Improving Outcomes from Interdisciplinary R&D: How do experience and disciplinary variety, distance, and interdependence matter?

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Executive and Organizational Decision Making & Cooperation

- *Factors that impact executives and organizations processing of information for decision making*

- *Cooperation within and between organizations & teams (R&D alliances, joint ventures, team science)*

- *Policy implications for government spending on research and development*
Theory Development

Knowledge Meshing Capability

Inter-organizational Structural Imperatives
- Project Parameters
- Skilled PI & Team
- Project Team Work Plan
- Superstructure

Team Emergent States
- Collective Identity
- Leadership
- Trust
- Conflict Management

Team Knowledge Processes
- Communication
- Elaboration of Task-Relevant Information
- Team Learning

Interdisciplinary Development (Translation)

Team Performance
- “General” Papers
- “Specialized” Papers
- Patents
- Market Entry
- Speed to Entry
- Academic Impact (citation weighted)
- Social Impact (welfare improvement)

Interdisciplinary Discovery (“aha” nugget)

Path Dependence
Social Complexity
Causal Ambiguity

Time 0
Time 1
Time 2
Time 3
Time 4
Laboratory of Analytic Sciences (LAS) Collaboration between NSA and NCSU

Initial Commitments to Interdisciplinary Integration

Job Design
- Team Heterogeneity*
- Participation

Interdependence
- Task Interdependence
- Goal Interdependence
- Outcome Interdependence

Emergent States
- Leadership
- Team Empowerment
- Trust
- Conflict/Disagreement

Team Knowledge Processes
- Communication & Collaboration
- Elaboration of Task-Relevant Information
- Team Behavioral Learning

Team Performance
- Team Productivity
- Individual Satisfaction
- Team Effectiveness

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NIH Nanomedicine Centers

Interdisciplinary team science: when researchers draw on expertise from two or more disciplines in order to co-invent or solve a problem

2 stages of “Knowledge Meshing” Capability: 8 NDCs

1) Interdisciplinary Discovery:
   Coalescence of knowledge from multiple disciplines: “aha” nugget

2) Interdisciplinary Development:
   Team-based translational development: reduction to practice
NIH Nanomedicine Centers

NYU  UCSF  UIL  BCM  UCB/LBNL  UCLA  UOC  GA Tech

179 Individual Researchers; >350 articles; >7500 forward citations
Conceptual Framework

1) Interdisciplinary Discovery

   a) **Adjacent**: Broadening Innovation
      (Tech reinforcement & extension; Behavioral: commitment & shared passion)

   b) **Interdependent**: Punctuated Innovation
      (Tech reliance on more distant disciplines; Behavioral: reciprocity)

   c) **Discontinuous**: Revolutionary Innovation
      (Tech requirement of distant disciplines; Behavioral: common mission)
Conceptual Framework

Impact
(Quality, Quantity, Novelty)

Adjacent
Interdependent
Discontinuous

Overarching Hypothesis:
The more distant the disciplines, the higher the impact of the resultant science…to a point.
Hypotheses

1. **Experience** with Interdisciplinary Research
   a) Increases likelihood of high quality publications
   b) Reduces time-to-publication of high quality research

2. **Knowledge** Variety on Team
   a) Increases breadth of publications
   b) Greater the publication quality

3. **Disciplinary Distance** on Team
   a) Closer: likely to publish in similar subject categories & journals
   b) More distant: likely to publish in new subject categories/journals

4. **Technology Interdependence** (complementarities) between Disciplines on Team
   a) Increases quality of publications
   b) Reduces time-to-publication of high quality research
   c) Reduces time-to-publication of clinically-oriented research
Contributions

1) **Improving Outcomes of Interdisciplinary R&D**

a) Discovery Phase: degree of interdisciplinarity and impact
   i. Implications for NIH (and NSF) requests for proposals
   ii. Implications of leadership changes at Federal Funding Agencies and associated mandates
       In NDC case: shift from blue sky to translational

b) Development Phase: critical components of the knowledge meshing capability
   i. Implications for team formation and management
   ii. Range of performance measures
Next Steps

Suggestions welcomed!

a) Alternative measures for Disciplinary Distance and Interdependence?
   i. Beyond similarity or co-occurrence measures
      “Family tree” structure? (e.g., of MeSH terms or Web of Science subject categories)
      Discipline X is in the same branch of science as Discipline Y
   ii. Relationships between disciplines on the team?
       a. Discipline A depends on Discipline B (e.g., for an input to run experiments; or to migrate to translation)

b) How to best control for “degree of difficulty” across NDCs?
   Might have low publication count due to complexity

c) What might be a good comparison program? Challenges in finding one
d) Fieldwork: Survey of the NDC members

I. Sample questions:

i. During your NDC, what were the **top three challenges** of working with people from other disciplines?

ii. What **specific techniques related to team management** seemed to be most effective in getting your NDC teammates from different disciplines to **work effectively together**?

iii. During your NDC work, to what degree did your interactions with people from **other disciplines** contribute to:
   a. the **novelty** of the results produced by your NDC
   b. your **ability to make progress** on the core goals of the grant
   c. your **enjoyment**

iv. How were **graduate students** encouraged to move between and interact with the labs collaborating in the NDC?

v. Thinking about the other researchers in your NDC, who did research:
   a. **Closest** to yours?
   b. **Farthest** from yours?
   c. **Most dependent** on yours (i.e., their lab needed your lab’s help to do their NDC research)
Thank you!

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