Interdisciplinary Collaboration at the University Level

Andrea Chu
Honors Research Thesis
Advisor: Dr. Eric Toman
School of Environment and Natural Resources
The Ohio State University

ABSTRACT:

Traditionally academic approaches have been divided into disciplines including natural sciences, social sciences, and the humanities. This disciplinary approach has contributed to the development of a substantial depth of knowledge within each particular field of inquiry; however, limited connections have been made between disciplines. Currently, there is a growing recognition that no one discipline has all the answers for many of today's pressing questions particularly those related to the environment, yet little research has been completed on the factors that encourage or constrain interdisciplinary research. This study addresses this research gap by completing qualitative interviews with faculty researchers across several disciplines and departments at The Ohio State University. Most participants indicated that societal problems are complex, non-linear, and dynamic, and require integrated approaches to gain a richer understanding of these problems and inform potential responses. While most participants recognized growing support for interdisciplinary efforts among university and college administration, experiences at the department level vary widely suggesting differences in how particular disciplines value interdisciplinary research as well as institutional support for such approaches within departments. Institutional incentives and constraints at the department-level appear particularly important to the success of interdisciplinary collaborations.

INTRODUCTION:

The Ohio State University, led by Dr. E Gordon Gee, has pledged itself to a One University Framework Plan to unite the many different areas of the university into a comprehensive, integrated whole. As a public research-oriented institution, part of this grand scheme for the university is a push for interdisciplinary research that will "address societal needs." The call for interdisciplinary collaboration in research is nothing new; in fact Ohio State's own Kitty O. Locker wrote "The Challenge of Interdisciplinary Research" in 1994, and others have pushed for such integration as far back as the 1960s. Projecting what she believed to be an end of a discipline-based approach, Locker wrote "Traditional disciplines – the way in which US universities have divided knowledge and allocated power – are under attack" (1993), yet it seems that little has changed in the interim. Many in the scientific community believe in the importance of interdisciplinary research (IDR) to the advancement of science, yet it seems to still largely be the exception to the norm in current research and academic organization. This study presented here examines why there has not been more progress at Ohio State despite substantial support from researchers' interest and the university. We also examine how some researchers have found success doing ID work under the current framework and consider whether their experiences can provide a model to more effectively encourage IDR at a larger scale.

Current Trends and Importance of Interdisciplinary Research

"In spite of its difficulty, interdisciplinary research is desirable—perhaps essential if we wish to advance knowledge." –Locker

Interdisciplinary research has been widely lauded as desirable, or even required, for further scientific advancement and contributing to solutions for societal problems (Campbell 2004, Fox & Rohlich 1968, Locker 1993). Many universities, think tanks, and other institutions have dedicated time and energy into facilitating IDR. From Michael Crow of Arizona State University to Dr. E Gordon Gee of Ohio State, university presidents see the need for dramatic change in the behemoth of institutions of higher education to adapt to the new age where the environment of education is shifting rapidly, due to things such as the prevalence of technology in a globalized world (Vescovi 2010, ASU). The number of interdisciplinary centers at universities has increased exponentially in recent years, and the dollars allotted to IDR is unprecedented. It is clear that big players in the educational and research world are pushing for a change in the university structure for better facilitation of a new kind of research.

There has been increasing recognition that the issues the world faces today are complex, non-linear, dynamic, and highly resistant to the reductionism that has dominated scientific research for centuries. Widespread environmental crises are often followed by countless policy failures in natural resource management that demonstrate the weaknesses of a piecemeal approach with separate attentions to social and natural sciences (Liu et al., 2007a). For example, fisheries collapse due to lack of ecological knowledge of fish cycles and sociologic knowledge of fishing community behaviors as well as the lack of global climate legislation both show how a lack of integration can lead to ongoing problems for many stakeholders and an inability to address the underlying causes of existing challenges. Anthropogenic drivers are causing environmental circumstances to change rapidly all over the globe, and this will affect both ecosystems and human societies. Socioeconomic and political structures play an integral role in the effectiveness of natural resource management strategies and the resilience of both human and natural systems, yet their integration with natural science research is limited (Liu et al., 2007a). Thus combining the realms of many disciplines is seen as necessary for tackling the complex problems of the world.

IDR has become a powerful "buzzword" that has received substantial attention. It is often used in conjunction with "sustainability," another such buzzword. Environmental crises are often the focal point of ID projects because of their wide scope and complexity. Many projects, terms, and initiatives have sprung up from ID roots, such as Coupled Human and Natural Systems (CHANS), Team Science, and even the Innovation themes of Ohio State. Funding agencies are particularly interested in IDR. The National Science Foundation, arguably one of the largest funders of academic research at universities, has a section of funding devoted to IDR.

> *NSF has long recognized the value of interdisciplinary research in pushing fields forward and accelerating scientific discovery. Important research ideas often transcend the scope of a single discipline or program. NSF also understands that the integration of research and education through interdisciplinary training prepares a workforce that undertakes scientific challenges in*

innovative ways. Thus, NSF gives high priority to promoting interdisciplinary research and supports it through a number of specific solicitations.(nsf.gov)

Yet the NSF still primarily funds disciplinary research with IDR still serving as a special delineation of projects, separate from the norm.

As a concept, IDR is defined differently by different scientific disciplines, funding bodies, and university administrations. Several words to describe this approach to research, including multidisciplinary, transdisciplinary, antidisciplinary, among others, adding to the confusion regarding IDR. Krishnan describes this problem:

> *Although the idea of 'interdisciplinarity' is certainly a very compelling one, it also appears that the term is so loosely and insufficiently defined as to make it almost meaningless. Mattei Dogan and Robert Pahre therefore suggest to banish the term altogether. Interdisciplinarity is now made up by a range of very different concepts like crossdisciplinarity, multidisciplinarity, supradisciplinarity or transdisciplinarity, which are often talked about as if they were just one. Even if there is agreement on the terms, it still remains unclear what is to be accomplished. Furthermore, what would a social scientist have to do to in order to be called interdisciplinary: get funding from more than one research council?; collaborate with people in the natural sciences or perhaps just with other social scientists of a different specialisation?; or merely read some books outside the own discipline? Would it be even possible not to be interdisciplinary in some form or way, or are there any obvious criteria for what exactly distinguishes interdisciplinary research from disciplinary research? (Krishnan, 2009)*

Thus, distinctions between different terms and what constitutes IDR are still unclear. However, many organizations and researchers engaged in supporting or publishing IDR elect not to define the term at all. Before we can begin to answer what IDR is or how to facilitate IDR at universities, we must first look at the origins of disciplines, and how interdisciplinarity is a reaction to such history. To start, we review the history of the modern university and the first divisions of disciplines.

Historical Lines – A Brief History of University Structure, the Origin of Disciplines & Resulting Difficulties

"There is only one subject-matter for education, and that is Life in all of its manifestations." – Alfred North Whitehead

The first known concept of what we now consider a university dates back hundreds of years in Western and Central Europe. Universities came to prominence "at a time when European society was structured around Christianism and when Christian theology was the standard by which everything was measured." (Ford 2002). Universities established learning in terms of religion, and service to the Church. Remnants of this history are still evident in modern universities today.

The word discipline has Latin roots, from the words *discipulus* and *disciplina*, which mean "student" and "teaching," respectively. But a quick search of the term (Figure 1) reveals that it now has quite a few meanings aside from a "field of study."

Verb forms of the word discipline bring different associations to the noun form. From "punishment" to "train or develop" to "impose order upon," the word discipline takes on a number of interesting associations (Mirriam-Webster).

Krishnan describes Foucault's views on disciplines and its multiple meanings with the result of there being

> *An important moral dimension to 'discipline' that defines how people should behave or think. Michel Foucault has famously interpreted 'discipline' as a violent political force and practice that is brought to bear on individuals for producing 'docile bodies' and minds. In this process of disciplining for the general purpose of economic exploitation and political subjugation the 'disciplines' do not remain external to the subject, but become increasingly internalized…For Foucault disciplining is thus a process aimed at limiting the freedom of individuals and as a way of constraining discourses. (2009)*

Figure 1:Definitions of Discipline from Merriam-Webster. Available at Meriam-Webster.com

In this way, a discipline can be seen as a way of enforcing a certain way of thinking and endorsing specific kinds of knowledge creation.

Disciplines were solidified as an integral part of the modern university at the University of Berlin which rose to prominence in the early 1800's. The University of Berlin was the symbol of German Idealism – the idea that intellectual scholarly pursuit, free from practicality or utility, was the ultimate truth. Only the study of "pure knowledge" would be practiced at Berlin, seen as above previous institutions that existed only to serve the state or the church. The first division between the humanities (*Geisteswissenschaft*) and the natural sciences (*Naturwissenschaft*) was solidified here, and "there was no need to have any knowledge of more than one discipline, for every discipline had its

own intrinsic worth and ultimate value." (Ford, 2002). In many ways, this the organization of knowledge into disciplines was passed down to our modern day university.

There are many ways of defining a discipline, but in particular, it can be said that a discipline is "a technical term for the organisation of learning and the systematic production of new knowledge." (Krishnan, 2009). However, beyond this general level it becomes difficult to specifically define and distinguish between existing disciplines.

> *It is quite revealing that a lot of 'pseudo-militaristic' and geopolitical metaphors have been used in the disciplinarity vs. interdisciplinarity debate, either to justify or to denigrate IDR. One might think of the terms 'borders', 'boundaries', 'territories', 'kingdoms', 'fiefdoms', 'silos', 'empire building', 'federalism', 'migration' and so on. In some of these debates knowledge is almost treated like a geographic territory over which one can fight and which can be controlled by 'disciplinary factions'. In reality, there are lots of overlapping jurisdictions and constantly shifting and expanding knowledge formations. (Krishnan, 2009)*

And these borders are still a source of conflict. They have a very historical place in the university, and their ties with Western ideologies is still evident. They came out of a line of thinking that was born during the Enlightenment. The Enlightenment was the start of a massive proliferation of a particular ideology: that the world's mysteries can be solved by breaking complex things down into smaller and smaller pieces (e.g. reductionism). Interdisciplinarity is a reaction against this thinking into holistic problem solving. In fact, many marginalized groups, academic and otherwise, see disciplines as a formal oppression of certain perspectives. Lisa Duggan reviews *The Queer Art of Failure* and in her critique of mainstream academics, calls disciplines "the zombies of intellectual life right now—like capitalism, they keep coming back from devastating crisis and critique. We are encouraged to describe our work as interdisciplinary, multidisciplinary or transdisciplinary, so that the disciplines may survive alongside our critical practices, fundamentally informing them." (2012)

Yet another structure of the university that has come under severe criticism is tenure. Tenure as we know it today came about in the early 19th century as a way to protect academic freedom of professors and prevent financial donors from interfering with faculty with differing perspectives. (Amacher & Meiners, 2004) However, the tenure process can also be viewed as reinforcing the importance of a home discipline with faculty required to advance knowledge and adhere to the research and publication norms of their particular discipline in order to receive tenure.

Generally, the promotion and tenure process is based on the principles outlined by the America Association of University Professors in 1940:

> *After the expiration of a probationary period, teachers or investigators should have permanent or continuous tenure, and their service should be terminated only for adequate cause, except in the case of retirement for age [largely abrogated by federal law] or under extraordinary circumstances because of financial exigencies*

Thus, tenure-track faculty are provided with some guarantees of stability in their employment after completing a successful probationary period and passing their unit and university's tenure evaluation (Armacher & Meiners 2004). The tenure evaluation process varies from university to university, and

even from department to department in the same university, but in each case this process involves an assessment of the faculty members' contributions by colleagues of higher academic rank within their home unit. Thus, a successful tenure decision depends on completion of a portfolio of work deemed appropriate by senior colleagues.

The tenure process raises the interesting question of how this evaluation affects researcher decisions to partake in IDR or not. Researchers may realize the need for interdisciplinary work and believe in its importance, but, "the nature of the current federal support system—and of the research community—counters these beliefs." (Metzger & Zare, 1999). Thus, new faculty members may feel constrained in their ability to engage in IDR given concerns over how it will be evaluated by other faculty within their departments or due to the potential lack of funding opportunities to support such research. There are currently many structural and social barriers to a more effective working environment for researchers to do research spanning multiple disciplines. In reviewing challenges associated with IDR, Locker concluded that IDR requires more time and effort than traditional research and is less likely to be cumulative, and this sways many away from delving into other subjects outside their specialties (1994).

Metzger and Zare (1999) explored federal agency and university tenure policies that affect the nature of interdisciplinary research. They conclude that no ranking system exists to evaluate interdisciplinary programs and many mid-level administrators at university institutions have no reason to encourage thinking outside the department.

In addition to the tenure process and potential difficulties obtaining funding, differences in research methods and paradigms also create consternation between research investigators of different disciplines working together on a project. Relatedly, concerns that concepts from another field can be taken out of context, misapplied, or cherry-picked unintentionally, also dissuades interdisciplinary work. Academic reputations are at greater risk when using a wide range of information, particularly when they are outside of an investigator's expertise because the lack of familiarity with general state of research can lead to poor research practice and eventually discredit the researcher (Locker, 1994).

In her own experiences, Campbell (2005) looks at the obstacles in academia regarding the perceptions of certain journals and lack of incentives to participate in interdisciplinary research. Researchers are less willing to submit their work to newer interdisciplinary journals due to their lesser reputation. Moreover, articles in such journals are less likely to be cited in other work by other authors; an important criteria in evaluating the impact of a particular article. Furthermore, reviewers who participate in the peer review process tend to have biases towards more familiar disciplines and methods of research, which may influence the reviews received by papers drawing on a diverse set of theories employing less traditional methodologies.

Fundamental differences in beliefs about advocacy and power relations in collaborations also lead to conflict. Ideological positions on issues may never be questioned within a discipline but on interdisciplinary projects they can present opportunities for growth or for divergence. Uneven numbers of social versus natural scientists can exacerbate issues further, since "It is sometimes exhausting to be the one person speaking a different language or trying to represent a broad suite of social science concerns," (Campbell, 2005). A similar statement could also likely be made by a

natural scientist engaged in a primarily social science project. Interdisciplinary research can provide people with many important learning experiences, but only if appropriately managed.

With these issues of stigma, institutionalized disincentives, lack of funding, and time, researchers are currently hard-pressed to seek out more opportunities for IDR. Some authors have considered some solutions to the concerns expressed. For example, Locker (1994) pushes reading and citing more widely, multi-modal approaches to data collection and analysis, interdisciplinary perspectives for criticism, and more transparent communication to other researchers and audiences. Campbell advocates for "developing publishing protocols, clarifying problem definition, integrating assumed objectives, and considering power relations," but understands that these take time to put into practice (2005). Metzger and Zare (1999) proposed creating a new federal program that conducts research with multiple disciplines to be owned by many agencies and approved by Congress. For them, this "relatively modest investment would reap substantial returns in enriching and enlarging the national research enterprise, in directly addressing several national goals," (Metzger & Zare, 1999).

Despite the widespread approval of top-level administration in agencies and universities towards interdisciplinary research, the state of knowledge and opinion about IDR among many active researchers is fairly sparse. Discovering the thoughts of researchers about the value of and factors that encourage or discourage interdisciplinary projects can facilitate more effective strategies to incentivize IDR. In order to propel more research investigators into voyaging into unknown territories of other research fields, a more bottom-up approach to looking at perceptions of interdisciplinary programs should be adopted, since "the best ideas often come from…the researchers themselves" (Metzger & Zare, 1999).

The Microcosm – Ohio State as a Case Study

"Ohio State Research, transcending disciplines, leading change, generating solutions." – Office of Research

The Ohio State University is a large, public, land-grant university dedicated to research with over 180 majors with most disciplines represented. The administration has clearly stated its support for interdisciplinary research in its Discovery Themes (specifically for hiring tenure track faculty) and the issues-based Centers and Innovation Groups promoted by the Office of Research.

At its highest levels, the university has expressed great interest in IDR. The president of Ohio State, Dr. E. Gordon Gee, has been a strong champion of promoting change at the university to better serve society and students as described below:

> *What Gee and Ohio State must achieve is nothing short of a radical reorganization of the American university, he says…For Ohio State ,that means organizing the university around ideas and institutes, as opposed to fiefdom-like schools. Gee prefers the term "trans-institutional" to "interdisciplinary" because he believes that traditional disciplines will have to change, or at least possess very permeable borders. Curricula must be quickly adaptable to meet society's needs, and new relationships must be forged with state governments, business, and nonprofits. "Fifty years ago, biologists and chemists didn't mix much," Gee says. "Today, bio-*

chemistry is a huge field. Universities are the future economic catalyst, and they must take a stronger leadership role in society." (Vescovi, 2010).

Ohio State is clearly calling for more integration between existing disciplines at the high administrative levels in a public manner. IDR is a term that is used repeatedly in university marketing literature. This study seeks to explore how such apparent support at university administration levels is reflected in the view of researchers that are on the ground, conducting the very research that is being emphasized.

METHODS:

This project examines the experiences of scientists conducting IDR at The Ohio State University. We seek to address the following research questions:

1.   What is the value of IDR to researchers?

2.   What are perceived barriers and incentives to IDR at Ohio State?

3.   How are researchers dealing with barriers?

4.   How is IDR encouraged or discouraged at different levels of administration?

5.   What do researchers believe can or should be done to encourage IDR?

To find out what barriers and incentives exist for ID collaboration, how researchers feel about the barriers and incentives, and why they continue to participate, it is appropriate to conduct qualitative research, specifically using case study research as a methodological approach. "The essence of a case study…is that it tries to illuminate a decision or set of decisions: why they were taken, how they were implemented, and with what result." (Schramm, 1971). This approach is preferred when the focus of the research is on contemporary events where the researcher has little control over the behavior of subjects (Yin, 2009). This case study aims to be explanatory, rather than predictive, to explore the mechanisms that affect interdisciplinary research at Ohio State. The Ohio State University is a large public university dedicated to research with over 180 majors with most disciplines and departments represented, and thus provide s an interesting case study for large research institutions.

For this project, data was gathered using semi-structured interviews. Semi-structured interviews follow a general set of questions or topics developed by the research team, however, interviewers may deviate from predetermined questions to explore relevant ideas that emerge during the interviews. This method was selected given the relatively limited prior research competed on participants of IDR in order to provide necessary flexibility to observe new views and topics raised by study participants. The data collection instrument was constructed with open-ended questions about researchers' backgrounds, current position and projects, and their attitudes on and experiences with IDR and CHANS (see appendix 1). Questions included identification of incentives and barriers, what benefits or consequences were encountered by researchers participating in IDR, how IDR was viewed by others at the university, and what further incentives were needed. Participants were also encouraged to discuss anything else they viewed as relevant.

Interviews were completed between July 2012 and February 2013. An initial list of ID researchers was compiled by the research team and invitations to participate were sent to this first group in July. This initial list was composed of researchers at Ohio State that were involved in Coupled Human and Natural Systems projects funded by the National Science Foundation. Interested and available parties were interviewed on an ongoing basis depending on their availability. After this initial list of potential participants was identified , the snowball sampling method was employed to find additional researchers that were known to conduct (or have conducted in the past) interdisciplinary research. At the end of each interview, participants were asked to recommend any other ID researchers they knew of on campus, and invitations to participate were continually sent until January of 2013. In total, 18 semi-structured interviews were conducted with professors from 13 different departments at Ohio State. Most (16) of the total were recorded and transcribed. Interviews ranged from 20 - 80 minutes in length.

With the snowball method, the sample of researchers is not necessarily representative of the broader population of faculty at Ohio State. The final group of interviewees consisted of those already known to have conducted IDR and are more likely to have been successful in their endeavors, having been recommended by others. Many of the researchers were direct collaborators with each other and perhaps shared similar views. Researchers that were not interested in doing IDR were not represented. However, as our research questions are focused on understanding first-hand experiences with IDR, participants in this study do represent our population of interest.

Data was analyzed using grounded theory, which is an inductive approach to qualitative analysis. "A grounded theory is one that is inductively derived…it is discovered, developed, and provisionally verified through systematic data collection," rather than collecting data to fit a specific, predetermined theory (Strauss & Corbin, 1990). Grounded theory employs a systematic approach to data analysis, of which the first step is open coding. After the interviews were transcribed from audio files into text, ideas and concepts were identified and then coded with corresponding labels. Codes were organized hierarchically into categories (see appendix 2). Coding and data analysis were completed using NVivo, a software program designed to collect, organize, and analyze qualitative and mixed method research. The resulting coding structure was then used to develop a theory to describe and explain interview findings.

FINDINGS AND DISCUSSION:

"But the purpose of research universities is generally to push the envelope of knowledge, try to chip away at the big problems, things unknown, slowly work towards some answers. These are often things that you wouldn't immediately get monetary benefit out discovering. Incremental discoveries or real fundamental discoveries that take a long time to achieve. Something beneficial, so that's what universities are." - Participant

The participants of this study were all known to have had some experience with IDR and many were known to have been particularly successful in conducting it. But these researchers are still in the minority despite the university emphasis on IDR. In this section, we present findings under each of our general research questions and conclude by considering some potential approaches to better facilitate more IDR at Ohio State.

18 interviews were conducted with faculty in thirteen departments (shown in figure 2) in five colleges. Of those interviewed, five were assistant professors, eight were associate professors, and three were full professors, and one held a position as a lecturer and one was a senior lecturer. There were six female and twelve male interviewees.

Figure 2: Departments of Participating Researchers. Text size indicates the proportion of researchers interviewed within the department.

All participants spent significant portions of the interview discussing barriers, incentives, and levels of support, with regards to both their own experiences as well as perceptions of other researchers' experiences.

The following sections include a description of responses from participants as well as direct quotations to illustrate the points below. Quotations are offset from the text and highlighted in italicized font.

What is the value of IDR to researchers?

Participants were asked what motivated them to participate in IDR, and what its benefits were. The participants saw IDR as highly valuable "in terms of solving practical applied problems and in terms of the university accomplishing things that are actually good for society." IDR was seen has having a great potential to contribute new knowledge because:

> *Not all problems are simple, many problems are really at the crack between what classical topical disciplines have been dealing with. In fact all of the hard core topics have been worked to death. So now more and more research is kind of pushed to the edges where it's left the edges because they didn't handle it before because it wasn't obvious that it's their problem.*

In fact many researchers described strictly disciplinary research as being overworked and saw IDR as a new frontier, a way for the future. As scientists, many saw a void in certain types of research questions and took it upon themselves to fill in the gaps. Large societal problems were always either specifically mentioned or alluded to when asked about the value of IDR. IDR was needed for:

> *Helping solve the world's problems, these major problems…whether it's climate impacts or nutrient pollution…society benefits tremendously from that. I mean it's, in my view…most of the problems that we face are going to depend on successful collaborations involving researchers from different disciplines. So that would be the big benefit. I mean you can get a little philosophical, and sort of have other benefits. You know, if we show that working together solves problems, I could see that, you know, that team building thing, promoting the merging of minds for other avenues, but the primary benefit's gonna be just you know, through…what's going to happen to our world, basically.*

Concerns about societal problems were of immense importance to participants and their beliefs about the value of IDR. But the value of IDR was generally expressed not only on a societal scale, but a personal one as well. As most participants stated they enjoyed working in group settings, IDR was valuable in that way to them due to most IDR projects being team-based. IDR was interesting, challenging and exciting, and allowed the participants to continue learning through other researchers. When asked what motivates them to conduct IDR, one participant said

> *What motivates me? Well you know, a passion for this, some kind of questions and problems and things that uh connect, social and environmental systems. I guess also I do really like, I enjoy working with people who have different perspectives, sometimes it's very frustrating and challenging but it's also really rewarding. And probably I also like working with other people so like working in a group environment.*

Thus, the value of IDR to researchers seems to be both beyond and beneath the university structure in scale. Participants did not mention the university in conjunction with reasons why IDR was valuable, only that the university was supportive of such endeavors.

What are perceived incentives and barriers to IDR at Ohio State?

Incentives

Incentives for IDR were very much related with the perceived value of IDR. Many participants described having felt "pushed" or "pulled" into IDR, rather than seeking out IDR as a first approach. One participant said:

> *I think, it's the only way I feel I can solve a lot of the types of questions I'm addressing. I work, at large, spatial scales, and on problems that are very complex and have multiple interactors and multiple drivers, so I do a lot of work at the ecosystem level. And…because of the complicated nature of the questions I'm asking, I need different perspectives and different tools to, to get it, to sort of answer the questions I need to answer.*

The most cited reason for doing IDR was the impact of such work. The researchers indicated that the impact of the applied research in solving societal problems was important to them and IDR was the "only way" to solve such large, complex issues. Many felt that they had, as researchers and scientists, to contribute knowledge to solve global problems.

> *The problems of the world are not isolated to one discipline at a time, we need to be working together, talking together, teaching students together. Because we're not going to solve the issues that are the most concerning to us if we don't.*

> *I think in this day and age to solve the kinds of societal problems that we want to solve, [IDR] almost mandatory, in a lot of cases.*

> *I think the big problems of today are ID problems. So we need to solve them using an ID approach.*

Again, the incentives for IDR tended to be unrelated to university support, but rather more closely

aligned with each researchers' personal interests and beliefs about the value of IDR.

When asked about personal benefits of IDR, the most frequent words mentioned were that IDR was "fun," "interesting," and "challenging." These three terms in particular turned up consistently across interviews, and were almost always mentioned together.

> *Its challenging and fun...Yeah I just find it more interesting than doing things that are more isolated and um, I think anyone who's in the school here or any sort of ID place, like that's why you're there. You're interested in solving big problems and you can't do that by looking at it with one kind of lens. You need to look at it in multiple ways and you need to make sure what you're doing informs other peoples work.*

Thus, most of the incentives mentioned did not actually stem from the university or external funding agencies, but rather came from the individual researchers themselves and their perceived value of IDR. Although some participants mentioned the opportunity of attracting new funding may encourage *others* to pursue IDR, none of the interviewed participants cited funding as a main reason why they personally conducted IDR. Thus, neither funding nor the university structure seems to be providing the tangible support needed to incentivize researchers who do not find their own reasons for IDR to conduct IDR. The incentives that exist are fairly personal.

Barriers

Participants were also asked to describe the types of barriers they faced in completing IDR. It is interesting to note that many of the barriers cited were projected onto other researchers in other departments rather than being noted as having a direct negative influence on their own work. This could indicate that these specific participants were more successful in avoiding these barriers or that the barriers themselves were perceived but not actually being experienced.

Most commonly identified barriers were either structural (relating to how credit might be received or IDR projects or publications could be advanced) or cultural (relating to less tangible things including difficulties communicating with scientists from other disciplines and not completing work that aligns with what one's discipline may view as "good" science). (Figure 3). This discussion also highlighted strong interconnections between these two types of barriers; participants noted how cultural barriers like attitudes could influence structural barriers like standards used in promotion and tenure evaluation.

Barriers were coded both generally (culture or structure) and specifically (i.e. evaluation or funding). General cultural barriers were cited 21 times across the interviews, while general structure was cited 17 times (Figure 3). Lack of credit/appreciation/reward for IDR, difficulties in tenure evaluation, and difficulties in publishing were the most commonly cited specific barriers. One participant describes cultural and structural components as follows:

> *There's the cultural component of the disciplines that are involved and then there's the university who does want ID both in the classroom and [in] the research...but are having a hard time doing it within the framework wasn't set up to be ID*

Lack of credit was cited 17 times by seven researchers. Difficulties in tenure and publishing were cited 17 and 15 times, respectively, by eight researchers. With regards to these potential barriers to completing IDR, one participant observed:

> *Disincentives would be tenure. And your personal research identity. So that's a big disincentive for people. They feel like…they're not going to be rewarded for it from a tenure perspective.*

Similarly, another cited certain departments as being restrictive in publishing expectations (e.g., expected journals where faculty would publish their findings) and noted:

> *If what you've viewed is only through the narrow prism of 'we want you to publish here' then it's a clear disincentive, you can't do other things.*

It is clear that departmental delineations are important in creating disincentives to engage in IDR, as described by Metzger & Zare (1999).
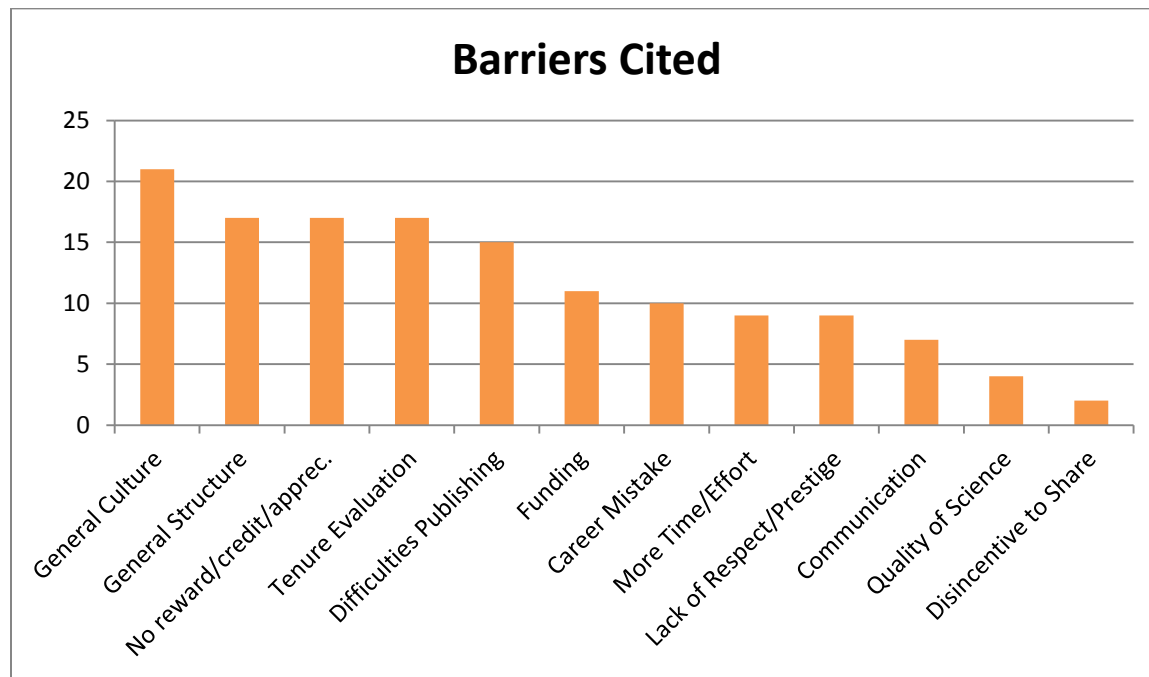

Figure 3: Barriers Cited of Conducting IDR

Concerns that IDR would be of inferior quality compared to disciplinary science were expressed by surprisingly few participants, countering one of Locker's (1994) points of concerns of ID researchers on producing poor quality science. Difficulty communicating with scientists from different disciplines was also cited surprisingly infrequently, only being mentioned 7 times. Participants indicated that communication challenges exist, but that a good rapport with team members was enough to overcome communication barriers, downplaying much of Campbell's findings in 2005 on differing languages between different disciplines.

Interestingly, although general culture was cited more often than general structure, of the specific barriers mentioned, most tended to be structural in nature. This could be due to specific cultural barriers being more difficult to describe. But another possibility is that cultural barriers play a more superficial role than structural barriers. One participant described these barriers as follows:

> So there's the cultural component of the disciplines that are involved, and then there's the university who does want ID both in the classroom and [in] the research, but are having a hard time doing it within the framework [that] wasn't set up to be ID

Participants generally saw the university structure as a system that was not built to systemically facilitate IDR, particularly with the organization of departments both financially and in terms of tenure and promotion. The history of departments and universities were seen to play a huge role in why specific departments were more or less supportive of IDR. Problem oriented or inherently interdisciplinary departments were seen as somewhat more supportive of IDR but this was not always the case.

The specific barriers cited by participants tended to be at the department level. Since tenure evaluations are primarily completed within departments, the culture and norms at this level had the power to greatly restrict IDR.

How are researchers dealing with barriers?

Once barriers were identified, we explored the ways that participants dealt with the barriers to conduct IDR. One of the first tactics used by participants was to convince superiors within their department of the value or IDR. A particular problem was in the authoring of publications. Some participants had to:

> educate some of my colleagues that the whole is greater than the sum of its parts. It's not like because there's two of us on there that my contribution is half a paper. Or you know that, something's possible that wouldn't be possible otherwise. So I think we've had to work in this department to educate some people of the value of IDR.

If working within the department structure was not fruitful, participants often found ways to work outside of their home departments.

One of most cited ways of maneuvering around departmental barriers was participation in problem oriented institutes or centers. The perception of success of these centers was rather mixed, but most saw this as a partial solution to many of the departmental barriers that researchers faced when trying to conduct IDR. Problem-based centers/institutes have been used as structures outside of departments that can provide the interstitial spaces for ID researchers to conduct IDR.

These centers often provided another piece that was seen as very important to facilitating IDR-- small seed grants. These seed grants allowed researchers to start a project, assemble a team, and apply for larger external grants, such as a CHANS grant from the NSF.

> The seed grants are the main thing, so seed grants so the little grants to get you started, that's one thing. And then there's different initiatives like the Food Innovation Center, Poverty

> *Center…and then we got our group, a little money for the Complex Systems group… And so they, what they do is, what the university does is they um, there are little competitions. The requirement is that you get people from multiple colleges from multiple departments and multiple disciplines. Uh and you get a little bit of money but then you activities started, so you have talks, workshops, seed grants. And those seed grants also have the conditions that it involve multiple departments. And um, that helps a lot. Of course all of the big, I get basically all my money from NSF, and those are the big, the big grants are ID grants. And so the seed grants at the university level help you prepare to get a grant in for the NSF for these ID projects.*

One last way that researchers conducted IDR without the support of their department is to participate regardless of departmental structure and culture. "I'm a senior person and I can kind of do what I want. Right?" was one participant's response. Other participants cited those they knew from other less supportive departments who decided to engage in IDR for their own reasons despite the contrary culture in their home unit. A participant interviewed described another researcher they knew who had ignored his department's wishes:

> *He actually had to be like 'sorry I'm going to do it anyways' and its worked out okay for him because he's very productive and very good at what he does, but for some people they never would have. One of the main reasons why he says he did it is, 'cause it was challenging and fun. Like he was kind of getting bored with doing his same old stuff. And he likes interacting with other people and thinking about things in different ways and being exposed to new ideas. Um, so that to him was enough of an incentive I guess to like ignore the warnings from his department and do it anyways.*

How is IDR encouraged or discouraged at different levels of administration?

Higher level administration has shown substantial verbal support, but from the perspective of our study participants, the support does not always translate to tangible help in the form of training, workshops, university funding, or amenable criteria used in promotion and tenure processes within departments. Despite the higher level administration support and call for IDR, it is the lower level administration that can act more as a roadblock via evaluation processes. Higher levels do not, in general, provide concrete support, whereas departments often create serious challenges to IDR. The tension between the different levels of administration causes some inconsistent messages to researchers looking to participate in IDR. With tenure and reward structures functioning mainly at the department level, most of the impact of encouragement or discouragement falls at this scale.

Most participants indicated that IDR has become increasingly accepted and supported over time. Although they often mentioned past or current struggles, participants tended to believe that IDR is gaining recognition and approval on average. There was wide consensus that IDR was desired at higher levels of OSU administration, such as at the university scale and above. President Gee's calls were often specifically mentioned as a proponent of IDR.

> *My perspective of Ohio State is that they…want to see IDR. Seems like most of the proposals that the seed grants they put out, make available they want to see, you know, cross-discipline*

> *collaboration. It's almost mandatory.*

> *I think the university has become more, um, explicit, in noting…they want to see IDR. That they, they value IDR. It's harder to make that happen. I mean it's a huge university. But I think the university has, especially since Gee has come in, has been clear in, in saying that IDR is important and that's part of I think, um, why you see the restructuring that Gee has been kind of pushing throughout the university to be more problem focused instead of discipline focused.*

However, the caveat mentioned along with the upper level support was the lack of either a) lower level support, b) implementation/facilitation for IDR, or c) more tangible (rather than verbal) support. There was skepticism in the success of the implementation of this support into concrete structures or programs that researchers could use. History again plays a role in this situation, as one participant points out:

> *I mean it seems like things are better than they've ever been at OSU but OSU's not been a very ID place is my understanding. That we don't have a tradition, unlike similar universities, or universities of similar stature. We don't have a large tradition of big ID centers we don't have a lot of forum for that. That is something they've really been working on the last six, seven years.*

Most of the barriers cited were more centrally controlled at the department level. Perceptions of a lack of credit/reward/appreciation as well as consideration of IDR in tenure evaluation are primarily fall under the jurisdiction of each department or college rather than higher level administration. Researchers cited "there is some tension at the lower levels, between the lower levels and the higher levels" of administration in terms of their support for IDR.

> *I think that sort of work gets a lot of lip service and people claim that it's valuable but there's a few a few points you know in one's research career where push comes to shove or where rubber meets the road or whatever the metaphor is you want use and those places are getting papers published in high impact journals and uh in your uh reappointment and promotion decisions.*

> *There's been no like training or you know, resources, or anything like that put into supporting it. Um, from the school or the university or anything. So again I think what draws people to it is…I think personality is a lot of, personal interest, um, the ability to communicate with others or the interest in doing that, um, and then if there's legitimate, good funding for it and people have the interest in doing it then they'll do it.*

This disconnect between the university support and the departmental barriers restricts more researchers from engaging in the IDR that institutions see as important. Although researchers recognize that Ohio State has made efforts towards building bridges between departments, removing barriers, and creating incentives, many researchers see that this is not enough to draw others into IDR. Many of researchers interviewed have been able to successfully navigate the bureaucracy and convince their superiors of the value of IDR, but it may be the case that they are a small minority.

What do researchers believe can or should be done to encourage IDR?

"We need courage, not money".—Participant

Despite the wide range of experiences, both positive and negative, all researchers indicated that IDR should have a place at research universities like Ohio State and are well aware of the advances in science via disciplinary avenues.

Participants generally did not personally see a need for more incentives. It seemed, for them, that the funding was available, the need was there, and the territory was yet uncharted. IDR seemed to be the only way for them, and one participant stated "I think the world is being pushed there for pragmatic and sort of scientific structural reasons." The reason that IDR was stifled was not the lack of incentives, but the presence of too many barriers (particularly promotional and financial) that were uneven across different departments.

> *I think some greater institutional structure and support, maybe greater you know recognition and value of it in terms of promotion and tenure. Again not necessarily, you know for me at the college level, but for the university as a whole, I think it's pretty uneven across campus. So I know of situations for example, in another department where someone had a hard time getting tenure because of doing IDR and it was just because her department didn't want to recognize some of the research.*

Thus, there are various ways in which the university can address these issues. All participants place substantial emphasis on scientific rigor, yet are very colored by their particular departmental or disciplinary experiences. Their opinions on how to encourage IDR (and how much) varies greatly. Among our participants, three main group emerged regarding their recommendations for what should be done to facilitate IDR at Ohio State.

The conservatives- These researchers believe they are currently well supported, and that the university is providing what is required to conduct IDR. They have been able to seek out the resources they need, such as seed grants and have managed to secure tenure, thus see a need for only limited change. Conservatives agree that the university is not structured with IDR in mind, but can serve the needs of IDR researchers nonetheless.

The reformists- Reformist researchers see the need for more substantial change to facilitate IDR. A reworking of the reward structure is seen as vital, and they advocate more support both administratively and financially. They see and appreciate certain measures to get around ID obstacles, such as the formation of centers that are outside of departments, but see this as insufficient. The inner workings of departments are of high concern to reformists.

The radicals- Radicals see IDR as a vital and necessary way forward. They consider the current university structure restrictive and believe that much greater change is necessary. This group tends to look at barriers to IDR on a larger scale than the others. They often see scientific disciplines as outdated. Radicals are not looking to abolish the university or dismantle departments, but look to work beyond departments.

One point of interest was that although top-down pressure from higher level administration to departments to support or encourage IDR would seem to be the easiest way to remove barriers to IDR, this was not suggested by participants. Participants seemed hesitant to suggest compromising the autonomy of departments, at least their own. And no matter how much issue a participant took

with the department structure, not one was supportive of abolishing it in favor of a different kind of organization. Departments allow researchers a certain amount of autonomy from the university and despite the frustration and anxiety they may cause from time to time, researchers tend to enjoy the freedom in the structure in some way.

In fact, many saw disciplines as essential to the interdisciplinary process as a tool for honing specific skills and training scientific thought. Researchers were not seeking abolition of disciplines, but rather some sort of compatibility between them. Duggan was spot on when she described disciplines as "the zombies of intellectual life right now—like capitalism, they keep coming back from devastating crisis and critique. We are encouraged to describe our work as interdisciplinary, multidisciplinary or transdisciplinary, so that the disciplines may survive alongside our critical practices, fundamentally informing them." (2012) Ohio State researchers are engaging in just this kind of zombie academics. The way forward may not be the destruction of departments or disciplines, but beginning to stitch them together for heterogeneous, yet interdisciplinary, work towards solving the societal problems researchers find important.

CONCLUSION:

Universities are currently in a contradictory position of encouraging a kind of research they were not built to facilitate. While the current university structure is not ideal for IDR, the successes achieved by participants here suggest IDR is still possible despite such structural challenges. Researchers feel that opportunities for research funding and department promotion and tenure criteria are the current largest barriers to IDR at the university. But several steps could be taken to evolve into institutions better suited for IDR both from the top and bottom of the university structure. Higher levels of administration must support IDR in more concrete terms and providing incentives to restructure tenure policies to more fully support ID collaboration. Departments also have structural and cultural mechanisms that provide disincentives to completing IDR, such as attitudes on article publication. Department leadership plays a large role in providing necessary support, but individual researchers must make their needs known.

It seems that researchers that have been successful in IDR have been in supportive departments or have been able to push their way through the disincentives of conducting IDR currently in place within their departments. With department culture and structure being cited as the main barriers to IDR, while also being a source of pride and strength of a discipline, departments are the battleground where IDR support must be fought for. Or rather, where barriers are to be eliminated. But a top-down approach is not necessarily the desired way to introduce this change. Provided that researchers are already maneuvering the current system and finding ways to change perceptions of IDR within their own departments, researchers themselves may be the most effective game-changers. As external funding and higher level administration are already publically in support of IDR and researchers make clear their needs from the bottom, department leadership may become more open to considering IDR in terms of reward, evaluation, and publication. As each department is already fairly autonomous from higher level administration, a grounding in researcher needs in facilitating IDR can be more productive coming from researchers themselves rather than higher level administration, such as the university president. It seems most appropriate to address incentives and barriers at the department level where individual units can do so on their own terms with their own

faculty in conjunction with more direct, tangible support for individual researchers from top levels in the form of strategic restructuring of tenure policy and problem-based centers. Higher level administration can provide researchers with the tools and support necessary to pressure unsupportive departments into reevaluating their reward structure and tenure policies to help remove barriers to IDR at Ohio State.

WORKS CITED:

Amacher, R. C., & Meiners, R. E. (2004). *Faulty towers: Tenure and the structure of higher education*. Oakland, Calif: Independent Institute.

About Michael M. Crow. Retrieved from <http://president.asu.edu/about/michaelcrow>

Babbie, E. R. (1992). *The Practice of Social Research*. Belmont, Calif: Wadsworth Pub. Co.

Campbell, L. M. (2005). Diversity: Overcoming obstacles to interdisciplinary research. *Conservation Biology, 19*(2), 574-577.

Dietz, T., Ostrom, E., & Stern, P. C. (2003). The struggle to govern the commons.(review). *Science, 302*(5652)

Discipline. (n.d.). Mirriam-Webster Online. Retrieved from http://www.merriam-webster.com/dictionary/discipline

Duggar, Lisa. (2012, April 12). Bullybloggers on Failure and the Future of Queer Studies. Retrieved from http://bullybloggers.wordpress.com/2012/04/02/bullybloggers-on-failure-and-the-future-of-queer-studies/

Ford, M. P. (2002). *Beyond the modern university: Toward a constructive postmodern university*. Westport, Conn: Praeger.

Fox, I. K., & Rohlich, G. A. (1968). Interdisciplinary research in environmental sciences. *Journal (Water Pollution Control Federation), 40*(3), 395-398.

Krishnan, A.(2009, January). What are Academic Disciplines? Some observations on the Disciplinarity vs. Interdisciplinarity debate. *ESRC National Centre for Research Methods NCRM Working Paper Series*). Retrieved from http://www.forschungsnetzwerk.at/downloadpub/what_are_academic_disciplines2009.pdf

Liu J, Dietz T, Carpenter SR, Alberti M, Folke C, Moran E, et al. (2007). Complexity of coupled human and natural systems. *Science (New York, N.Y.), 317*(5844), 1513-6.

Liu, J., Dietz, T., Carpenter, S. R., Folke, C., Alberti, M., Redman, C. L., et al. (2007). Coupled human and natural systems. *Ambi AMBIO: A Journal of the Human Environment, 36*(8), 639-649.

Locker, K. O. (1994). The challenge of interdisciplinary research. *Journal of Business Communication, 31*(2), 137-51.

Metzger, N., & Zare, R. N. (1999). Interdisciplinary research: From belief to reality. *Science, 283*(5402)

Monticino, M., Acevedo, M., Callicott, B., Cogdill, T., & Lindquist, C. (2007). Coupled human and natural systems: A multi-agent-based approach. *Environmental Modelling & Software, 22*(5)

Pickett, S. T. A., Cadenasso, M. L., & Grove, J. M. (2005). Biocomplexity in coupled natural-human systems: A multidimensional framework. *Ecosystems, 8*(3), 225-232.

Redclift, M., & Sage, C. (1998). Global environmental change and global inequality. *International Sociology, 13*(4), 499-516.

Strauss, A. L. (1987). *Qualitative analysis for social scientists*. Cambridge [Cambridgeshire: Cambridge University Press.

Vescovi, J. (2010). E. Gordon Gee: Tied to Education. *Columbia Law School Magazine*. Retrieved from
http://www.law.columbia.edu/magazine/41324

Walsh S.J., & McGinnis D. (2008). Biocomplexity in coupled human-natural systems: The study of population and environment interactions. *Geoforum Geoforum, 39*(2), 773-775.

Yin, R. K. (2009). *Case study research: Design and methods*. Los Angeles, Calif: Sage Publications

APPENDIX:

1. Expert Interview/Consent Script

Thank you for participating in this project. As a reminder, the goal of this interview is to get a better understanding of your experience working in interdisciplinary research projects, **and your involvement in Coupled Human and Natural Systems research.**
There are no right or wrong answers; I am interested in your ideas. This is meant to be informal, but I do have a list of questions that I need to ask each participant. If you feel like I am asking something you have already addressed, please do not hesitate to tell me to move on or to say that you have nothing additional to contribute.
In addition, your participation in this interview process is confidential and voluntary. Your personally identifiable information will not be associated with your responses, and this information that we used to contact you will only be held by The Ohio State University for the duration of this project as part of our project records and then destroyed upon completion of the project. You may quit the interview at any time and/or decline to answer any question. This decision to discontinue participation will involve no penalty to you.
Do you have any questions?
We would like to audio tape these conversations to ensure accurate recall of your responses. These tapes will be used only for this project and will not be accessed by anyone other than the primary researchers. Do we have permission to audio tape these conversations? *[If yes, begin recording.]*
Please indicate that you understand the purpose of this research and that you are a willing participant in this project by answering "yes".
[For purposes of tracking the interviewer should then state their name, the date, location of the interview, start time and interviewee number – that information as well as any additional information below should be filled in].

Interviewee #:
Interviewer:
Location:
Start time: **End time:**
Date:
Interviewee name:
Interviewee position:

Interview Questions:
1. To get started, can you please describe educational background?
   a. Where did you receive your degrees?

   b. What was your area of emphasis?

2. Now can you describe your current position?
   a. What percentage of your effort is focused on research?
   b. How about teaching?
   c. Do you have any other responsibilities that require a significant portion of your time?

3. Can you describe the kind of research you do? Is it disciplinary or interdisciplinary?

4. There has been a lot of discussion lately about interdisciplinary research. In your own words, can you describe what interdisciplinary means?

5. Recently discussion has increased regarding interdisciplinary research. What are some of the terms you've heard used to describe this type of research?

   a. What about Coupled Human and Natural Systems research. What does this term mean to you?

   b. How is similar or different as interdisciplinary research?

   c. Do you partake in this kind of research?

   d. Has your concept of this type of research changed over the course of your career to date? How so?

6. Can you describe your involvement in interdisciplinary / CHANS research?

   a. What percentage of your research is interdisciplinary/CHANS?

   b. How long have you been involved in interdisciplinary research?

   c. How did you get involved in interdisciplinary research? Why?

   d. How long have you been involved in your NSF funded-CHANS research?

   e. How did you get involved in this project?

7. What motivates you to complete interdisciplinary research?

8. What do you think about the value of interdisciplinary research?

   a. What are some benefits of interdisciplinary research to **scientific advancement**?

   b. What are some benefits of interdisciplinary research to **you personally**?

   c. What are some benefits of interdisciplinary research **to society**?
9. How do you think interdisciplinary research is viewed by others within your field?

a. How about by others within the university?

b. And what about within your department? Specifically, is it viewed positively in regards to promotion and tenure?

c. Have you noticed any changes in how interdisciplinary research is viewed over time?

10. There has been some discussion about encouraging researchers to participate in interdisciplinary research. What are some incentives or other ways that interdisciplinary research has been encouraged?

a. Has your department done anything to encourage or provide incentives for interdisciplinary research?

b. How about within OSU?

c. Have funded agencies provided any encouragement or incentives? If YES, how so?

d. Are any additional incentives needed? If YES, what incentives would you suggest?

11. What are some specific disincentives or challenges to completing interdisciplinary research?
a. Disincentives:

b. Challenges:

12. How have these disincentives / challenges changed over the course of your career?

For these final questions, I would like you to think about one of your current interdisciplinary (CHANS) projects.

13. Can you describe the process of how this project came together?

14. How you characterize the interactions you have with researchers in different disciplines?

15. How do you address challenges with the different terminologies used by different disciplines included in your project?

16. How do you address challenges with the different methodologies used by the different disciplines included in your project?

17. Based on this current CHANS experience, would you do additional CHANS projects in the future? Why or why not?

18. Do you have any advice for others who are considering beginning CHANS research?

Closing
You have been very helpful and I appreciate the time you spent talking to me today.   Before we finish, is there anything further that you would like to add?
Great, I would like to thank you once again for sharing your knowledge and expertise on this topic with me.   Your thoughts and ideas will be useful in understanding the attitudes of researchers on interdisciplinary collaboration. Your responses will be used to develop a survey to be administered in the future. Thank you for your time.

2. Coding Structure

I. Background of researcher
   a. ID training
   b. Personality
   c. Demographic information
II. Barriers: (personal or observed)
   a. Disincentive to share information
      i. Due to stealing
      ii. other
   b. Difficulties in funding administration
      i. Between departments
      ii. Between universities
   c. Difficulties in publishing
   d. Communication line barriers
   e. Career mistake

- f. No or not enough reward or credit
- g. No appreciation
- h. Extra time and work
- i. Lack of respect for IDR
- j. Hard to evaluate

III. Factors for Success
- a. Particular team dynamics
- b. Clear communication
- c. Centers/Institutes

IV. Trends
- a. Increase in acceptance
- b. Higher level support
- c. Lower level inconsistency in support
- d. More support

V. Disciplinary Nature of departments
- a. Inherently ID disciplines/departments
- b. Historical ID ties to other disciplines/departments
- c. Problem based discipline/department

VI. Incentives
- a. Challenging
- b. Fun
- c. Applied to real world problems