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Developing Scientific and Technological Leadership and Human Capital: Impact of NSF Industry/University Cooperative Research Center (IUCRC) Directorship on Career Paths and Achievement

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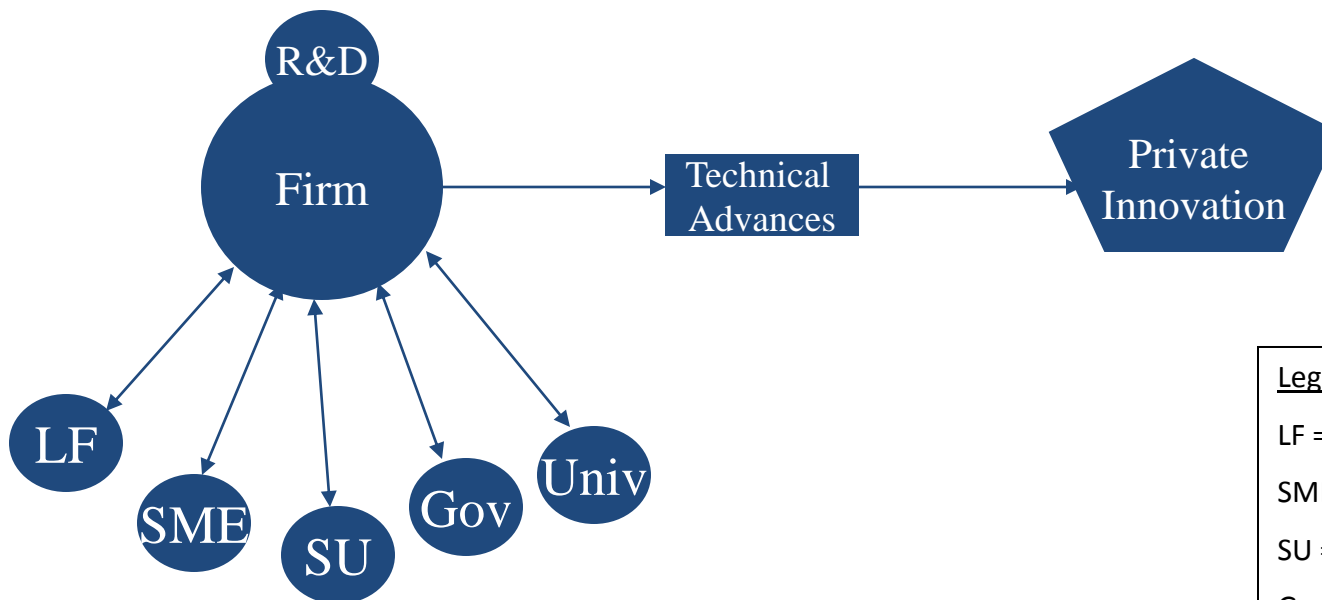
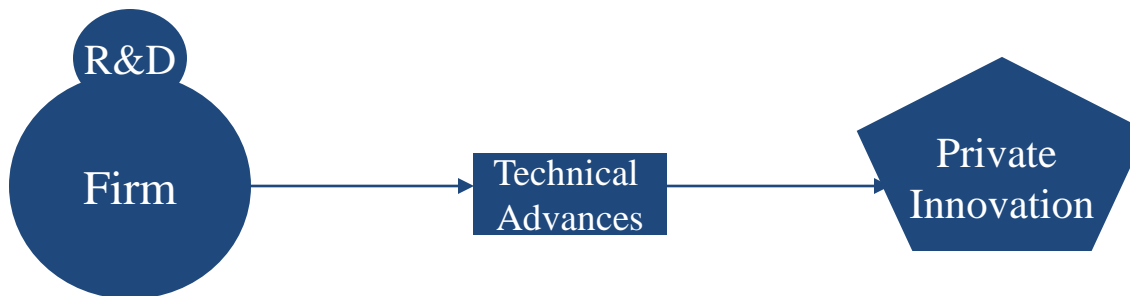


Overview

- Highlight the potential importance of human capital (HC) impacts from open innovation and cooperative research center perspective
- Provide a brief overview of research on HC impacts
 - Cooperative Research Centers
 - Students
- Report preliminary results from a study of a neglected center participants – faculty who become center directors



Traditional vs Open Innovation



Legend:

LF = Large Firm

SME = Small Med. Enterprise

SU = Start Ups

Gov = Government

Univ = Universities



Framework: S&T Human Capital

- Bozeman, B., Deitz, J.S., & Gaughan, M. (2001). Scientific and technical human capital: An alternative model for research evaluation. International Journal of Technology Management, 22, 636 – 655.

“Our approach... gives less attention to the discrete products and immediate outcomes from scientific projects and programs and more attention to scientists’ career trajectories and their sustained ability to contribute and enhance their capabilities.”

Human Capital

- New knowledge and competencies
- Tactic Knowledge



Social Capital

- Direct and indirect ties in a knowledge network

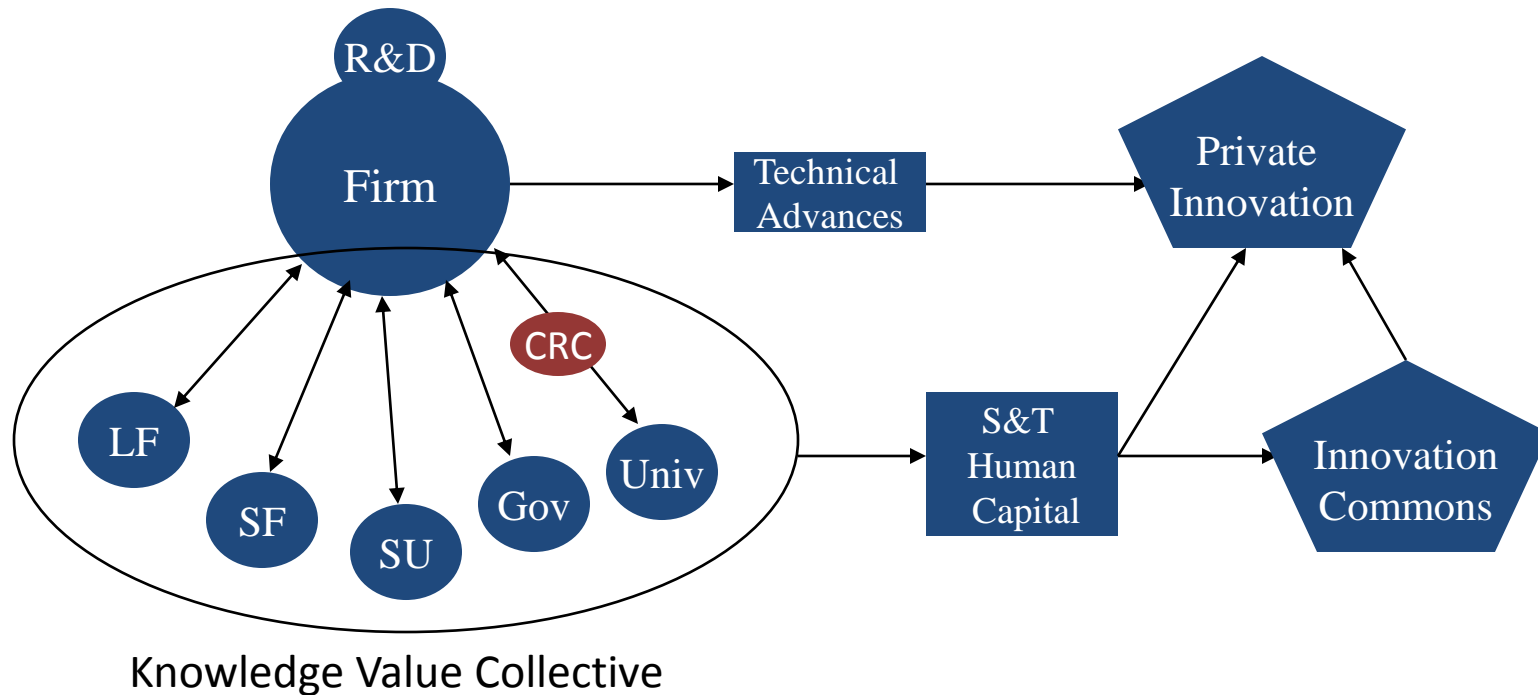


Capacity
Building



Societal Benefit

Technological vs. Human Capital Implications



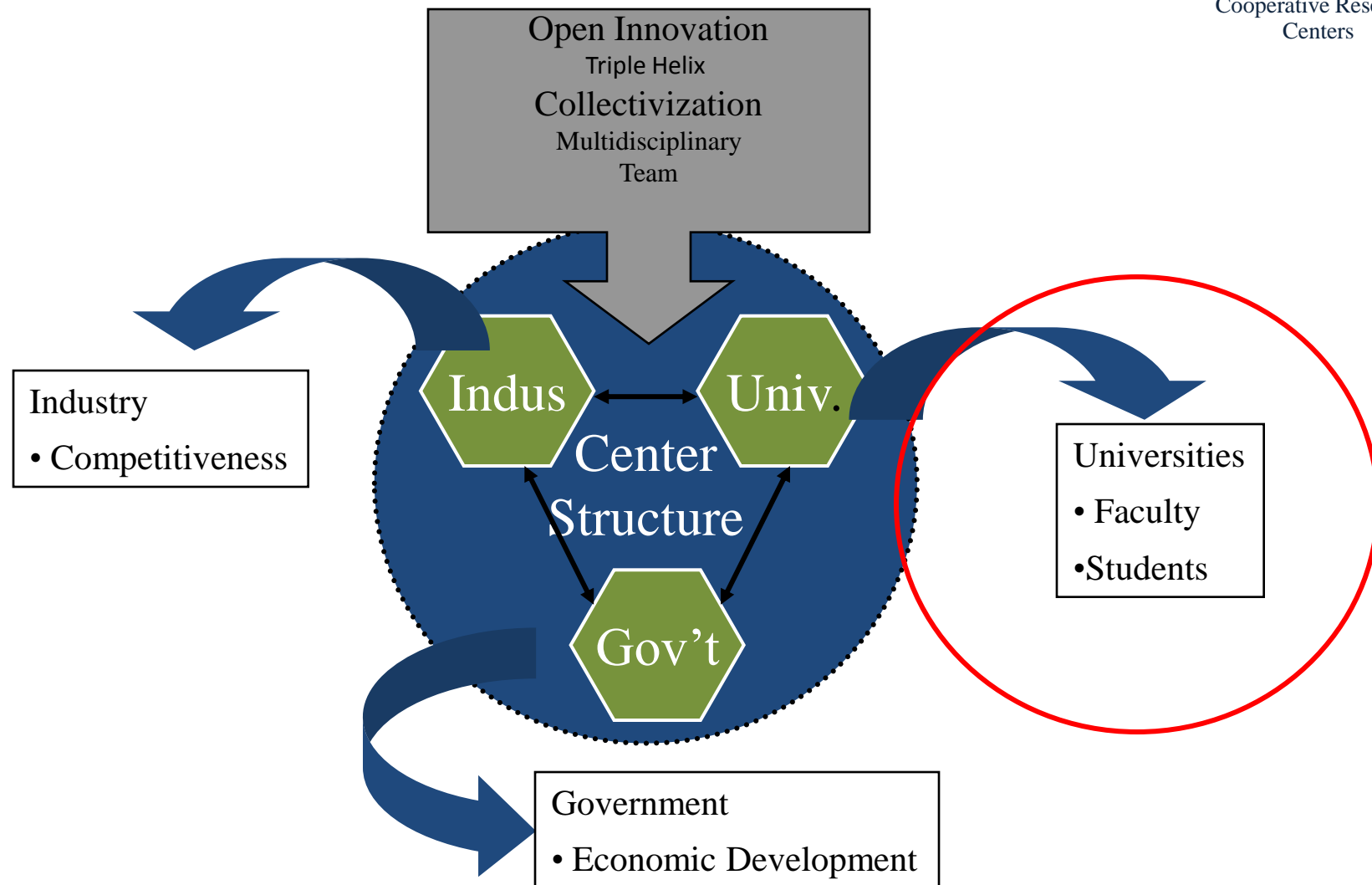
Cooperative Research Centers (CRCs) and Open Innovation



- CRCs: organization or unit designed to foster research-based interactions between public and private sector, stimulate innovation (Boardman & Gray, 2010)
- US Context: Industry/University
 - Pervasive mechanism: 1,200-5,000
 - Educational mission



CRCs Are Complex Systems





Context: the IUCRC Program

- Longest operating CRC in the U.S.
- Modest government support (\$100k-200k/year)
 - Very dependent on industry & entrepreneurial faculty
 - Average center budget: \$1.2 million
 - ~ 50 operating now
- Ad hoc organization within university
 - ~ 10-15 scientists; ~ 20-30 graduate students
- Increasingly multi-university in nature
- Consortial format: multiple firms; collective influence and ownership

Research on CRCs & Human Capital Impact on Students



Small body of research: ~ 5 studies

- IUCRC and Engineering Research Centers
- Informants:
 - Alumni & active students
 - Industry supervisors
- Methodology
 - Descriptive → Normative comparison → Comparison Group
- Mostly in the “gray literature”
 - Hard-to-find agency-funded technical reports
- Positive impacts and unintended consequences

C. Scott's IUCRC Grads vs Non-IUCRC Grads (Subjects) Follow-up Study



Selected 2 groups of graduates from each participating IUCRC's institution:

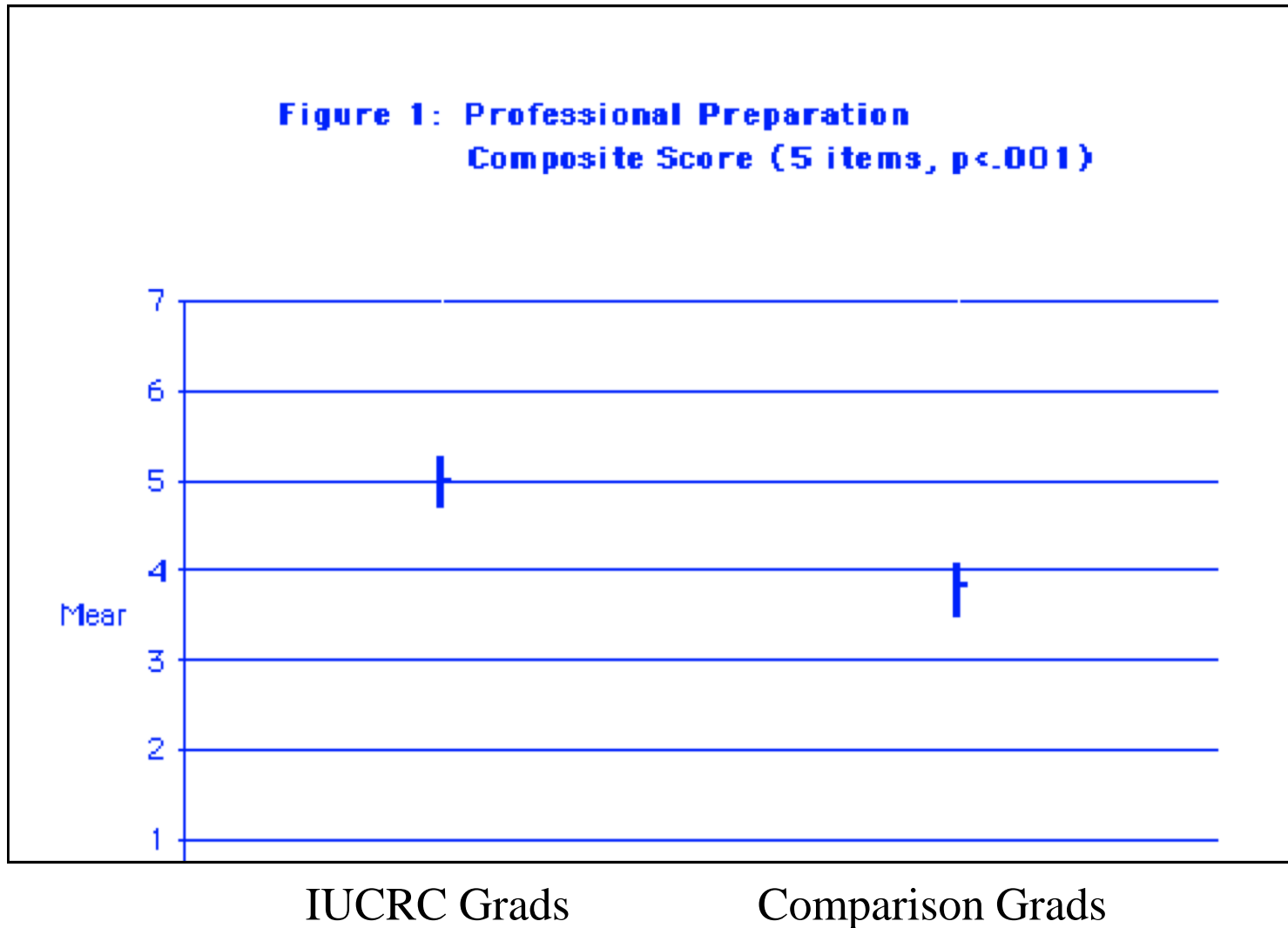
- ① 112 graduates who had had significant involvement in an IUCRC
(IUCRC “Treatment” Group)

- ② PLUS a group of 138 non-IUCRC graduates from similar graduate programs in the same institutions
(Matched Comparison Group)



Professional Preparation ($p < .001$)

**Figure 1: Professional Preparation
Composite Score (5 items, $p < .001$)**

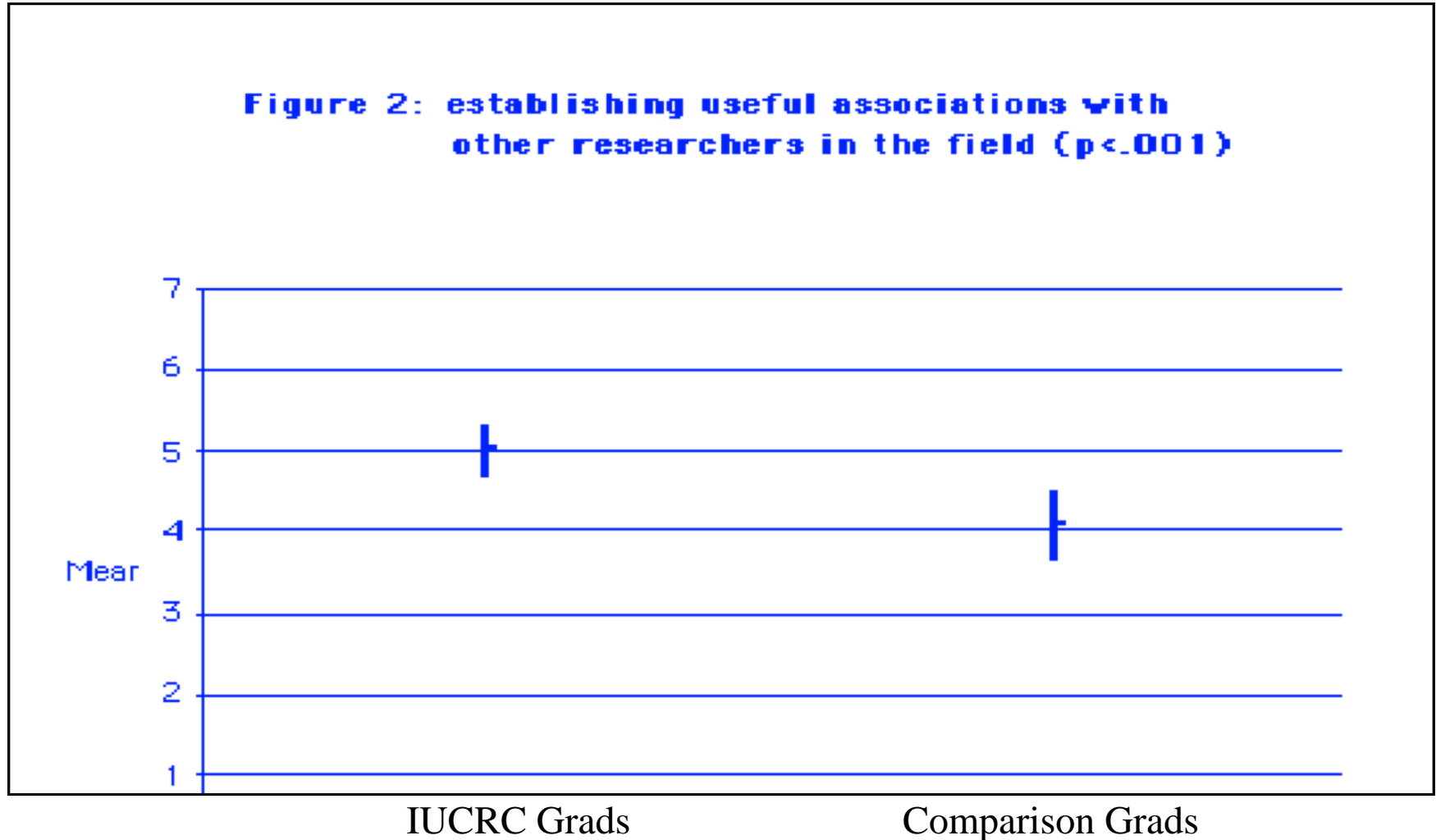


Establishing Useful Associations with Other Researchers ($p < .001$)



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Figure 2: establishing useful associations with other researchers in the field ($p < .001$)





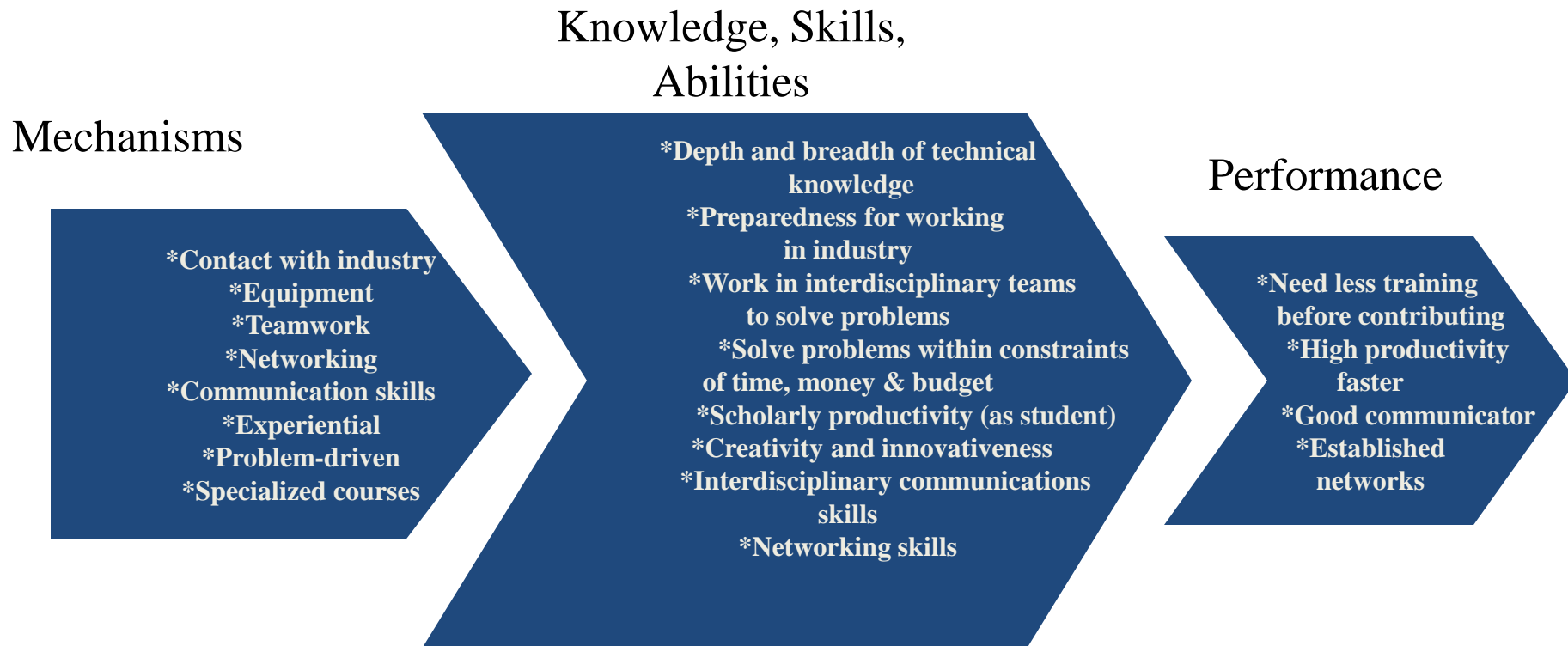
Scott 1991 Findings

- All significant differences favored the IUCRC Graduate Group.
- Means of 14 of the 17 comparable survey items were higher for the NSF center graduates.

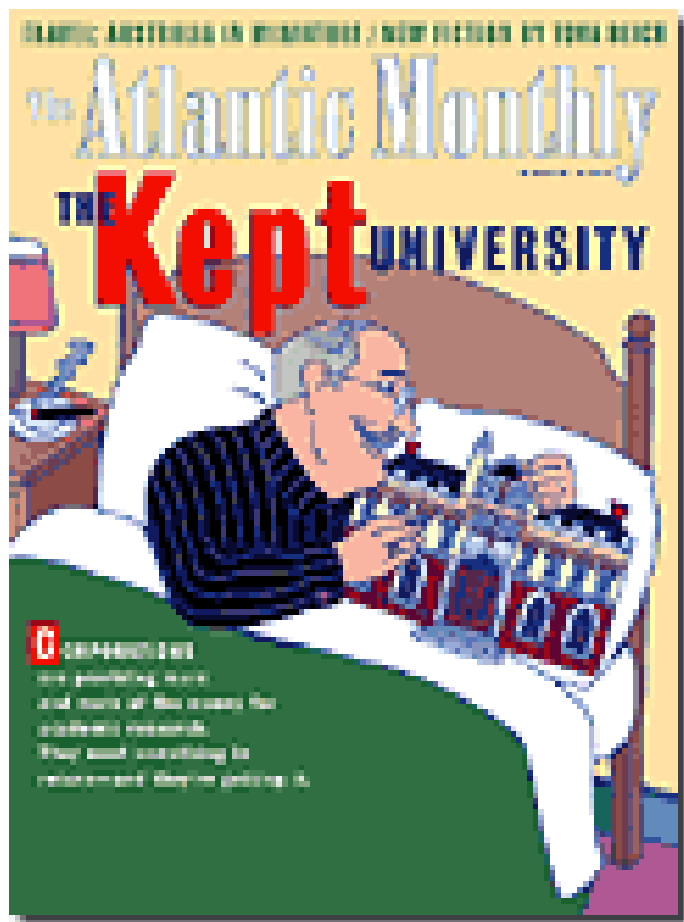


Findings

Based on alumni and industry reports...



Unintended Consequences



- Modest literature
- Faculty-focused
- Student-focused
 - Behrens & Gray (2002): *Res. Policy*
 - No differences in “climate for academic freedom”



Open Innovation Implications

- Convergent and persuasive reports from both alumni and hiring supervisor that CRC experience enhances
 - Human Capital: industrially relevant knowledge, skills and abilities (K.S.A.)
 - Social Capital: existing network ties; skills to develop new network ties
 - Little evidence on unintended consequences
- Economic Impact:
 - Direct Effect: \$50-100k (training & quick start) (SRC)
 - Innovation Commons: ????
- Less explored issues
 - International collaboration implications
 - Strong anecdotal evidence of impacts (IMS Center)
 - Faculty directors and their career paths



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IUCRC DIRECTORS **CAREER PATHS**



Overview

- Faculty and research centers
- The IUCRC and the center director
- Study goals and methods
- Study findings (to-date) on S&T Human Capital outcomes
- Center director as a career path
- Implications for human capital and open innovation
- Next steps and cautionary notes



Faculty & Research Centers

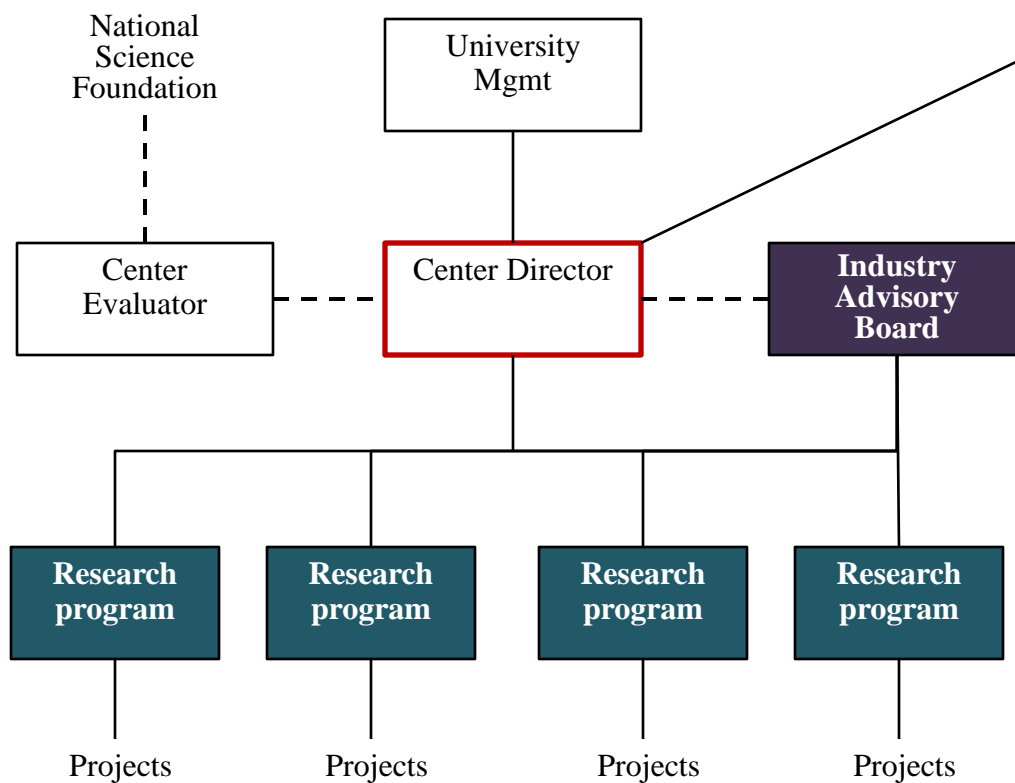
- Studies with implications for human capital, social capital, and open innovation:

Authors	Types of Centers	General Findings
Gaughan & Bozeman (2002)	Engineering Research Centers, Science & Technology Centers	Center-affiliated faculty were more likely than unaffiliated faculty to receive industry grants.
Dietz & Bozeman (2004)	Dept of Defense, Dept of Energy, and NSF centers	Center-affiliated faculty with past industry experience produced more patents than those without prior industry experience.
Turpin, Garrett-Jones, & Diment (2007)	Australian Cooperative Research Centers	Center-affiliated faculty develop diverse networks of partners, with implications for career-related outcomes.
Ponomariov & Boardman (2010)	Various	Center affiliation has positive implications for faculty productivity and for inter-institutional, inter-disciplinary, and cross-sector collaboration.
Boardman (forthcoming)	Various (based on degree of ties to industry)	Faculty at centers with industry ties were more likely to interact with private companies.

- What about the faculty scientists who create and manage these complex, multifaceted boundary-spanning organizations?



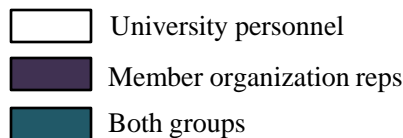
Structure of an IUCRC



Regular faculty members

who:

- Have no position authority
- Act as an intrapreneur
- Manage center operations
- Develop a technical vision
- Span multiple boundaries
- Create a multi-disciplinary research team

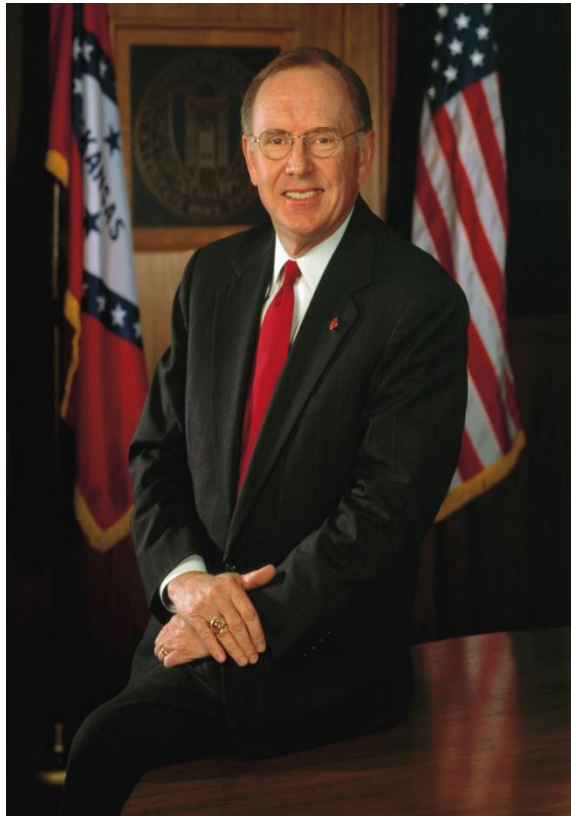


Gray & Walters (1998). Managing the IUCRC. Battelle Press : Columbus OH

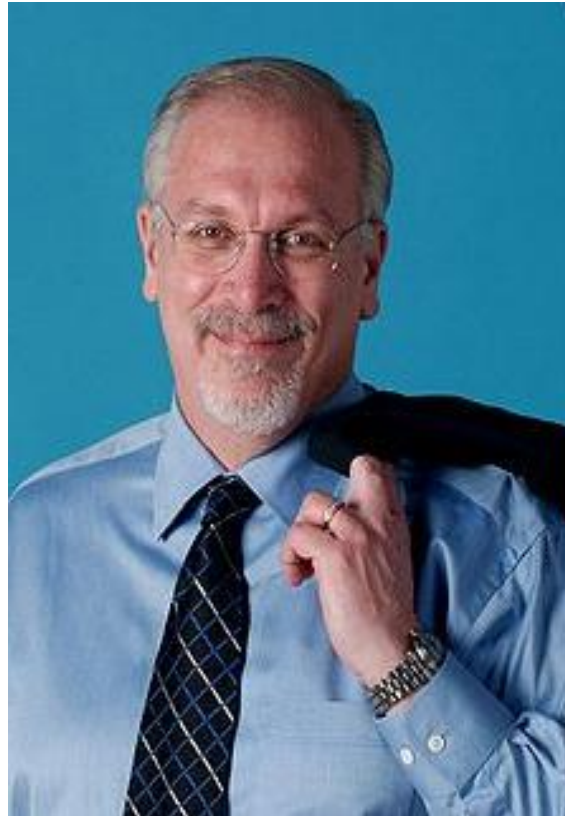
Exceptions or the Rule?



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Dr. John White



Dr. Richard DeMillo



Dr. Sarah Rajala



Study Objectives

- **Goals**

- To determine the professional trajectory and achievements of CRC directors and extent to which these outcomes can be attributed to their CRC experience and training.

- **Objectives**

1. **To understand what the center director experience is like**
2. **To assess the extent to which faculty exhibit various career and professional outcomes after serving in the role of IUCRC director.**
3. To understand the extent to which various factors including center involvement, personal characteristics and institutional characteristics are related to career trajectory, productivity and achievement outcomes
4. To shed light on the knowledge and skills directors need to be successful during and after their appointment



Study Design

- Mixed methods
 - Qualitative
 - Focus group with IUCRC directors
 - Interviews
 - Quantitative
 - Web-based survey (98 tenure/ tenure-track faculty, current/former IUCRC directors)
 - CV Analysis (in progress)



On-the-job Learning

“Becoming a facilitator. Becoming someone who brings faculty and industry together. Becoming a lawyer all the time. Being a tech transfer officer. Becoming a contracts and grants negotiator... I do all the negotiations before I hand it over to anybody, because they will screw it up 9 times out of 10.”

- center director, faculty member

- **Leading** or managing diverse teams
- **Securing** financial support for new ventures and activities
- **Developing** a broad research strategy or road map
- **Championing** ideas and projects with higher level administrators
- **Managing** budgets and allocating financial resources
- **Navigating** bureaucratic processes and procedures



Human Capital

As an IUCRC director I enhanced my skills and abilities to...

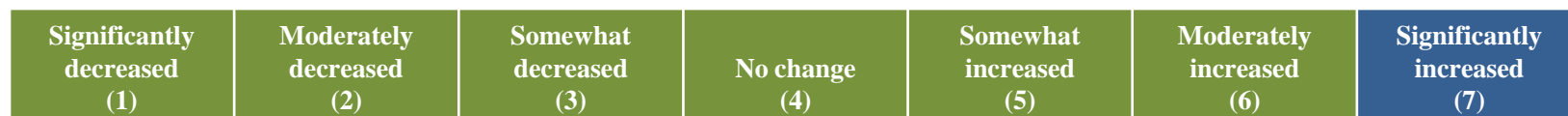


Item stem	Strongly Agree	Mn
...lead or manage diverse teams.	31.6%	5.80
...secure financial support for new ventures and activities.	29.6%	5.80
...develop a broad research strategy or road map.	26.5%	5.75
...champion ideas and projects with higher level administrators.	25.5%	5.60
...manage budgets and allocate financial resources.	24.5%	5.55
...navigate bureaucratic processes and procedures.	23.5%	5.52



Social Capital

During your tenure as an IUCRC director, did the frequency of your interactions with the following groups increase or decrease?



<u>Item stem</u>	<u>Significantly incr'd</u>	<u>Mn</u>
Researchers in U. S. industry	40.8%	6.03
Faculty researchers in U. S. universities other than my own	23.5%	5.71
University administrators and support offices	22.4%	5.56
Faculty researchers in my department or program	18.4%	5.28
Faculty researchers outside my department or program	18.4%	5.46
Researchers who reside in nations other than the U.S.	11.2%	4.98
Students I supervised in my lab or group	8.2%	4.46
Students outside my lab or group	7.1%	5.13
Researchers in U. S. government laboratories	7.1%	4.96



Negatives?

“That's a really good question because in my field at least there are conferences and meetings that mostly academics go to; I no longer go to them because that is not where my customer is. So I go where my customers are which is mostly industry.”

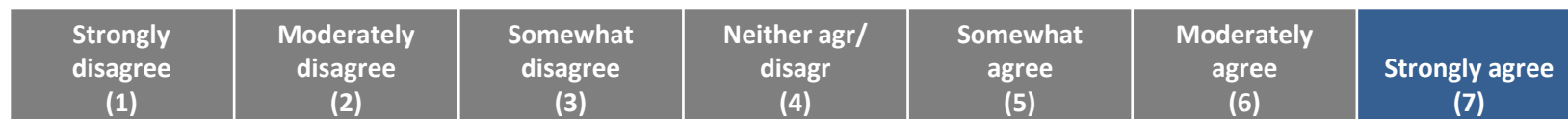
- Center director,
faculty member

- 15% reported a decrease in interactions with students in their own labs.
- 13% reported a negative impact on their journal publication rate.
- 26% reported a negative impact on their teaching involvement.
- 11% reported a negative impact on their overall satisfaction at the university.



Enabling Others

As an IUCRC director I was able to...



Item Stem

...positively impact the image or prestige of my home university.

...enhance the experience for graduate students in my own lab.

...enhance the career prospects of graduate students.

...connect together organizations and researchers with similar interests.

...enhance the careers of other faculty researchers.

...address important industrial or societal needs.

...enhance the experience of graduate students outside my own lab.

Strongly Agree

Mn

42.4%

6.05

33.3%

5.73

33.3%

5.99

33.3%

5.98

28.3%

5.86

28.3%

5.71

17.2%

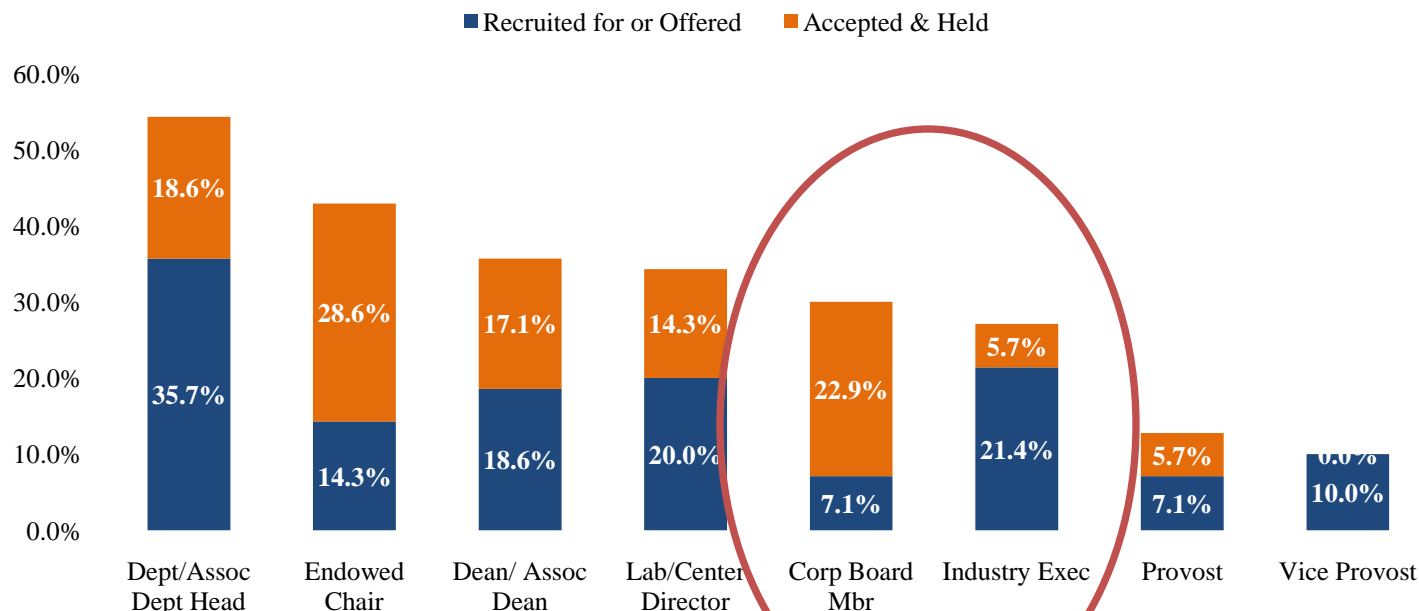
5.49



Career Opportunities

Since beginning your role as IUCRC director, what positions were you recruited for or offered, and what positions did you accept?

Career Impacts on Former Directors and Current Directors with 5+ Years of Service in the Role (n=70)

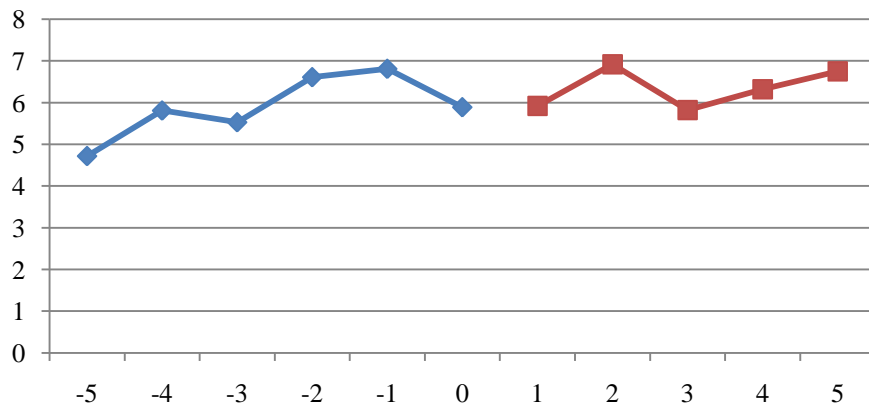




Mining CVs (Preliminary)

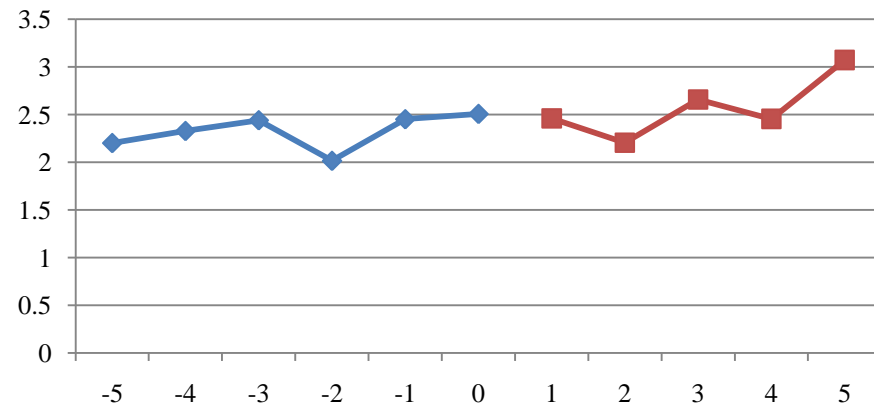
- Publications and co-authors, before and after acceptance of the CD role
- Visually, limited impact on publications pre- to post- acceptance
- Initial ANOVA models indicate possible, significant increase in average number of co-authors following CD role

Average annual publications, pre- and post-acceptance of CD role



(Note: n-sizes range from 28-36)

Average co-authorships, pre- and post-acceptance of CD role



(Note: n-sizes range from 28-36)



Survey Analysis (Preliminary)

- Influences on Perceived Impact

- DV: overall influence of CD position on career (1 = No influence, 10 = Very great influence); n=96, mn = 7.10, stdev = 2.49.

	<u>Step 1</u>			<u>Step 2</u>		
	B	β	<i>p</i>	B	β	<i>p</i>
Prior ind/gov experience (0, 1=Yes)	.51	.10	.31	.52	.10	.19
→ Start Age 45 to 54 (0, 1=Yes)	1.05	.21	.06	.64	.13	.14
→ Start Age 55+ (0, 1=Yes)	-1.31	-.20	.08	-1.03	-.16	.09
Founding director (0, 1=Yes)				-.09	-.02	.84
Time allocated to role (0-100%)				.22	.16	.06
Enhanced KSA's (scale, r = .92)				.73	.30	.00
Influenced grants/ consulting (scale, r = .73)				.58	.19	.05
Influenced prof. visibility (scale, r = .79)				.88	.30	.00
Influenced pubs & teaching (scale, r = .72)				-.30	-.11	.23

$$R^2 = .12, p = .01$$

$$R^2 = .51, p = .00$$

$$\Delta R^2 = .38, p = .00$$



Other variables for analyses

- Primary v site director
- Prior relationship to center (e.g., faculty, student)
- Prior work experience
- Currently active in or 'retired' from IUCRC program
- Years as director
- Social capital items (not scalable; limited simple structure, low r's)
- Ability to enable others (scale, $r=.87$)
- Impact on overall satisfaction at university
- Positions recruited for (after assuming CD role)
- Positions accepted (after assuming CD role)
- Type of career path
- Merged CV data (?)

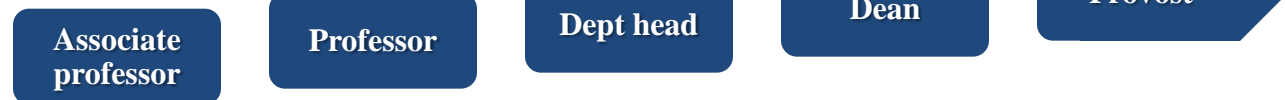


Alternative Career Path

“And then I was offered a dean position and then I went through with it because some friends asked me to look at it. I went through with it, I looked at it, and it really took me about half a day to say ‘no.’ And again I just am having fun. I think I am having a lot more impact; I think about the students that we are training, the industries that we are creating.”

- Center director, faculty member

1. Administrative/ Managerial



2. Scientific/ Technical



3. Science- saturated administrative





Conclusions

- Beginning to understand what it means to a faculty member to become a CRC director
- Role of CRC director offers faculty an opportunity to:
 1. Dramatically enhance their capacity to generate and diffuse knowledge
 - Rapid accumulation of human capital and social capital
 - Strategic leadership and influence over center resources
 2. Gain skills and competencies to create and manage mechanisms to further develop the capacity of the broader system.
 - Capability to grow and expand existing centers
 - Capability to create cross-sector research organizations



Conclusions cont'd

- *CRC director opportunities cont'd:*
 3. Make significant and enduring contributions to their field (and to economic development)
 - Augment the human and social capital of others
 - Leverage the resources of a center to achieve a technology vision
 4. Become a champion for open innovation
 - Move beyond a traditional academic career framework
 - Encourage and support open innovation by creating:
 - Knowledge value collectives
 - cross-sector collaboration
 - Inter-institutional collaboration



Next Steps

- Predictive analyses to investigate influence of various personal and experience factors on subjective and objective outcomes
- CV analysis
- Strategically sampled interviews to try to understand causal factors
 - Accepted leadership role vs. declined vs. not offered



Cautions

- Cautions:
 - Generalizability: single program; volunteer sample
 - Self report evaluations (social desirability bias)
 - No comparison group
- But this is the first systematic data on this important group...



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QUESTIONS?