Innovating a Faculty-driven Model to Facilitate Transdisciplinary Research at the UU

A case study to understand disturbance and recovery of intact systems in disparate fields

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EXECUTIVE SUMMARY

When researchers transcend the bordered academic structures of their own departments, they often generate extraordinary intellectual leaps in their fields of study. However, transdisciplinary research (TR) is notoriously difficult to foster in R1 institutions because of formidable spatial, logistical, and intellectual barriers to such collaborations. **We propose to innovate and disseminate a low-cost faculty-driven model to foster TR by engaging individual researchers from widely different disciplines around a common theme in ways that will move their own and others' fields forward.** Our case study will *develop theory on disturbance and the role of legacy structures in the recovery of systems*, using ecology as our focal field, and exploring links with a diverse set of "analogue" fields (e.g., neurology, civil engineering, economics, burn trauma, traffic engineering, child development), all of which have rich existing research on this theme. Faculty from each field have been identified to participate in a semester-long Colloquium coordinated by post-docs, assisted by undergraduates, which will produce insights about the theme and our process that will be disseminated in research papers, a public forum through the Natural History Museum of Utah, and grant proposals for disciplinary and TR funding sources. This initiative is a scalable pilot program that creates a template for faculty grant writers to add innovative and educational, public engagement, and broader impact activities to NSF and other proposals, thereby increasing their competitiveness. This program serves as leverage for increasing the overall funding through the office of the VPR.

INTRODUCTION

Researchers often generate intellectual leaps in their own fields when they transcend the bordered academic structures of their departments and institutions. *Transdisciplinarity research* (TR), the collaborative strategy by which participants share and adapt discipline-specific approaches, methods, and ways of knowing, can result in new ways of understanding one's own data, which can lead to transformative research pathways in all academic fields[1]. High-level academic leaders are promoting arenas for TR nationally (e.g., NSF's CREATIV initiative) and within the University of Utah (UU) (e.g., Entrepreneurial Faculty Scholars, EFS). However, the structure of R1 institutions presents formidable spatial, logistical, and intellectual barriers to such collaborations. Even if faculty envision TR questions, it is time-consuming or impossible to intentionally locate or informally encounter like-minded faculty. Often, creating common ground between different disciplines runs counter to traditional academic pursuits.

BACKGROUND

As a case study for our process, we will examine the theme of disturbance and recovery, as it relates to many fields and is of interest from both theoretical and applied points of view. Ecosystem ecologists explain and predict the ways that materials and energy flow in intact and disturbed biomes[2]. Theory on impacts disturbance on forest function is developing, with specific interest in the specific functions of "**legacy structures"** (e.g., forest trees left standing in pastures)[3] in restoring ecosystem functions such as water and nutrient cycling, seed dispersal, and pollination.

But ecosystems are not the only systems that experience disturbance and recovery and that sustain legacy structures. A human brain, a highway, a family, a city, a pastoral village are all systems with critical internal connections that are vulnerable to breakage that results in loss of functions. A stroke causes loss of speech; an accident interrupts the flow of traffic; an emotionally distant parent disrupts infant social development; and political unrest creates forced migrations. Legacy structures may boost function in these systems and be key to recovery. For example, residual undamaged brain axons exhibit "neuroplasticity", which compensates for damaged neurons;

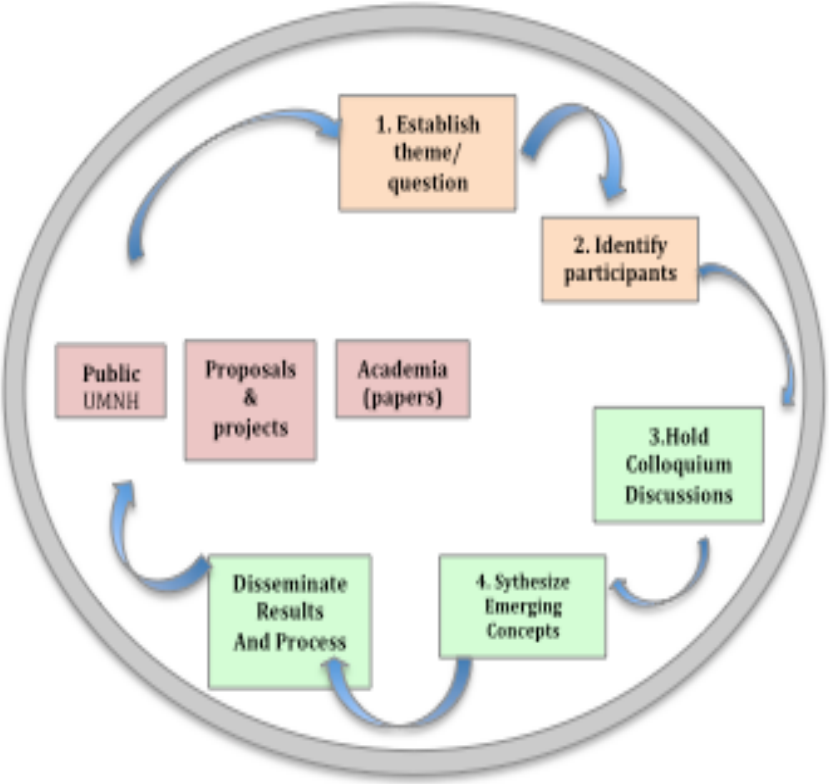
the presence of a loving caregiver provides the critical attachment point for an infant. Legacy structures may also hinder recovery: the preservation of a historic building may interfere with urban revitalization. Researchers in these fields have developed relevant approaches, tools, and theory to understand (Table 1), and exchanges with other fields could provide new insights and pathways of TR.

PROPOSED WORK

We propose to innovate and test a faculty-driven model to foster TR by engaging individual researchers from widely different disciplines around a common theme in ways that will move their own fields forward. This is an adaptive, low-cost, extensible model that can be used by participants in any field and at any level of intensity and time frame. As a case study, we will focus on the topic of *disturbance and the role of legacy structures in the recovery of systems*. Ecology is our focal field, which we will connect to a diverse set of non-ecological ("analogue") fields (e.g., neurology, civil engineering, child development, economics, urban planning), all of which have rich existing theory and practices on the theme of disturbance and recovery. We have identified a group of faculty from 8 disciplines who wish to engage in discussions about TR. Each has committed to share approaches, tools, and models in our own fields, integrate and synthesize commonalities, and then disseminate our results and process, first to the receptive EFS audience, and then to other researchers at the UU and, ultimately, around the country. We will also present the process and ideas to the public through the existing university-wide lecture series, the *Utah Museum of Natural History Lecture Series* (formerly, *"Nature of Things"*).

METHODS

Our model (Fig. 1) creates an iterative, question-driven process, two steps of which we have carried out (orange boxes). 1) Establish a theme or question addressed in the focal/analogue fields; 2) Identify participants; 3) implement and evaluate the TR Colloquium; 4) apply process to the EFS and modify as needed; and 5) disseminate through public lectures, toolkits, and scientific papers; and generate new proposals and projects.



2013 Preliminary work: We established the theme to understand the role of relict structures - forest trees left standing in pastures after tree harvest - in disturbance and recovery of forest ecosystems. We identified experts in analogue fields (below) by using the "Find the Researcher" feature on the UU website (http://faculty.utah.edu/findaresearcher/). We sent individual letters of invitation to those with relevant research publications. Many initial contacts referred us to other, more appropriate, researchers; we have secured commitments from 8 faculty whom we invited for in-depth discussion and who provided seminal readings in their field.

2014-2014 Work: In Fall 2014, we propose to gather participants (faculty and post-docs) from each of the analogue fields (others may participate as observers in person or by Skype) in a bi-weekly Transdisciplinary Colloquium called *"Transdisciplinary Studies of Disturbance and Recovery*". At each 2 hr meeting, a faculty member will summarize theory, concepts, tools, and visualization techniques used by that field about our theme in the lab or conference room of the speaker to expose participants to the discipline's "feel and stuff". Some sessions will include a participatory demonstration (e.g., forest ecology = on-campus tree-climbing; traffic engineering = computer model demo; urban planning = guided walk in downtown Salt Lake City). Each session will be captured by a note-taker and videotaped; an advanced student in the UU Film

Department will create a 10 min video for the website and our toolkits (below). These will be available to the VPR.

EVALUATION

We will assess success if the process results in one or more of the faculty gain new insights, tools, or perspectives about disturbance, recovery, and legacy structures for their own and other fields, based on exit interviews conducted by project staff. For the Lecture Series, we will use UMNH's existing exit surveys and social analytic tools to assess audience size and impact, with additional questions that determine how the experiences enabled attendees to connect ideas and relationships from one discipline to another.

DISSEMINATION

To disseminate preliminary Colloquium outcomes, we will present process and outcomes to the EFS group at their Fall 2015 meeting for input and modification. We anticipate that some of them will apply this model for themes of their own. We will then assemble TR process toolkits (electronic and hard copy) consisting of notes, video, readings, interviews, and evaluation results. We will disseminate this work through: 1) written and video materials on campus websites and hard-copy toolkits distributed by the Center for Science and Mathematics Education and the Office for Sponsored Research, and the Center for Teaching and Learning Excellence; 2) one or more concept papers in peer-reviewed journals of the participants' fields and in more general scientific and educational publications (e.g., BioScience, Chronicle); and 3) talks at disciplinary and general (e.g., AAAS) scientific meetings.

LEVERAGE AND ANTICIPATED BENEFITS

This model will be used to gather preliminary groundwork for larger grants. An earlier version of this project ($949,000) was submitted to the **National Science Foundation Ecosystems Program**, but was rejected on the grounds that although the ecological questions were sound, the proposed transdisciplinary work was too great a risk for their funding criteria. We plan to resubmit this project to the NSF in 2015, drawing upon the pilot work we propose here. We will also submit a proposal to the **Keck Foundation** (http://www.wmkeck.org/grant-programs/grant-programs), which seeks projects ($500K-$5 million) for interdisciplinary research that is "distinctive, novel in its approach, innovative, and has the potential to break open knowledge in their field, and that cannot be funded by conventional sources.

Developing and testing this model with an extensible case study that addresses our theme (disturbance and recovery) will provide a process for researchers in other fields with other themes (e.g., decision-making; scaling issues; theory-practice relationships, visualizing data). Using this model, researchers will be able to identify faculty in other departments, organize a Colloquium to a share perspectives, and generate new proposals for programs that require or favor TR approaches. In addition, educational components include new interactions among faculty, post-docs, and undergraduate students.

In summary, this TR initiative is a scalable pilot program that creates a template for faculty grant writers to add innovative and educational, public dissemination, and broader impact activities to NSF and other proposals, thereby increasing their competitiveness. This program serves as leverage for increasing the overall funding through the office of the VPR; enhancing public awareness, and enhancing donor development, museum development, state-level educational opportunities, and leadership by UU.

BUDGET

Concepts & approaches of participating researchers and fields (plus forest ecology)

Brain And Nerve Trauma: Meic Schmidt; Neurosurgery; Dr. Chuck Norval, Bioengineering

When brains are injured, unharmed "legacy" neurons can shift their original function to compensate for impaired functions (neuroplasticity), which occurs through cortical remapping in response to injury. Theory about the role of legacy structures is lacking. *Legacy structures may shift their function following disturbance.*

Theoretical macroeconomics, Gabriel Lozada, Dept. of Economics

A economics concept for legacy structures is insurance and risk. Insurance is what economists use to help out when disturbances happen. Economists try to find the optimal number of legacy structures to retain without compromising investments. *It is important to weigh the risk of retaining vs. not-retaining legacy structures.*

Human development and family studies: Dr. Russ Isabella, Dept. of Human Development

A rich theory in psychology ("Attachment Theory") guides research in the formation of human relationships. Infants must develop a relationship with one primary caregiver for normal emotional development. The breaking of a primary bond can in some cases be replaced by "substitute" or legacy caregiver bonds in still unknown ways. *Legacy structures may affect trajectories that affect both the forming and the loss of critical attachments.*

Traffic and civil engineering, R.J. Porter, College of Civil Engineering

Understanding flows of traffic originated in fluid dynamics. Current work is based on "traffic flow theory", which examines quantitative characteristics of changes in speed, density, and viscosity of vehicular movement. Nearly all work on traffic disturbances and recovery comes from observational (rather than experimental) work, and then applying those observations to predictive models. *Flows of materials from one venue to another can be quantitatively analyzed as many discrete units in motion, arising from theory on observations and modeling.*

Urban planning: Sarah Jack Hinners, Dept. of Urban Ecology

Specific structures in urban systems increase resilience, from three perspectives economic, physical and social standpoints. The key to urban resilience is often tied to the diversity of drivers of the local economy. A city that makes good investments in infrastructure maximizes resiliency. A strong and well-connected community has an advantage in the case of a disaster due to shared resources. *Analogue fields use ecological concepts and vocabulary. Legacy structures may make a system more resilient in the face of large disturbances.*

Burn trauma and recovery: Ward Scott, School of Physical Therapy

The "landscape" of healthy skin is vulnerable to "disturbances" of burns. Damage is assessed by the thickness of the burn, rather than the area. Little theory exists; treatment is based on empirical data. Treatment of burn trauma was restricted to the physical recovery of skin, but now, social and psychological factors are also considered. *Legacy structures do not function to regenerate in some systems, so direct transplanting from outside sources is required. Social context is relevant for recovery.*

Refugee resettlement: Yda Smith, School of Occupational Therapy

Refugees are people who reside outside their place of origin because they have suffered or fear persecution because of race, religion, or political opinion. The "disturbance" of relocating people to a different culture causes acute and chronic social problems. "Anchor theory" holds that a person or family who retains the original culturecan be of benefit or detriment to the settlement of the community, but can also hinder societal integration. *Legacy structures hold both positive and negative functions for resilience.*

Modern dance, Ellen Bromberg, Department of Dance

In many societies, the practice of dance can be stringent and cause disturbances in the "normal rearing of children. Participation in such traditions as ballet, ritual dance of Bali, and others requires a "disturbance" in the life of a child/adolescent that stretches through early adulthood. After that, the individual must "recover" to rejoin mainstream society, drawing upon "relict" connections with family and society.

REFERENCES

[1]Rosenfield, P. 1992. The potential of transdisciplinary research for sustaining linkages between the health and social sciences. Social Sci. Med. 35:1343–1357.[2]Laszlo, A. & S. Krippner. 1998. Systems theories: their origins, foundations, and development. *Systems Theories and A Priori Aspects of Perception*. ElsevierScience.[3]Nadkarni. N. &N. Wheelwright. 2000. Monteverde: Ecology and Conservation of a Tropical Cloud Forest. Oxford Univ. Press, Oxford.