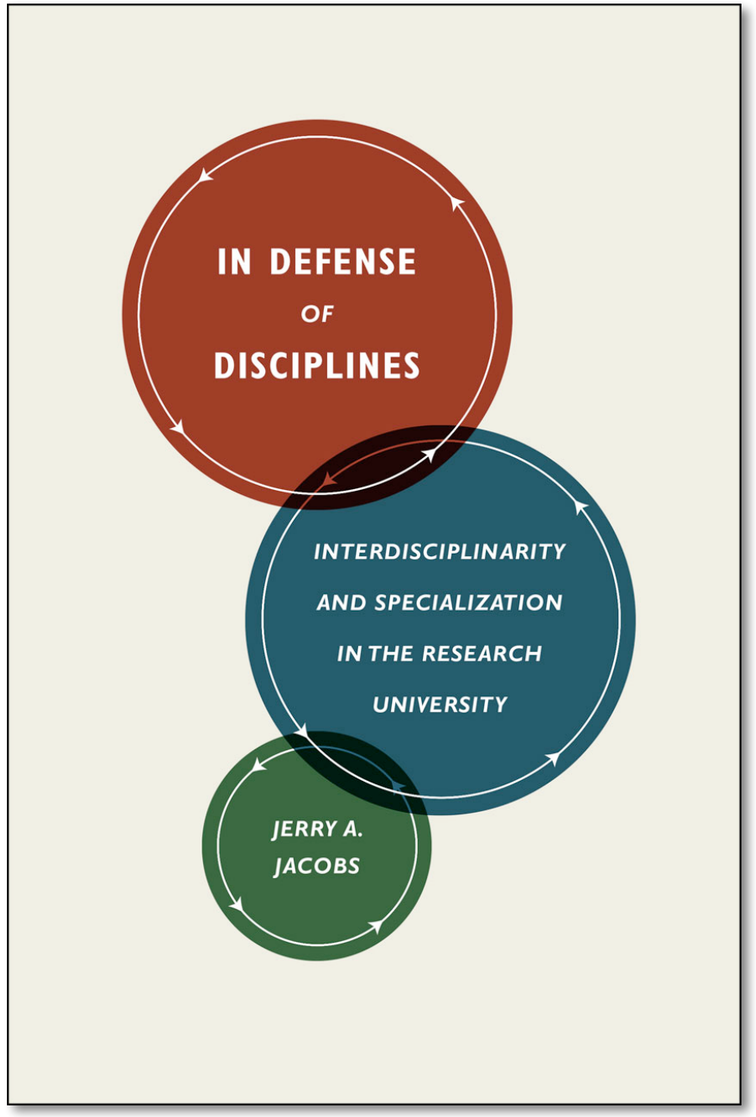
U.S. Interdisciplinary degree programs grew from 674 - 1,633 (250% increase).
Enrollment grew only 18%.

Increased IDR funding, associations, journals.

2013


palgrave pivot
SUSTAINABLE KNOWLEDGE
A Theory of Interdisciplinarity
Robert Frodeman

2013


IN DEFENSE OF DISCIPLINES
INTERDISCIPLINARITY AND SPECIALIZATION IN THE RESEARCH UNIVERSITY
JERRY A. JACOBS

Fundamental Challenges of Society

Education

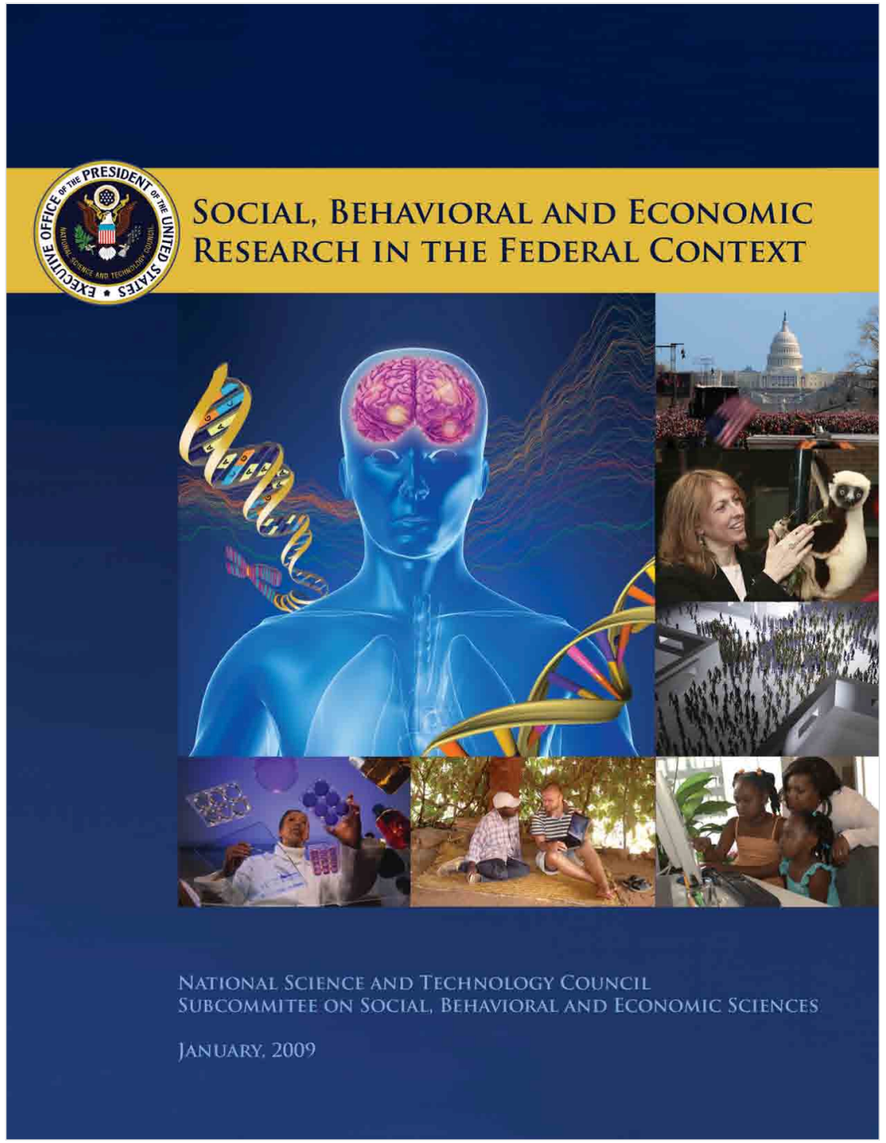
Health

Cooperation and Conflict

Societal Resilience and Response to Threats

Creativity and Innovation

Energy, Environment and Human Dynamics



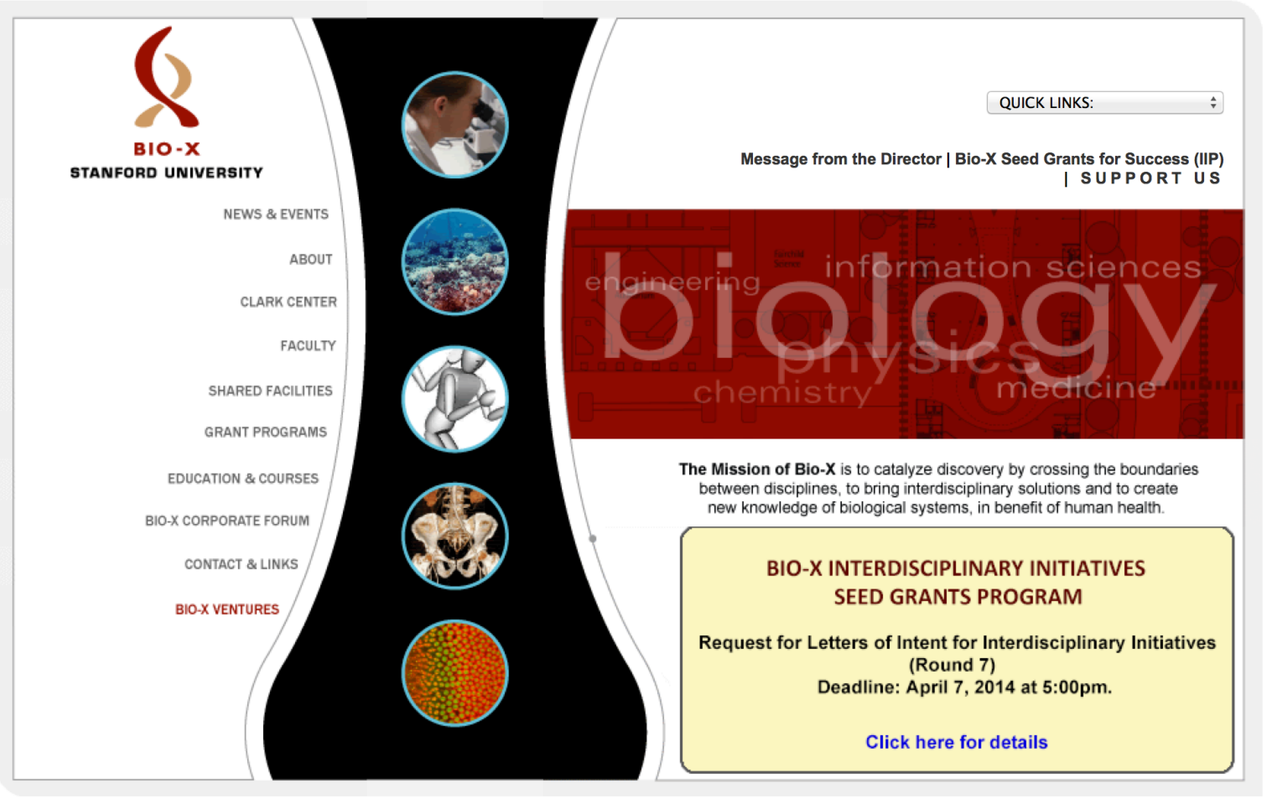
NSTC, 2009

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.



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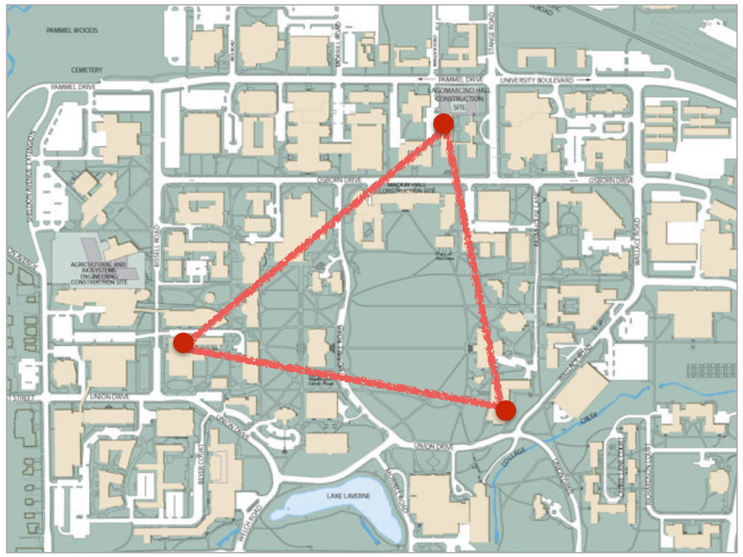
Coordinating with each other.



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Coordinating with each other.

Dividing up the money.

$2,400,000 Grant, 3 yrs	
Mary Juan Nic Jasmine Riya Dao	2 Partner Universities ~$83,000/yr

$500,000 Grant, 3 yrs	
Mary Juan	~$83,000/yr

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.

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.

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

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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

SciEthics Interactive

Larysa Nadolny
School of Education

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

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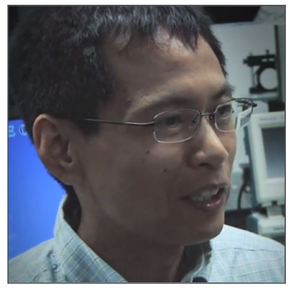
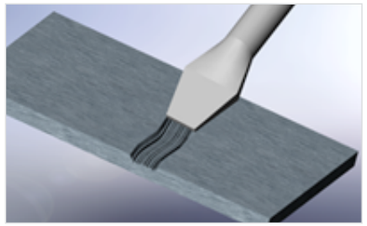


Song Zhang
Mechanical Engineering

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

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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

Les Miller
Computer Science

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

Mike Goodchild
Geography
UCSB

Keith Clarke
Geography
UCSB

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10+ REU Sites
Research Experience for Undergraduates

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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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What IDR will you do?

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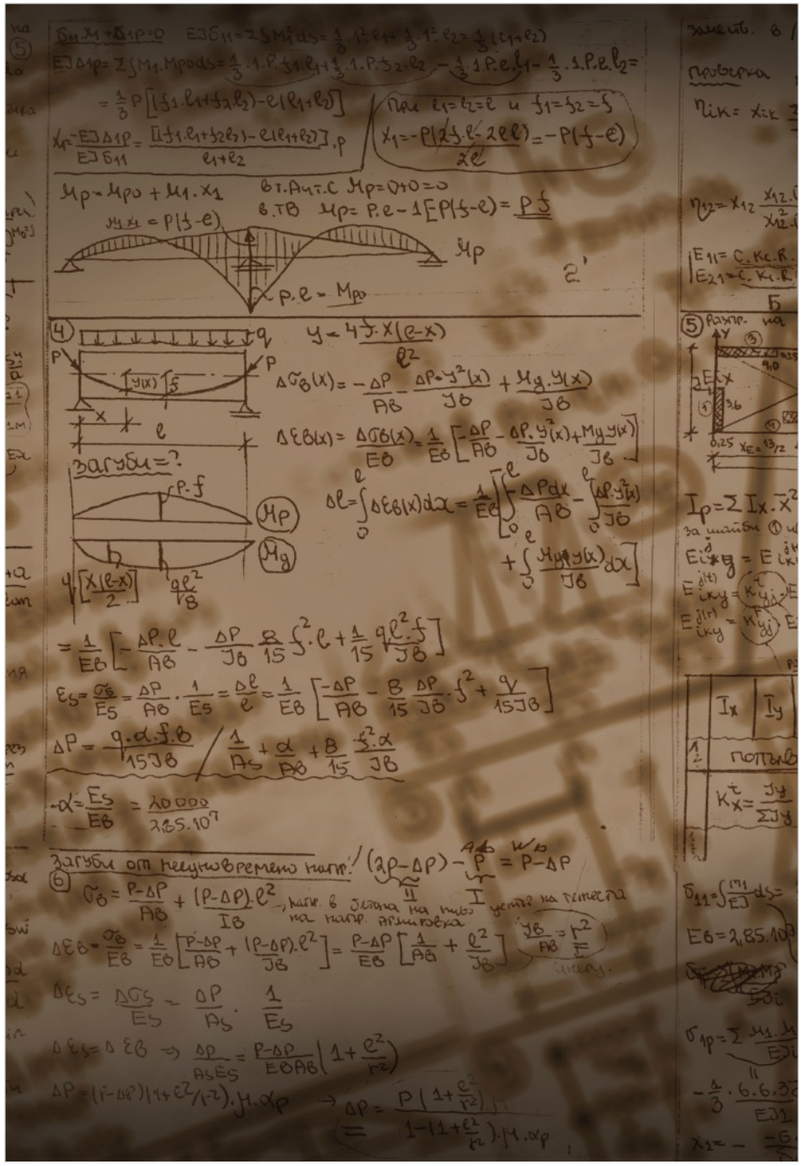
Thank you

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